REPUBLIC OF KENYA

LEARNING GUIDE

FOR

AGRICULTURAL EXTENSION

LEVEL 6

TVET CDACC
P.O BOX 15745-00100
NAIROBI

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FOREWORD

The provision of quality education and training is fundamental to the Government's overall strategy for social-economic development. Quality education and training will contribute to achievement of Kenya's development blue print and Sustainable Development Goals (SDGs). This can only be addressed if the current skill gap in the world of work is critically taken into consideration.

Reforms in the education sector are necessary for the achievement of Kenya Vision 2030 and meeting the provisions of the Constitution of Kenya 2010. The education sector has to be aligned to the Constitution and this has triggered the formulation of the Policy Framework for Reforming Education and Training (Sessional Paper No. 4 of 2016). A key provision of this policy is the radical change in the design and delivery of the TVET training which is the key to unlocking the country's potential in industrialization. This policy document requires that training in TVET be Competency Based, Curriculum development be industry led, certification be based on demonstration and mastery of competence and mode of delivery that allows for multiple entries and exit in TVET programs.

These reforms demand that industry takes a leading role in TVET curriculum development to ensure that the curriculum addresses and responds to its competence needs. The learning guide in Agricultural Extension enhances a harmonized delivery of the competency-based curriculum for Agricultural Extension Level 6. It is my conviction that this learning guide will play a critical role towards supporting the development of competent human resource for the Agricultural Extension sector's growth and sustainable developments.

PRINCIPAL SECRETARY, TECHNICAL AND VOCATIONAL TRAINING
MINISTRY OF EDUCATION

PREFACE

Kenya Vision 2030 is anticipated to transform the country into a newly industrializing; "middle-income country providing a high-quality life to all its citizens by the year 2030". The Sustainable Development Goals (SDGs) further affirm that the manufacturing sector is an important driver to economic development. The SDGs number 9, which focuses on building resilient infrastructures, promoting sustainable industrialization and innovation can only be attained if the curriculum focuses on skill acquisition and mastery. Kenya intends to create a globally competitive and adaptive human resource base, to meet the requirements of a rapidly industrializing economy through life-long education and training.

TVET has a responsibility of facilitating the process of inculcating knowledge, skills and attitudes necessary for catapulting the nation to a globally competitive country, hence the paradigm shift to embrace Competency Based Education and Training (CBET). The Technical and Vocational Education and Training Act No. 29 of 2013 and the Sessional Paper No. 4 of 2016 on Reforming Education and Training in Kenya, emphasized the need to reform curriculum development, assessment and certification to respond to the unique needs of the industry. This called for shift to CBET to address the mismatch between skills acquired through training and skills needed by the industry as well as to increase the global competitiveness of Kenyan labor force.

The TVET Curriculum Development, Assessment and Certification Council (TVET CDACC), in conjunction with industry/sector developed the Occupational Standards which was the basis of developing competency-based curriculum and assessment of an individual for competence certification for Agricultural Extension level 6. The learning guide is geared towards promoting efficiency in delivery of the curriculum.

The learning guide is designed and organized with clear and interactive learning activities for each learning outcome of a unit of competency. The guide further provides information sheet, self-assessment tools, equipment, supplies, materials and references. I am grateful to the Council Members, Council Secretariat, Agricultural Extension experts and all those who participated in the development of this learning guide.

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CHAIRMAN, TVET CDACC

ACKNOWLEDGEMENT
This learning guide has been designed to support and enhance uniformity, standardization and coherence in implementing TVET Competency Based Education and training in Kenya. In developing the learning guide, significant involvement and support was received from various organizations.

I recognize with appreciation the critical role of the participants drawn from technical training institutes, universities, private sector and consultants in ensuring that this learning guide is in-line with the competencies required by the industry as stipulated in the occupational standards and curriculum. I also thank all stakeholders in the Agricultural Extension sector for their valuable input and all those who participated in the process of developing this learning guide.

I am convinced that this learning guide will go a long way in ensuring that workers in Agricultural Extension sector acquire competencies that will enable them to perform their work more efficiently and make them enjoy competitive advantage in the world of work.

DR. LAWRENCE GUANTAI M'ITONGA, PhD
COUNCIL SECRETARY/CEO
TVET CDACC

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ACRONYMS

AIRC	Agricultural Information Resource Center
AIS	Agricultural Innovation Systems
AKIS	Agricultural Knowledge Information Systems
ASAL	Arid and Semi-Arid Lands
BC	Basic Competency
CBET	Competency Based Education and Training
CAN	Calcium Ammonium Nitrate
CC	Core Competency
CDACC	Curriculum Development, Assessment and Certification Council
CO	Common Units
CU	Curriculum
DACUM	Developing A Curriculum
DEM	Department of Environmental Management
DPA	Diammonium Phosphate
ESPs	Extension Service Providers
FFS	Farmers Field School
FIFO	First in First Out
ICT	Information Communication Technology
IPR	Intellectual Properties Rights
KALRO	Kenya Agricultural and Research Organization
KCSE	Kenya Certificate of Secondary Education
LPM	Livestock Production and Management
MDAs	Ministries, Departments and Agencies
NPK	Nitrogen Phosphorous Potassium
OS	Occupational Standard
OSHA	Occupational Safety and Health Standards
PPE	Personal Protective Equipment
pH	Hydrogen Concentration ions
QMS	Quality Management System
SOP	Standard Operating Procedures
SSAC	Sector Skills Advisory Committee
SWOT	Strength Weaknesses Opportunities and Threats
SWC	Soil and Water Conservation
TVET	Technical and Vocational Education and Training
TOT	Transfer of Technology

CHAPTER 1: INTRODUCTION

1.1. Background Information

This learning guide has been developed in line with the functions of TVET CDACC as stipulated in Article 45 (1a) of the Technical and Vocational Education and Training (TVET) Act No. 29 of 2013 and the Sessional Paper No. 2 of 2015 that embraces Competency Based Education and Training (CBET) system. It is therefore, the sole intent of this document to provide guidelines for a Competency-Based Agricultural Extension curriculum for level 6.

Agricultural Extension level six qualification consists of: competencies that a person must achieve to apply agricultural extension and rural sociology, produce conventional and non-conventional livestock, manage soil and water resources, formulate livestock feeds, process farm products, protect crop, produce horticultural crop and manage farm. Extension and advisory services play important role in agricultural development through delivery of knowledge, technologies and innovations. It links agricultural producers to other factors in the agricultural products value chains and economy. The services are critical in transformation of subsistence farming to commercial agriculture, promoting house hold food security and improving incomes.

This learning guide consists of interactive learning activities, content, further reading, self assessment, relevant and related references that enhance implemention of Agricultural Extension Level 6 qualification. It enables the trainee to acquire the competencies that enables him/her to undertake the various processes in Agricultural Extension. The guide further provides illustrations, web links, case studies, examples and resources on how to implement all the learning outcomes/elements described in the Curriculum and Occupational Standards with a particular focus on the trainee.

1.2. The Purpose of Developing the Learning Guide

Agricultural Extension Level 6 curriculum development process was initiated using the DACUM methodology where jobs/occupations were identified. Further, job analysis charts and occupational standards were generated in collaboration with the industry players under the guidance of TVET and CDACC (Curriculum Development Assessment and Certification Council). The result of the process was Agricultural Extension Level 6 Occupational Standard (OS) and Curriculum. The Curriculum was further broken down into units of learning. To effectively implement Agricultural Extension Level 6 Occupational standard and Curriculum, learning guides are required to provide training content, guide the learners and trainers on the learning process aimed at impacting the relevant knowledge, requisite skills and the right work behaviour/attitude to the industry. Learning guides are part of the training materials.

1.3. Layout of the Trainee Guide

The learning guide is organized in chapters. Chapter one presents the background information and purpose of developing the trainee guide. Each of the units of learning/unit of competency is presented as a chapter on its own. Each chapter presents the introduction of the unit of learning/unit of competency, performance standard and list of the learning outcome/elements in the occupational standards.

Learning Activities

For each learning outcome, the learning activities are presented by covering the performance criteria statements and trainee's demonstration of knowledge in relation to the range in the occupational standard and content in the curriculum.

Information Sheet

The information sheet is a section under each learning outcome that provides the subject matter in relation to definition of key terms, methods, processes/ procedures/ guidelines, content, illustrations (photographs, pictures, video, charts, plans, digital content, and simulation) and case studies.

Self-Assessment

Self-assessment is linked to the performance criteria, required knowledge, skills and the range as stated in the occupational standards. This section further provides questions and assignments in which trainees demonstrate that they have acquired the required competences and an opportunity to reflect on what they have acquired. It is expected that the trainer keeps a record of their plans, their progress and the problems they encountered which will go in trainee's portfolio. A portfolio assessment consists of a selection of evidence that meets the pre-defined requirements of complexity, authenticity and reliability. The portfolio starts at the beginning of the training and will be the evidence for the development and acquisition of the competence (summative and formative) by the trainee. It is important to note that Portfolio assessment is highly emphasized in the learning guide.

Finally, the guide presents tools, equipment, supplies and materials for each learning outcome as guided by the performance criteria in the occupational standards and content in the curriculum. References, relevant links and addendums are provided for further study. The units of competency comprising this qualification include the following common and core units of learning:

Core Units of Learning

Summary of Core Units of Competencies

Table 1: Summary of Core Units of Competencies

Unit of Learning Code	Unit of Learning Title	Duration in Hours	Credit Factors
AGR/CU/EXT/CC/01/6	Agricultural extension and rural sociology	180	18
AGR/CU/EXT/CR/01/6	Conventional and non-conventional livestock production	170	17
AGR/CU/EXT/CR/02/6	Soil and water resources management	190	19
AGR/CU/EXT/CCR/03/6	Livestock feeds formulation	180	18
AGR/CU/EXT/CR/04/6	Farm products processing	210	21
AGR/CU/EXT/CR/05/6	Crop Protection	220	22
AGR/CU/EXT/CR/06/6	Horticultural crop production	200	20
AGR/CU/EXT/CR/07/6	Manage farm	150	15
	Industrial attachment	480	48

CHAPTER 2: APPLY AGRICULTURAL EXTENSION AND RURAL SOCIOLOGY/ APPLYING AGRICULTURAL EXTENSION AND RURAL SOCIOLOGY

2.1 Introduction

This unit specifies competencies required to understand agricultural extension and rural sociology. It involves understanding of paradigm shift, Government procedures, rural sociology, farmers' training and visits. The significance of studying agricultural extension and rural sociology is that it changes the behavior of farmers as desired therefore, provides knowledge and understanding about the farmer as compared to rural social system.

The critical aspects of competency to be covered include: demonstration and understanding of paradigm extension, Government procedures, rural sociology and understanding of farmers training and visits. The basic resources required for this particular unit include: Textbooks, notebooks, flipcharts, projector, computers, manuals, whiteboards, masking tapes and font pens.

The unit of competency covers four learning outcomes. Each of the learning outcome presents; learning activities that covers performance criteria statements, thus creating trainee's an opportunity to demonstrate knowledge and skills in the occupational standards and content in curriculum. Information sheet provides; definition of key terms, content and illustration to guide in training. The competency may be assessed through written test, demonstration, practical assignment, interview/oral questioning and case study. Self assessment is provided at the end of each learning outcome. Holistic assessment with other units relevant to the industry sector workplace and job role is recommended.

2.2 Performance Standard

Demonstrate understanding of paradigm extension, government procedures, rural sociology and farmers training and visits as per farmers requirement, government objectives and guidelines, community and farmer's needs.

2.3 Learning Outcomes

2.3.1 List of Learning Outcome

a) Demonstrate understanding of paradigm extension
b) Demonstrate understanding of government procedures
c) Demonstrate understanding of rural sociology
d) Demonstrate understanding of farmers training and visits

2.3.2 Learning Outcome No 1: Demonstrate understanding of paradigm extension

2.3.2.1 Learning Activities

Learning Outcome No 1: Demonstrate understanding of paradigm extension	
Learning Activities	**Special Instructions**
1.1. Transfer Agricultural technologies to farmers as per technological invention. 1.2. Advice farmers on technology as per the farmers requirement 1.3. Train farmers as per human resource development plan 1.4. Fund of the farmers activities as per government policy	Discussion on how technology is helpful Having a meeting to train farmers- field

2.3.2.2 Information Sheet No2/LO1: Demonstrate understanding of paradigm extension

Introduction

This learning outcome covers; paradigm approaches such as technology transfer, advisory service, human resource development, facilitation for empowerment.

Definition of key terms

Technology transfer: This is the process of transferring technology from one person to another.

Paradigm: A distinct set of concepts or a thought patterns, including theories, research methods and standards of what constitute to legitimate contribution to the field.

Content/Procedures/Methods/Illustrations

1.1. Agricultural technologies are transferred to farmers as per technological invention

Technology transfers is an integral part of the extension process involving transfer and spread of technical innovation and know how to farming population.

The transfer of technology (TOT) model of research -extension -farmer linkage is based on the tenants of DOI theory. In particular on a description of the diffusion process as a normal bell-shaped curve with farmers being in one of the five categories according to their appearance on the curve.

The process of transferring agricultural technology

Agricultural extension is aimed at transferring agricultural technology and persuading farmers to adopt and use these technologies on their farms because farmers need the new technology to increase on their agricultural production.

The agricultural technologies to be transferred to the farmers must be good and superior to the old agricultural techniques used by farmers in order to be adopted.

Process of agricultural technology transfer is done through two basic stages: i.e.

i. Transfer and dissemination of agricultural technology to the farmers.
ii. Convince farmers to adopt this technology in their farms.

Agricultural Extensions are usually recommended experts who have practical experience in the dissemination of agricultural technologies and knowhow to deal with farmers. The process can be defined as the transfer of technologies integrating and interconnecting a series of sub-process.

i. A transfer or delivery of the new technology from the source to the target area.
ii. A process of localization of technology which is intended to make the technical shift with the environmental conditions in the target area and if it is compatible with the prevailing agricultural systems in the region.
iii. Persuading farmers to adopt new technology.
iv. Enabling the targeted farmers to apply the technology in their farms by giving the knowledge and skill required.
v. The provision of technical application requirements.
vi. A diagnosis and treatment of problems that may arise during the application and dissemination of the new technology.

The transfer of agricultural technology to farmers

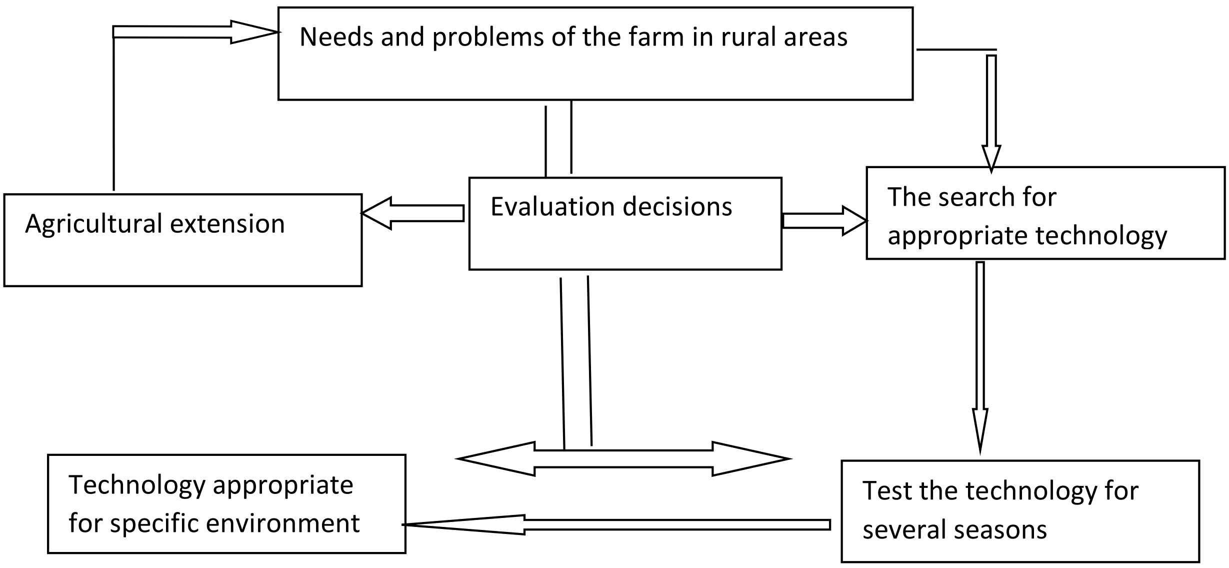

Figure 1. Farmers are advised on technology as per the farmers requirement

After the transfer of agricultural technologies to farmers based on their needs for the techniques, it is necessary to convince them to adopt these new techniques. Adoption is a mental process which consists of several stages and relates to the farmers decision to accept or reject a particular technique.

Stages in adoption

a. **Stage of knowledge:** At knowledge stage the farmer will receive the information about the new technology because farmers tend to adopt these technologies that are compatible with their needs for agricultural techniques.
b. **Stage of persuasion**: After the farmer gets sufficiently familiar with the new agricultural knowledge, a stage of persuasion starts. This stage involves analysis and evaluation of the available information on the technology. If the results are positive, the farmer will adopt the technology and will first use it in small scale and later on expand the application but if the result is negative, the farmer will reject.
c. **Stage of decision**: At this stage which means an individual's choice to adopt or reject the new idea, if the technology is not useful to a farmer, he/she will reject but if it is useful, he/she will adopt.
d. **Stage of confirmation**: At this stage of confirmation knowing that the decision is not the end of the adoption process, an individual try to verify the choice he has made and obtain information whether it was a good decision.
e. **Stage of consequences:** According to information obtained by the individual in the previous four stages in the individual phase of consequences he will make decision on whether to adopt the agricultural techniques for good or no

N/B: Not all farmers are equal in the adoption of agricultural technologies.

Categories of farmers adopters for modern agricultural techniques

The adopters are divided into five categories.

1. **Early adopters:** Constitutes of 13.5% of the group so they are an integral part of the society system. They usually depend on the opinion of the leader in most cases.
2. **Early majority:** Amounts to 34% of the individual adopters of new technology in the social system
3. **Late majority:** They constitute of about 34% of the social system. Members of these categories adopt agricultural idea after they have been adopted by the members at the social system in order to get the best benefits.
4. **Laggards/ late adopters**: Constitutes ration 16% of the members of the social system. They accept agricultural technologies slowly because they are worried and fear for new agricultural techniques and ideas.
5. **Adventurers**: They constitute ration 2.5% of individual adopters at the idea of social system. They are very eager to experiment new idea

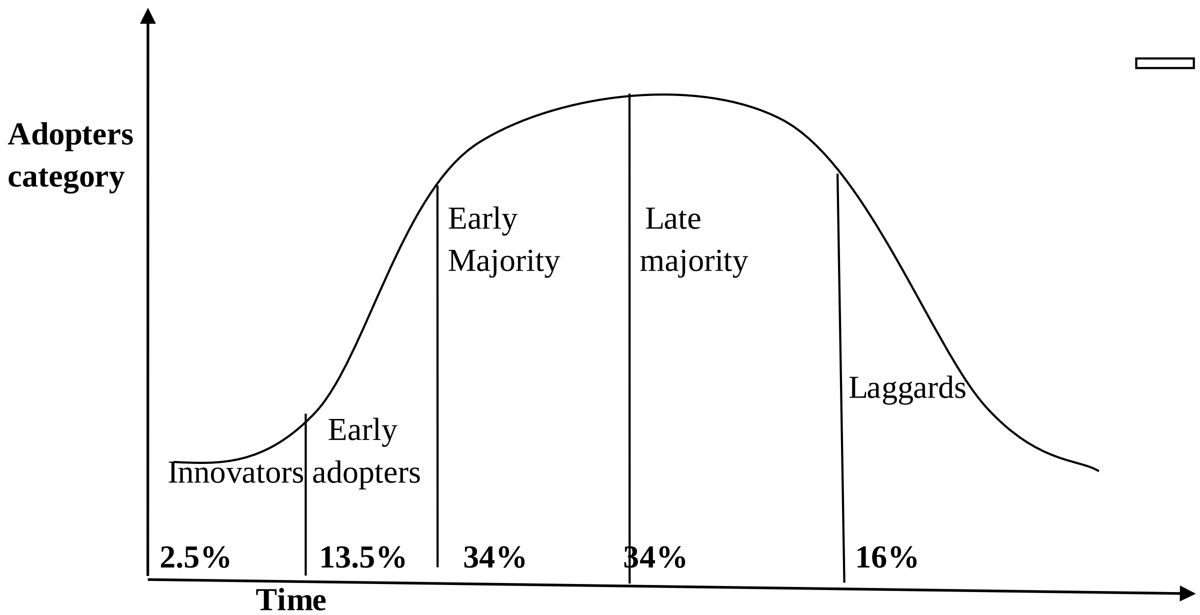

Figure 2. Adopters Categories

After the extension officer has disseminated the new technology to the farmers and has known the adopters of the technology, he/she will go on and advice the farmer depending on the requirement at the farm. The advice mostly given to the farmers includes characteristics such as on the use, what is required to be done when using the technology in order to improve on productivity, effect of the technology when used inappropriately either to the environment or individual, operation and maintenance of the techniques among others.

1.2. Farmers are trained as per human resource development plan

Training is an organized activity aimed at imparting information, improving on the recipient's performance or to help him acquire knowledge and skill about something.

Farmers are usually trained on some new innovations and ideas in order to increase on agricultural knowledge thus increasing on agricultural production.

Farmers are also trained in order for them to improve on their ways of farming to modern so as to increase productivity.

Methods used to train farmers

These are ways used to create situation in which information can pass freely between the extension worker and the farming community.

They are the methods of extending new knowledge and skills to the rural people by drawing their attention towards them, arousing their interests and helping them to have a successful experience of the new practice.

Conditions necessary for effective use of teaching methods include;

- Learning situation
- Learning objectives
- Learning experiences
- Use of a variety of teaching methods

Learning situation: Comprises of the extension clear objectives, knows the subject matter to be taught and is able to communicate freely with the farmers. The learning situation also includes the people who are capable and interested in learning and the subject matter which must be pertinent to farmers needs which is taught at people's intellectual levels.

Essential elements from effective learning situation

- An instructor
- Learners
- Subject matter
- Training material
- Physical facilities

Extension methods may be classified into three categories.

- Individual methods
- Group methods
- Mass methods

1. Individual methods

These are used in extension training in recognition to the fact that learning is an individual process and that the personal influence of the extension worker is an important factor in securing people's participation in extension activities. The various methods which come under the classification of individual methods include farm and home visits, office calla, telephone call, personal letter, informal contracts and result demonstration.

Farm and home visits

This is essential element of extension education.

They provide a means of personal communication between the farm family and the extension officer in an environment where they can discuss matter of common interests in privacy and without distractions and interruptions commonly experienced in group extension activities.

Purposes of farm and home visits

a) To acquaint extension worker with the farmers and the family.
b) To answer specific requests for help.
c) To gain firsthand knowledge on problems faces by farmers.
d) To explain a recommended practice.
e) To plan an activity such as demonstration.
f) To invite the farmer to participate in the planned activity.
g) To discuss policies and programs.
h) To recruit train, encourage a local volunteer leader.

Office calls: They are made by farmers for the purposes of satisfying a felt need. They are an expression of interests by the farmer in a need which he/she hopes the extension worker can help him/her meet. Office calls provides the extension worker with knowledges of needs of the farming community.

Telephone calls: Are mitigated by either the farmer or the extension officer. They are useful in giving specific information relating to the treatment of known diseases, control of insects, pest or to answer questions on interesting broad categories.

Personal letters: Are useful in answering requests for information as follow-up after visits and offices calls and in contracting local volunteer leaders.

Result demonstration: Is a method of teaching designed to show by example the practical application of an established fact or group of facts. This shows after a period of time what happened after a practice is adopted.

Advantages of result demonstration.

- Furnishes local proof of the desirability of adopting a recommended practice.
- Is an essential method of introducing of a new subject.
- Appeals to the eye and reaches the "show me" individuals.
- Provide good source of information for meeting new items.
- Furnishes cost data and other basic information.

Disadvantages

- Requires large amount of time.
- The cost is high per practice change. Teaching value is frequently destroyed by unfavorable conditions**.**

2. Group extension teaching method.

Group method take into account the inclination of individual to respond to the pressures and opinions of the groups in which he participates and listen to the views of other before arriving to a decision about making changes in his farming operations.
Group method includes; general meetings, group discussion, exhibitions, tours and field trips, method demonstration, extension schools and farmer training.

Group meetings

Includes all kind of meetings held by the extension worker except demonstration meetings. The method of conducting the meetings may be lectures, discussion, showing of slides and motion pictures or any combination of these. Towards the end of the meeting the extension worker should allow for questions and answers in order to clarify specific ideas.

General types of meetings involved in extension work

a. **Organizational meetings:** Includes board of directors meeting, youth clubs.
b. **Planning meetings:** Requires preparation of a large amount of situation materials.
c. **Special interest meetings:** Are engaged to serve the educational needs of groups within common interests.
d. **Training meetings**
e. **Community meetings**

3. Mass methods

Individual and group methods cannot reach everyone who wants and needs information so mass methods which have wide coverage such as radio, television, cinema van and public address are used.

Forms of extension training methods.

The extension teaching methods can be classified according to forms such as written, spoken and audio visual.

Important methods under each of these three categories are:

Table 2: Extension training methods

Written	Spoken	Objective or visual
Bulletings Leaflets Articles Personal letters Circular letters	General meetings Farm and home visits Office calls Telephone calls	Result demonstration Demonstration posters Motion pictures or movies chart

Selecting and using teaching materials.

For an effective use of extension teaching method, it is not enough to know these methods and their techniques. What is more important is the appropriate selection of a method for a particular situation.

Farmers learn about the new practices through several stages. The stages are:

a. **Awareness stage:** When a person comes to know of a new practice but lacks the complete idea.
b. **The interest stage:** When the farmer becomes interested in a new idea and wants to know more about it.
c. **The evaluation stage:** When the farmer mentally applies the new idea to his present situation and evaluates it.
d. **The trial stage:** When he applies the new idea on a small scale in order to determine its utility under his own situation.
e. **Adoption stage:** When he decides to continue. The full use of the practice.

1.3. Farmers activities are funded as per government policy

Funding: The provision of financial resources to farmers.

- Access to finance is critical for the growth in agricultural sector.
- Agriculture is a very unique enterprise requiring money to purchase equipment and materials, initiate projects in an area, purchase teaching materials.
- It is impossible to teach agriculture as an extension officer without funding.

Why extension activities need to be funded

1. For transport purposes in order to reach the target group.
2. To be able to purchase the agricultural demonstration materials for farmers to be able to have a practical knowledge about the new technology for easy and faster adoption

.

Sources of Funding for Extension Activities

i. Government budget

Government disburses money to the agricultural sector every financial year. This money can be given to extension officers in various sub sectors where there is need of improved agricultural knowledge for them to go and educate the farmers on new farming methods and technologies that when used appropriately can lead to increased productivity thus the economy of a country is also boosted.

ii. Grants

Most agricultural activities that are carried out are supported by grants from NGOs and other project developers.

iii. Research institutions

Research institutions for agriculture fund extension officers to carry out extension services in their areas of interests in order to come up with solutions of the problems of the farmers in terms of new technology.

iv. Organizations

Organization dealing with agriculture are greater sources of funds to most agricultural related organizations.

They provide funds to extension activities in order to come up with valid ways of boosting agriculture in the world so as to have food security in the countries affected by law food supply.

v. Local farmers

Local farmers can also fund extension activities when they need to have a clear knowledge about something especially new innovations that may boost their productivity thus profitability.

vi. Donations

Other agricultural related organizations in an area can donate funds to the extension officer to enable them carry out extension activities on a particular area of interests so that they can persuade the farmers to adopt what they have to offer to them for a win situation.

vii. Bank loans

Farmers may borrow loans from the banks by use of security e.g. tittle deed in order to get finances to venture into production agricultural activities.

viii. Family and friends

Extension activities can be funded by family and friends who have accepted that what you are doing will be beneficial at long last.

Conclusion

This learning outcome covered on paradigm approaches such as technology transfer, advisory service, human resource development and facilitation for empowerment as used in agricultural extension and sociology.

Further Reading

1. Abrew S.de (2003) Uganda: Promotion and strengthening of sustainable farmer group and associations, FAO/TCP/UGA/2904(T). FAO

2.3.2.3 Self-Assessment

Written assessment

1. Agricultural technologies transferred to farms must be ________and_________ to old Agricultural techniques.
    a) Good and superior
    b) Compatible
    c) Resemble

2. Process of agricultural technology transfer is done through two basic stages which one is not?
    a) Transfer and dissemination of agricultural technology to the farmer
    b) Adoption of new technology by the farmer
    c) Demonstration of how the new technology is used
3. The following are stages of adoption. Which one is not?
    a) Stage of knowledge
    b) Stage of confirmation
    c) Stage of rejection
    d) Stage of decision
4. Stage of precaution involves analysis and _____________ of the available information on the technology.
    a) Monitoring
    b) Evaluation
    c) Picking
5. People who are eager to adopt new technologies ideas are known as
    a) Laggards
    b) Investors
    c) Earl majority
    d) Adventures
6. The following are conditions for effective teaching methods apart from.
    a) Learning situation
    b) Learning experiences
    c) Learning objectives
    d) Teachers experience
7. Extension method can be classified into ________________groups.
8. __________________methods are used in extension training in recognition to the fact that learning is an individual process.
9. Methods that come under individual methods includes.
10. State two purposes of farm and home visits.
11. General types of group meetings involved in extension work include.

Oral Assessment

1. Discuss selecting and using of teaching materials.
2. Explain different types of funding of extension activities.

Case Study Assessment

You are an extension officer of a particular area and you have a duty to disseminate a new technological information to the farmers in the area. Which methods of teaching will you use to pass information to a number of people in order for the adoption to be carried out on time?

Practical Assessment

1. Carry out extension teaching to farmers around your area on the following areas.
    a) Crop production practices
    b) Good livestock production activities
    c) Use of knowledge on teaching methods in agricultural extension.

2.3.2.4 Tools, Equipment, Supplies and Materials

- Textbooks
- Notebooks
- Flipcharts
- Projector
- Computers
- Manuals
- whiteboards
- Masking tapes
- Felt pens

2.3.2.5 References

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2.3.3 Learning Outcome No.2: Demonstrate understanding of government procedures

2.3.3.1 Learning Activities

Learning Outcome No.2: Demonstrate understanding of government procedures	
Learning Activities	**Special Instructions**
Formulate Policies on agricultural matters as per government objective Disseminate information to farmers as per the government guidelines Procure products for farmers use as per procurement procedures Prepare financial reports on farmers activities are accounting guidelines Prepare periodic report on agricultural occurrences as per the reports format	Class Discussion

2.3.3. Information SheetNo2/LO2: Demonstrating understanding of government procedures

Introduction

This learning outcome covers; Policies on agricultural matters, dissemination of information to farmers; how to prepare financial reports.

Definition of key terms

Data collection: The process of gathering and measuring information on variables of interest in an established systematic fashion.

Data analysis: The process of evaluating data using analytical and statistical tools to discover.

Content/procedures/methods/illustrations

2.1. Policies on agricultural matters are formulated as per government objective

Public policy formulations are the main steps followed by the law makers drafting a bill to law.

Public policy formulation process in Kenya

The following stages are followed when formulating a policy:

- Problem identification
- Agenda setting
- Policy design
- Committee approval
- Parliamentary or county assembly approval

Problem identification

Public policy making starts by clearly defining the policy problem or question. A problem is identifiable when there exists an unsatisfactory set of conditions for which relief is sought from the government. Usually, the problem is identified ministries, departments and agencies. At this stage, the following questions should be answered.

a) What is the nature and magnitude of the problem?
b) What group in the population suffers from the identified problem?
c) How did the problem come about and why does it continue?
d) What are the immediate and underlying causes?
e) What should be done about the problem?

Agenda setting

This is the process by which problems and alternative solutions gain government attention. Since many problems require government responses, a fitting process is used to ensure that only a few come to the attention of the government officials. When the policy issue and alternative policies occupy a slot on agenda, then policy drafting begins.

Policy Design

This is the development of an effective course of action to reach policy goals through specific projects, programmes and activities. This stage involves; policy analysis, planning and resource scheduling.

a) Policy analysis. Involves critical thinking about causes of public problems, the various ways the government might act on them and which policy choices make most sense.
b) Planning. Involves goal setting, developing strategies, outlining the implementation arrangements and allocating resources to achieve these goals. Inputs from policy analysis and planning are consolidated into a draft policy. In the spirit of public participation, the draft policy is widely shared with stakeholders for their input. After all these, a final policy document is prepared.

Cabinet or county executive committee approval
The cabinet secretary or the county executive committee member reviews the final policy document to ensure that proper analysis has been conducted.
Different approaches have been identified and discussed and the policy document provides the best option available to readdress a situation. They also ensure that fiscal, constitutional and other possible implications of the policy are clearly brought out in the policy. Once satisfied, the policy document is submitted to the county executive or cabinet committee for approval.

Parliamentary or county assembly approval
Once the policy document is approved by the cabinet, it is published and tabled in the respective house or assembly for debate and approval. The policy document may be approved by the house with or without amendments. The views of the executive may be sought of value addition and further clarification.

- Asset

Once the policy is passed by the respective house, the speaker of the respective house submits the approval policy to the president of the government for formal endorsement. This is done by affixing the national and county seal and signing.

- Publication

Upon assent, the policy is published as a white paper which is a statement of intent and detailed policy plan which often forms the basis of the legislation. The executive is expected to widely circulate the policy and keep the public informed of the likely effects of the policy.

- Draft Bill

If it is determined that the new law is necessary to achieve objectives and the implementation of the policy, the concerned MDAs will commence the process of drafting the bill.

Information is disseminated to farmers as per the government guidelines
Information dissemination is the passage of information to the people concerned. The process of disseminating information largely depends on communication. Communication is the process of transmitting and receiving messages.

Elements of communication process
Communication process starts with a sender who has a message for a receiver. Communication involves two or more people. The sender has the responsibility for the messages. The sender's message travels to the receiver through one or more channels chosen by the sender. The channels may be verbal or non-verbal. They may involve only one of the senses hearing for example or they involve all five of the senses: Hearing, sight, thoughts, smell and taste. Non-verbal communicators rely on seeing rather than hearing. Communication is therefore more than just an exchange of words as all behaviors convey some message and are therefore a form of communication. In

communication, the understanding of meanings and interpretations of messages is crucial to positive communication. In order for positive communication to occur, individuals need to be responsible in both speaker and listener roles so that they share a clear and accurate understanding of the messages.

The process of communication

i. The intentions, feelings or ideas which lead to sending a message that carries some content.
ii. The sender encoding the message by translating the ideas into a message appropriate for sending.
iii. Sending the message to the receiver.
iv. The channel through which the message is translated.
v. The receiver decoding the message by taking it and interpreting its meaning depending on how well the receiver understands the content of the message and the intentions of the sender
vi. The receiver responding internally to this interpretation of the message.
vii. The interfering with communication.

Communication process illustration

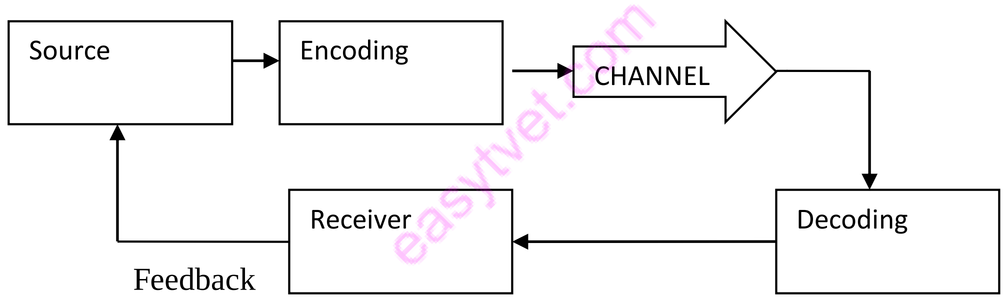

Figure 3. Communication process illustration

Types and levels of communication

Communication exits on a number of levels and in a variety of forms. These levels include:

- **Intrapersonal communication**: Refers to ways we communicate with ourselves.
- **Interpersonal communication:** Takes place when there are more than two people involved but interact and converse with each other.
- **Small group communication:** Takes place when there are more than two people involved but small enough to allow each participant to interact and converse with each other.
- **Public communication:** This refers to public speeches that are delivered in front of an audience.

Forms of communication

- **Non-verbal communication:** It involves physical ways of communication. It also refers to the use of symbols other than words to transmit messages. It includes gestures, body language and how we utter words.
- **Written verbal communication:** This is the writing of words you want to communicate. Good written communication is essential for extension communication. Posters, flyers, leaflets, magazines, emails, reports, memos and articles are some of the ways of using written communication in extension.
- **Visual communication:** This is the visual display of information like topography, photography, signs, symbols and designs. Effective communication is essential for the success of any type of information delivery. Therefore, developing communicative skills is a must. By using all these forms of communication, information is easily disseminated to the target groups with ease.

2.2. Products for farmers use are procured as per procurement procedures

Regardless of the uniqueness, every procurement management process consists of 3Ps namely; Process, People and Paperwork.

- **Process:** This is the list of rules that need to be followed while reviewing, ordering or obtaining and paying for goods or services. Checkpoints increase with complexity of the purchase.
- **People:** These are the stakeholders and their specific responsibility in the procurement cycle. They take care of the initiating or authorizing every stage of the process. The number of people involved is directly proportional to the risk and value of purchase.
- **Paperwork:** This refers to the paperwork and documentation involved in every stage of the procurement process flow, all of which are collected and stored for reference and auditing reasons.

The procurement process flow

To keep the procurement management process fair, transparent and efficient, a good understanding of procurement process flow is key.

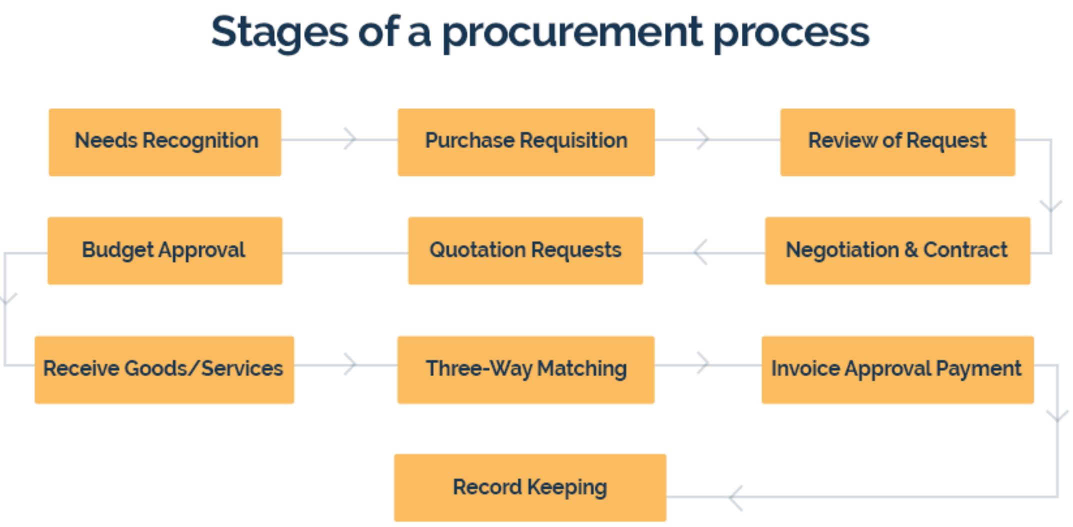

Figure 4: Procurement process

https://kissflow.com/wp-content/uploads/2018/08/Procurement-Process.png

The following are the stages involved in procurement process

i. Needs recognition
ii. Purchase requisition
iii. Review of request
iv. Negotiation and contract
v. Quotation requests
vi. Budget approval
vii. Receive goods and services
viii. Three-way matching
ix. Invoice approval and payment
x. Record keeping

2.3.Financial reports on farmers activities are prepared accounting guidelines

Financial reports are documentation on the financial uses in an organization. Examples of financial reports include; Balance sheets, cash flows, income statements among others.

Importance of financial reports

- Helps farmers to comply with various statues and regulatory requirements.
- Facilitates statutory audit
- Forms the backbone of financial planning, analysis, benchmarking and decision making.
- Helps the farmers to raise capital both domestic as well as oversees.
- For the purpose of bidding, labor contracts, government supplies etc.

Types of financial statements

There are four main types of financial statements. These are:

- Statement of financial positions
- Income statement
- Cash flow statement
- Statement of changes in equity

Statement of financial position

This is commonly known as a balance sheet. It presents the financial position of an entity at a given date. It is comprised of the following:

a) **Assets:** This is something a business owns or controls.
b) **Liabilities:** This is something a business owes to someone.
c) **Equity:** This is what the business owns to its owners. This represents the amount of capital that remains in the business after its assets are used to pay off its outstanding liabilities

Income statement

Also known as the profit and loss statement, it reports the farms financial performance in terms of profit or loss over a specified period.

Elements of income statement

a) **Income:** What the farm business has earned over a period. E.g. revenue dividend income.
b) **Expense:** The cost incurred by the business over a period of time.

NB: Net profit or loss is arrived by deducting expenses from income.

Cash flow statement

Cash flow statement presents the movement in cash and bank balances over a period. The movement in cash flows is classified into the following segments:

a. Operating activities. This represents the cash flow from primary activities of business.
b. Investing activities. This represents cash flow from the purchase and sale of assets other than inventories.
c. Financing activities. This represents cash flow generated or spent on raising and repaying share capital and debt together with repayments of interest and dividends.

Statement of changes in equity

Details the movement in owners' equity over a period of time. The movement in owners' equity is derived from the following components:

a. Net profit or loss during the period reported in the income statement
b. Share capital issued or repaid during the period
c. Dividend payments
d. Gains and losses recognized directly in equity
e. Effects of change in accounting policy or correction of accounting error

NB: Examples of the financial reports i.e. Statement of financial report, income statement, cash flow statement, statement of change and equity are on the website.

© Corporate Finance Institute®. All rights reserved.	Historical Results					
FINANCIAL STATEMENTS	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Income Statement						
Revenue	**102,007**	**118,086**	**131,345**	**142,341**	**150,772**	**158,311**
Cost of Goods Sold (COGS)	39,023	48,004	49,123	52,654	56,710	58,575
Gross Profit	**62,984**	**70,082**	**82,222**	**89,687**	**94,062**	**99,736**
Expenses						
Salaries and Benefits	26,427	22,658	23,872	23,002	25,245	26,913
Rent and Overhead	10,963	10,125	10,087	11,020	11,412	10,000
Depreciation & Amortization	19,500	18,150	17,205	16,544	16,080	15,008
Interest	2,500	2,500	1,500	1,500	1,500	1,500
Total Expenses	**59,390**	**53,433**	**52,664**	**52,066**	**54,237**	**53,421**
Earnings Before Tax	**3,594**	**16,649**	**29,558**	**37,622**	**39,825**	**46,314**
Taxes	1,120	4,858	8,483	10,908	11,598	12,968
Net Earnings	**2,474**	**11,791**	**21,075**	**26,713**	**28,227**	**33,346**
Balance Sheet						
Assets						
Cash	167,971	181,210	183,715	211,069	239,550	272,530
Accounts Receivable	5,100	5,904	6,567	7,117	7,539	7,807
Inventory	7,805	9,601	9,825	10,531	11,342	11,715
Property & Equipment	45,500	42,350	40,145	38,602	37,521	37,513
Total Assets	**226,376**	**239,065**	**240,252**	**267,319**	**295,951**	**329,564**
Liabilities						
Accounts Payable	3,902	4,800	4,912	5,265	5,671	5,938
Debt	50,000	50,000	30,000	30,000	30,000	30,000
Total Liabilities	**53,902**	**54,800**	**34,912**	**35,265**	**35,671**	**35,938**
Shareholder's Equity						
Equity Capital	170,000	170,000	170,000	170,000	170,000	170,000
Retained Earnings	2,474	14,265	35,340	62,053	90,280	123,627
Shareholder's Equity	**172,474**	**184,265**	**205,340**	**232,053**	**260,280**	**293,627**
Total Liabilities & Shareholder'	**226,376**	**239,065**	**240,252**	**267,319**	**295,951**	**329,564**
Cash Flow Statement						
Operating Cash Flow						
Net Earnings	2,474	11,791	21,075	26,713	28,227	33,346
Plus: Depreciation & Amortization	19,500	18,150	17,205	16,544	16,080	15,008
Less: Changes in Working Capital	9,003	1,702	775	903	827	375
Cash from Operations	**12,971**	**28,239**	**37,505**	**42,354**	**43,480**	**47,980**
Investing Cash Flow						
Investments in Property & Equipment	15,000	15,000	15,000	15,000	15,000	15,000
Cash from Investing	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**
Financing Cash Flow						
Issuance (repayment) of debt	-	-	(20,000)	-	-	-
Issuance (repayment) of equity	170,000	-	-	-	-	-
Cash from Financing	**170,000**	**-**	**20,000)**	**-**	**-**	**-**
Net Increase (decrease) in Cash	167,971	13,239	2,505	27,354	28,480	32,980
Opening Cash Balance	-	167,971	181,210	183,715	211,069	239,550
Closing Cash Balance	**167,971**	**181,210**	**183,715**	**211,069**	**239,550**	**272,530**

Figure 5:Statement of financial report

https://corporatefinanceinstitute.com/resources/knowledge/accounting/three-financial-statements/

2.4.Periodic report on agricultural occurrences are prepared as per the reports format

Occurrence: This is an incident or event that happens. Occurrence may apply to a happening without intent volition or plan.

Examples of occurrences that occur in agriculture include:

- Drought
- Floods
- Outbreak of pests and disease
- Geographical e.g. earthquakes

Agricultural occurrences must be written down by the farmers for further reference. Reporting of agricultural occurrences is written following the guidelines of the report format. While writing a report, the following format should be followed:

i. Title
ii. Summary
iii. Introduction
iv. Body
v. Conclusion
vi. Recommendations
vii. Appendices

The following should be put into consideration when writing a report

- Use names and pronouns
- Limit yourself to one idea per sentence
- Be clear and specific as possible
- Use simple language
- Stick to observable facts
- Write in paragraphs
- Use active voice
- Use bullet style

Conclusion

This learning outcome covered; the formulation of policies on agricultural matters, dissemination of information to farmers and procurement of farmers produce.

Further Reading

1. SIngh, S., AhlAwAT, S., & SAnwAl, S. A. R. I. T. A. (2017). Role of ICT in Agriculture: Policy implications. Oriental Journal of Computer Science and Technology, 10(3), 691-697.

2.3.3.3 Self-Assessment

Written assessment

1. Which one of the following is a stage in public policy formulation process?
    a) Policy design
    b) Conclusion
    c) Title
2. Planning involves the following activities which one is not?
    a) Goal setting
    b) Developing strategies
    c) Allocating resources
    d) Problem identification
3. The following are elements of communication process. Which one is not?
    a) Sender
    b) Receiver
    c) Written source
    d) Channel
4. Which one among the following is a type of communication?
    a) Intrapersonal communication
    b) Verbal communication
    c) Written communication
5. The following are forms of communication which one is not?
    a) Non-verbal communication
    b) Written-verbal communication
    c) Visual communication
6. Every procurement management process consists of the following except?
    a) Process
    b) People
    c) Paper
    d) Partner
7. Communication process starts with a sender who has a message for a __________
8. Nonverbal communication relies on ________rather than __________
9. Upon assent, the policy is published as a __________ which is a statement of intent and detailed policy plan.
10. __________ Form of communication involves physical ways of communication.
11. Balance sheet, cash flow statements, statement of equity are examples of __________

Oral Assessment

1. Explain the term communication, forms of communication and giving examples, discuss the different categories of barriers to communication.

2. Explain and give examples of the following categories extension methods
   a) Individual methods
   b) Group methods
   c) Mass methods

Case Study Assessment

You are an extension field officer of a particular area and you have been given a new technology to transfer from the research centers. Formulate ways through which information will be disseminated to the farmers for adoption.

2.3.3.4 Tools, Equipment, Supplies and Materials

- Textbooks
- Notebooks
- Flipcharts
- Projector
- Computers
- Manuals
- Whiteboard
- Masking tapes
- Felt pens

2.3.3.5 References

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2.3.4 Learning Outcome No 3: Demonstrate understanding of rural sociology

2.3.4.1 Learning Activities

Learning Outcome No 3: Demonstrate understanding of rural sociology	
Learning Activities	**Special Instructions**
3.1. Determine farmers culture, beliefs and norms as per the community 3.2. Involve local leaders in farmers activities as per farmers needs 3.3. Resolve farmers conflicts as per the conflict resolution methods 3.4. Form Farmers groups as per the farmers needs	Class discussion on conflict resolution methods

3.3.4.2 Information Sheet No2/LO3: Demonstrate understanding of rural sociology

Introduction

Livestock tools and equipment are tools and equipment used for routine, management practice in livestock. they are used for identification, castrations, dehorning, disease and parasite control, breeding milking and restraining animals depending on the type of the tool. Livestock tools and equipment are maintained to manage durability of the user; there are several reasons for maintenance of farm tools and equipment which will be discussed below.

Definition of key terms

Livestock: It is commonly defined as a domestic animal which are kept in agricultural surrounding to provide labor and products.

Livestock tools: These are livestock items that are mainly used to achieve a particular goal.

Livestock equipment: Set of tools that are to achieve a particular livestock objective.

Machines: Mechanical structures that use power to apply forces and control movements to apply forces and control movement to perform an intended action

Content/procedures/methods/illustrations

1.1. Tools, equipment and machines are assembled as per manufacturers manual.

Assembling of tools, equipment and machines should be done by experienced crew or personnel to cut off equipment setting cost which may arise is they are wrongly assembled. For example, during cleaning of machines, some parts need to be removed so that cleaning is effectively carried out.

Reasons for assembling tools

- To carry out maintenance practices
- For salvage purposes
- To put or store them according to their specific functions
  Equipment are put together and the indented purpose for assembling is carried out. Assembling area should be near the store

1.2. Tools, equipment and machines are cleaned as per manufacturers manual.

Cleaning tools regularly is essential is essential to their proper functioning. After day of work, machines and equipment will be dirt and should be cleaned after use to maintain g long shelf life. During cleaning it's advisable to use manufacturer's guidelines for proper cleaning and maintenance. Extremely harsh chemical should be avoided when cleaning them.

To clean and maintain tools, the operator needs the following tools

- **Cleaning supplies:** They include detergents sprayer, sponge, old rags or towels
- **Cleaning tools:** For example, steel wool, scrub brush and a rotary wire brush attachment for drill
- **Sandpaper:** Used to work on both wood and metal works
- **Lubricating oil:** Such as boiled in seed oil, tang oil, lane oil or cooking oil the best preferred oil are in seed and tang oils
- **Safety equipment:** wearing protective devices e.g. gloves, eye protection and dust mask when cleaning.

How to clean livestock tools, equipment and machines

Step1: Clean tools. Start by giving tools a good scrubbing to remove mud and grit from the blades and handles, dry them with old towels and set them aside overnight so that they dry completely, e.g. milking tools and equipment. If they are machines to be cleaned the cleaning site should have the following conditions:

- Close to the working are to minimize further contamination
- Accessible in all weather
- Contained for safe disposal of waste
- A way for water sources and public drains
- Flat for safety when working and to reduce run off

- Stable surface to prevent pre-contamination access to suitable cleaning equipment
- Identifiable for monitoring and controlling any pest that may establish on the site

Step2: Oil or grease metal parts

This will rust of the metal parts of the tools and equipment. oiling the moving parts makes the easy to work with and increases the efficiency of the tool and equipment.

Step 3: waste disposal

Waste in the form of contaminated water, debris, dust of chemical will often be left on the cleaning site.

Step 4: Hang tools and equipment

Tools and equipment should be hanged to prevent rusting while which may arise if placed on the floor.

Step 5: Sterilization

Tools and equipment, machines for livestock should be sterilized especially for treating animals to control spread of diseases.

Step 6: Store in their original cases

Tools and equipment should be in specific cases to protect them from damage. Machines should be packed or stored under shade

Reasons for cleaning tools, equipment and machines

- To last longer when maintained
- To make them work more efficiently
- To reduce the risk of injury to the people
- To reduce cost of maintenance

1.3. Tools, equipment and machines are sharpened as per manufacturers manual.

Sharpening is done for tools used in cutting e.g. castrating knife, hoof trimming knife and tooth clipping knife to avoid injury to the animals.

Steps followed when sharpening tools and equipment

Step 1: Clean the blades

Clean the blade with stiff brush and soapy water to remove any dirt rush or debris. Dry them and wipe the blades with light coat of motor oil. e.g. hoof trimming knife

Step 2: Examine the sharpness

Check first the manufactures guidelines and instructions for specific sharpening and cautions. Examine the blade edge to determine the correct sharpening angle.

Step 3: Begin grinding the blades

Place the grinding stone in either water or vegetable oil to make it wet and act as a lubricant.
Press the blade against the concave side of the stone while sharpening to maintain the correct angle. Keep the stone wet by periodically applying lubricant
Step 4: Smoothen the edges
Use finer grain stone and continue sharpening until you achieve a razor-sharp edge after you have achieved proper sharpness and angle in step 3 above. Do not reduce the leveled edge to prevent breakage.

Step 5: Test the sharpness
Holding the cutting edge onto a light source if bits reflecting the light it's not ready. Retest sharpness until it is achieved.

Step 6: Finish sharpening the blades by rubbing a light coat of oil on them to prevent rusting. Remove any dirt that has accumulated during the sharpening. Finally fix the tools to their store.

Reasons for sharpening

- To prevent injury to the animal during operation
- To increase efficiency of the tool
- To safe time

Materials for sharpening

- Wire brush
- Sand paper
- Oils
- Sharpening stones
- Files
- Bench vise
- Grinding wheel
- Scissor sharpeners

Tools and equipment should be sharpened when they become blunt because work will be inefficient. In case of an injury to the animal, it may predispose it to secondary infections

1.4. Tools, equipment and machines are greased or oiled as per manufacturers manual.

Steps followed during greasing /oiling

i. Start by choosing the grease gun loaded with grease as per manufacturer's instructions and precautions
ii. Locate the greasing points on the tool so that it will be easy to locate each day
iii. Quick inspection is to ensure grease nipples are not damaged

iv. If they are hand tools grease the blade and oil the rotating parts to prevent wear and tear
v. Wipe down the grease points with a rag to ensure there is no dirt accumulation
vi. Attach your grease nozzle and give a few pumps until you see grease exiting

Reasons for greasing /oiling

- To prevent wear and tear of livestock tools, equipment and machines
- To control rusting
- To reduce cost of maintenance
- To make the tool last long
- To increase efficiency
- Used to minimize power loss and heat generation

Tool used for greasing and oiling

- Greasing gun
- Fluids; oil and grease

Type of base oils groups

- **Mineral base oils**

These are derived from crude oil. They are used as lubricants in the automotive industry as well as industrial applications

- **Synthetic base oils**

They are derived from the chemical reactions of several components. They are higher in in viscosity components compared to mineral base oils **w**hich require additive to improve viscosity.

Greases: They consist is base oil of base oil additives which increase viscosity of the lubricants. Greases creates a water proof barrier against external elements e.g. water

Types of greases

- Silicon greases
- Food grade lubricants

Tools, equipment and machines are replaced as per the work policy.

Replacement is done when part or whole of the equipment breaks down. The tools can be repaired if possible because the replacement cost is high. There should be a data driven decision to determine whether to repaired or replace a piece of equipment.

Factors to consider during repairing and replacement

Analyze the cost: If it's a new tool consider its purchase cost, profit it will earn, salvage value, operating cost and service life. if the cost or replacement is higher than its value, the farmer should leave it

Consider the age of the equipment: If the equipment is old, it requires a lot of maintenance, which is costly. Its effective to replace the old equipment with a newer and technology advanced model will give better efficiency and longevity

Consider the cost of repair: The farmer should have a documenting asset repair events to provide information of repair. Its assist in making firm decisions

Consider downtime. Is the equipment takes a lot of time to repair, it will lead to low productivity? Decision should be made whether to repair or replace it

Consider safety: Old machinery may pose as hazard during operation if it malfunctions. The equipment will eventually wear out and therefore a decision should be made

Reasons for replacing the equipment

Deterioration: It is caused by decline of performance due to wear and tear or misalignment indicated by

- Increase in maintenance cost
- Increase in labor cost
- Loss of operating time due to breakdown

Obsolesce: Equipment become obsolete due to advancement in technology and unwanted manufacturing cost

Inadequacy: If the equipment cannot meet, the demand it was designed for replacement is required

Working conditions: If the machine or equipment leads to increased accidents, it should be replaced

Economy: If the existing equipment have outlived their effective life and it is not economical to continue with them

Parts to repair: Old equipment and machines should be replaced to increase productivity

Broken parts: Bend blades should be strengthened

Conclusion

This learning outcomes covered on assembling, fitting, cleaning, sharpening greasing and replacing of tools, equipment and machines as per manufacturers manual. Failure to follow such instructions and precautions will lead to high maintenance cost and productivity will be low

Further Reading

1. https://www,extension,issitate .edu/small/clean-and-maintain-garden-tools
2. https://garden solutions.ifas.ifl.edu/care/tools-and-equipment
3. peak revision K.C.S, E AGRICULTURE Chapter 4

3.3.5.3 Self-Assessment

Written assessment

1. Which one of the following is a sharpening tool?
   a) Bortuzzo
   b) Milking churn
   c) Files
   d) Stir cup
2. The following lubricants are used equipment and machinery. Which one is more effective in lubrication?
   a) Oil
   b) Grease
3. Which one of the following reasons for replacement refers to the replacement of outdated equipment due to technology?
   a) Deterioration
   b) Obsolete
   c) Inadequacy
   d) Working condition
4. The following factor are considered when analyzing cost of replacement
   a) Salvage value
   b) Purchase cost
   c) Operating cost
   d) Technology
5. Which one of the following describes best the replacement of a tool or equipment?
   a) Age of the machine
   b) Cost of the equipment
   c) Cost of replacing the higher than the value of the equipment
   d) Salvage value
6. Which one of the following is not a tool of lubrication?
   a) Greasing gun
   b) Oil
   c) Grease
   d) Petrol
7. Greasing lubricants contains the following components except one. Which one is the odd one out?
   a) Additives
   b) Base oil

c) Natural oil
d) Gelling agent

8. What do you mean by the term lubrication?
9. Differentiate between a livestock tool and equipment
10. Name two type of oils
11. Give one reason for maintaining tools and equipment
12. Give one reason for sharpening tools
13. Name two types of livestock

Oral Assessment

1. Give two examples of lubricants
2. Give examples of sharpening tools

Case Study Assessment

Visit the school farm store on the livestock tools, equipment and stationery section

a) Observe and identify each equipment state the function of the equipment
b) Describe how to maintain the tools
c) Give general reasons for maintain tools

Practical Assessment

1.You have been provided with the following tools after they have been used in a livestock production unit

Bortuzzo, wool shear, ear tagging, tattooing machine, disbudding wire and hoof trimming knifes

Questions

a) Perform the cleaning of each of the above tools
b) Store them properly

2. You have been provided with the following blunt equipment;
wools shear, hoof trimming knife and teeth clipping knife and grease
Grease the above tools appropriately

3. On the above tools provided in questions 2 above. For each of the above tool carry out sharpening techniques in each.

3.3.4.4 Tools, Equipment, Supplies and Materials

- Hoof trimming knifes
- Burdizzo
- wool shear
- ear tagging machines
- hammer
- tattooing machines
- trocar and Cannula
- teeth clipping knife
- pig restraining
- equipment feeding troughs
- disbudding iron dehorning wire

- milking pails
- sieve
- Ropes
- bolus guns
- DE wormers

3.3.4.5 References

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2.3.5 Learning Outcome No 4: Demonstrate understanding of farmers training visits

2.3.5.1 Learning Activities

Learning Outcome No 4: Demonstrate understanding of farmers training visits	
Learning Activities	**Special Instructions**
4.1. Identify farmers to be trained as per the farmers needs 4.2. Training resources are sourced as per training requirement 4.3. Identify methods of training as per the farmers needs 4.4. Train Farmers as the training manual 4.5. Carryout follow up on farmers activities as per training objectives	Organize group discussions

2.3.5.2 Information Sheet No2/LO4: Demonstrate understanding of farmers training visits

Introduction

The learning outcome to be coveted includes training methods, monitoring and evaluation.

Definition of key terms

Monitoring: This is the process checking progress on quality something over a period of time, keep systematic review.

Evaluation: Making assessment about quality of something to gauge the progress.

Content/procedures/methods/illustrations

1.1. Farmers to be trained are identified as per the farmer's needs, training resource are sourced as per training requirements.

i) Training of farmers for organic farming practice

This is an extension training that gives the improve farmers on environmentally friendly farming methods that discourage environment pollution. They include use of organic manure instead of fertilizers, weeding instead of using herbicides, natural pest control method instead of using pesticide and minimum tillage practices that aim to maintain good characteristics e.g. soil structure and other components. Materials required include manure samples from livestock, weeding machines and instructors to demonstrate the activities.

ii) Training of farmers for waste management

For proper agricultural production, water is a key component to enhanced crop farming and livestock survival. Water is essential for crop growth biological processes and other metabolic functions. Therefore, water management is essential. This can be done through provision of materials such as plastic tools, underground tanks construction, water canals (irrigating canal construction and small holding dams for water conservation for agricultural purpose.

iii) Training of farmers or pest and disease control

Pest and disease have adverse negative impact on production and therefore through clinical analysis and strategic control measures should be put ready for emergency in case of widespread risk of pest or disease. One way of pest and disease identification is by identifying symptoms of disease or presence of dangerous pest as gazette by relevant entities. Material needed include handbook, demonstration equipment diagram, photos of effects of pest and diseases and instructors who are well versed with technology about pest and diseases.

iv) Training of farmers on input management

Input includes fertilizers, seed and agro-chemicals. All this need application knowledge and skills about their usage. Farmers can be trained on efficient use of fertilizers since too much can lead to burning effects. They can also be trained on sources of ratified seeds with high germinating percentages and low dormancy, resistant to pest and diseases for high productivity. Training resources required include samples of input, demonstration farms where the use of inputs succeeded, trainers etc.

v) Training farmers on agribusiness role /entrepreneur

Agriculture production is a business just like other enterprises. Farmers should not produce for household consumption only but also for commercial, their financial benefits and therefore they need to intermarry aspects of farming and business ideas existing in agriculture sector. They need market information; linkage charts for market information may be provided to farmers and also be trained in market gaps for higher gains.

1.2. Methods of training are identified as per farmers needs

Farmers training involve number of methods in disseminating information to meet the needs especially in information gap these methods include:

i) Establishment of farmer training school/ resource information centers

Farmer's field schools are school without wall where demonstration, training session, and lecture setting usually take place

Participants observe, analyze, experiment, consult, and identify solutions among themselves when confronted with patterns.

ii) Farm, home, field visit

This is a tour that involves instructors interacting with the farmers of interest to share out the diagnosed problem and selectively coming up with a favorable solution to the problem. The Trainers of Trainers (TOT) also gives any other relevant information to farmers for either future use or general consumption if use be. This boost farmers confidence and objectivity towards involvement in the chain of production.

iii) Individual extension approach

An extension water can decide to use one on one approach where he/she visit the area of interest, meet people, know their ideas and what project they are thinking about, their needs , how they have organized their work duty roster and finally submit the findings to the governments' relevant entities for diagnosis and coming up with solution. This approach provides mutual discussion between extension workers and farmers.

iv) Commodity specialized training approach

Institutions and persons concerned with one particular commodity sometimes become impatient with other extension approaches that take time. Therefore, they organize a fast and highly specialized approach. This approach may focus on one aspect e.g. for crop, the organizer can decide to major on one cup or livestock sector.

This is mostly done by parastatal, especially when they want to increase productivity of commodity. It involves supporting functions such as research, input supply and output marketing. This approach aims to produce and market relatively high value commodities efficiently and effectively. A good example is when the government uses marketing board for efforts of crop simply to capture both foreign exchange and surplus in come without sharing with farmers.

v) Education institution approach

This involves participating in agricultural, School College, universities in agricultural extension activities. These institutions try to disseminate information to participants and other shareholders to improve quality and relevance of agriculture role. This form the basis/origin of information of most instructors who later forms a major part in carrying out extension in labour levels.

vi) Project approach

This approach comes as a substitute where a large government bureaucracy features in some approaches many be slow or may fail to have impact on agricultural production and therefore these approaches can achieve better results in a particular location during a specific time with large infusion of outside resources. The project within a specific time frame and therefore its continuity is not anticipated. Sometimes it is assumed that successful methods, and techniques demonstrated inside the project will be later replicated in other location.

vii) Train and visit approach (T and V approach)

This is a professional monitoring approach that test group of the farmers about instructed idea. This method aims to have competent, well-informed village and level extension officers with relevant techniques messages and bring formers problem to research.

viii) Farming system research approach

This method includes;

- Viewing the whole farm as a system
- Focuses in inter-dependence between the components under control of members of the farm household.
- Consider opportunities and problems
- Set priorities and correct problem to improve productivity.

1.3. Farmers are trained as the training manual

A manual is a booklet/template that provides step-by-step guideline that takes the facilitators through key contents of the farmer training programmer. Each sub-sector can have a specific training manual that comprehensively covers quality information about the sector and the information becomes a knowledge base for training farmers. Some of the manual identified include:

i. Organic agricultural training manual

This covers all farmers training about adoption of organic agricultural practice to enhance low residue in products. The emphasis is on friendly cultivation methods, less use of agro-chemicals and soil and water conservation measures. Farmers therefore have a specific guide on organic farming and it's used during training.

ii. **Trading system training manual**

This handbook covers training of farmers on market structure, composition, gaps and customer. It intensively covers market information that is needed for a tool for successful agri-business enterprise. Provision of information about demand and supply of essential in farming to reduce risks resulting from misdiagnose of existing market.

iii. Training manual for small holder dairy farm

This guide covers all information about dairy industry. Its analysis aspect for successful and profitable dairy enterprises. Farmers are trained on management, production, quality, product, sustainability and potential risk and general husbandly practices that a farm should adopt as minimum standard for success on the industry. Aspect of disease to avert effects and potential losses is also covered to verse farmers with knowledge that can make them flexible in collaboration with veterans' section for help.

iv. Agricultural values addition training manuals

This covers agricultural innovation systems. It emphasizes on improvement of the by-products and also some products that many use qualities up scaling. It looks at aspect of transforming quality of a product into a more valuable from that can be easily liked by customers. e.g. tomatoes can be processed into tomato sauce that can be used in most hotels. Therefore, farmers are trained on use of technology in value addition to enhance quality of the products.

1.4. Follow-up on farmers activities are carried out as per training objectives

This is a post training exercise carried out to find whether what was offered during training has been adopted practically by trainees. Some of the follow-up activities/ methods include:

i) Role play/ test visualization

This involves telling the trainees to do practically what they have been taught to demonstrate their full understanding.

ii) Abrupt farm unit

The trainer may decide to let the trainees go and practice what they have learnt at their forum and they make visit without issuing notice to know if the trainees are actually doing what was taught on their own without supervision.

iii) Train and visit approach

This is a management extension monitoring approaches where farmers are followed to their farms to assess whether they have implemented what they were trained on. However, this method is disadvantageous since farmers may only be active when they know the accessor is coming and fail to be productive after visit.

iv) Farmer to farmer post training extension

This is where farmers consult among themselves to gauge whether they understand the context and objectives of the training and therefore provides ground for each farmer to asses him/herself in comparison to his fellow farmers. This approach is advantageous because it is interactive since farmers belong to the same class level. There are no hierarchy, fears and differences.

v) Performance assessment monitoring approach

This entails analysis pro and post training performance and gauging whether there is a resultant improvement due to training. Any significant positive change therefore is termed as effect of the given training therefore appreciate the importance of the given training. Stagnation or reduction in performance may mean the training never had any positive impact or it affected farmers performance negatively e.g. through time wastage.

Conclusion

This learning outcome covered training methods, monitoring and evaluation of farmers and how they are important when carrying out an agricultural project.

Further Reading

1. www.Youtube.com//agriculturaltraininginstituteroleinextensionanddessemintaion ofinformation to farmers
2. Anderson and Feder, Ca, (2004). Agricultural extension. Good intention and hard realities. The World Bank Research Observer, 19 (1) 41-60.
3. Adams ME (1982) Agricultural extension in developing caution (NO.04;5544, A3) Harlor Longman.

2.3.5.3 Self-Assessment

Written assessment

1. Extension education to farmers on organic farming is a waste of time rather than investment in modern agricultural practice.
    a) True
    b) False
2. Commodity specialized approach is a method of farmer extension training. True or False?
    a) True
    b) false
3. The following manual can be available for training farmers objectively to enhance agricultural extension except?
    a) Dairy Farmers manual
    b) Organic agriculture manual
    c) product and disease central manual
    d) product advertisement manual
4. Value addition is not important in agriculture. It increases production cost. True or False?
    a) True
    b) False
5. Role play is not a method of post-training monitoring. True or False?
    a) True
    b) False
6. Training farmers based on need gaps is important in extension.
    a) True
    b) False
7. Monitoring is a waste of time to follow already evaluated people
    a) True
    b) False

8. Give three manuals important to extension farmers
9. Highlight 4 training approaches for agricultural farmers
10. Name two monitoring methods after train of farmers

Oral Assessment

1. State the main aim of project approach as a method of farmers training
2. Give two areas specialized in daily training manuals.

Case Study Assessment

After training farmer and giving them training manual, the trainees should employee community approach and make farms visit and as methods of methods evaluation to gauge level of implementation of what the farmer were trained on and make report with viable recommendation that serve as a feedback to the agricultural education and extension institutions concerned.

Practical Assessment

1. Students to go and practice content of organic farming manual offer the training and assessment will be done using abrupt visit method.

2.3.5.4 Tools, Equipment, Supplies and Materials

- Hoof trimming knifes
- Burtizzo
- Wool shear
- Ear tagging machines
- Hammer
- Tattooing machines
- Trocar and Cannula
- Teeth clipping knife
- Pig restraining
- Equipment feeding troughs
- Disbudding iron dehorning wire
- Milking pails
- Sieve
- Ropes
- Bolus guns
- DE wormers

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CHAPTER 3: PRODUCE CONVECTIONAL AND NON- CONVECTIONAL LIVESTOCK/PRODUCING CONVECTIONAL AND NON-CONVECTIONAL LIVESTOCK

3.1 Introduction

This unit specifies competencies required to produce convectional and non-convectional livestock. It involves selection of breeding stock, designing animal structures, constructing animal structures, installing and maintaining livestock tools, equipment and machines, breeding convectional and non - convectional livestocks, practicing livestock husbandry and managing young growing stock.The significance of this unit helps in development of new livestock breeds which can perform well in various ecological conditions. It also constitute important source of family income and food security and contribute to country's gross domestic income.

The critical aspects of competency to be covered include: ability to choose breeds select breeding stock, and understand breeding methods, design and construct animal structures, install and maintain animal tools and equipment, carry out livestock routine management practices and understand bio-security measures. The basic resources require in this unit include; materials tools and equipment, assesment location, personal protective equipment and various types of livestock.

The unit of competency has six learning outcomes. Each of the learning outcome presents; learning activities that covers performance criteria statements, thus creating trainee's an opportunity to demonstrate knowledge and skills in the occupational standards and content in curriculum. Information sheet provides; definition of key terms, content and illustration to guide in training. The competency may be assessed through written test, demostration, practical assignment, interview/oral questioning and case study. Self assessment is provided at the end of each learning outcome. Holistic assessment with other units relevant to the industry sector workplace and job role is recommended.

3.2 Performance Standard

The competency of this unit is to install and maintain livestock tools equipment and machines. Select breeding stock and breed the farm animals as per the animal breeder manual. Practice livestock husbandry and manage young and growing stocks based on LPM.

3.3 Learning Outcomes

3.3.1 List of Learning Outcome

a) Select breeding stock
b) Design and construct farm structures
c) Install and maintain livestock tools, equipment and machines
d) Breed farm animals
e) Practice livestock husbandry
f) Manage young and growing stocks

3.3.2 Learning outcome No 1: Select breeding stock

3.3.2.1 Learning Activities

Learning Outcome No 1: Select breeding livestock.	
Learning Activities	**Special Instructions**
1.1. Choose breeding stocks according to breeding standards. 1.2. Identify breeding methods according to intended breeder outcome. 1.3. Choose tools and equipment according to the requirement of the breeding operation. 1.4. Select breeds according to standard selection method. 1.5. Breed livestock according to the set criteria.	Facilitate learners to visit the farm Ask students to identify the types of cattle in the farm. Demonstrate selection of breeds.

3.3.2.2 Information Sheet No3/LO1: Select breeding stock.

Introduction

This learning outcome covers; breeding stocks, identification of breeding methods, selection of breeds and ways of how to breed livestock according to the set criteria.

Definition of key terms

Livestock: These are animals domesticated in agricultural setting to produce labor and products which are traded as a source of income (e.g.) meat, milk, fur leather and wool.

Reproduction: It is the biological process by both sexual and asexual means though which the off springs are produced from their parents

Genetics: It is the branch of biology which deals with the scientific study of genes, genetic variation and heredity in organisms. Example phenotypic

Equipment: It is the set of necessary tool, articles, clothing and physical resources used for a particular and heredity in organism, example farm machines.

Breeding: It is the sexual reproduction which involves bearing or generating off springs from the parent organisms that is either plants or animals

Breeding Standards: These are set guidelines in animal husbandry used to ensure the animals produced by a breeder or breeding facility conform to the specifics of the standardized breed. Example, in the American poultry Association, breed standards for poultry (e.g.) ducks and geese are divided by weight and chicken by size.

Content/procedures/methods/illustrations

1.1. Breeding stocks are chosen according to breeding standards.

Breeding stock: It is a group of animals specifically kept and used for the purpose of planned breeding. Example, bull kept for semen production and cow for calf's production. The breeding stocks are mainly chosen with care because they are purposely meant for upgrading the herd. The animals are chosen at different ages depending on the breed of the animal, example, the gilts are usually selected for breeding at five or six months of age, height at 15 cm of age.

How selection affect characters

- Heritability of the character
- The intensity with which the selection is done
- The internal between generations
- Type of selection being practiced

Factors to consider when choosing the breeding stock

Cattle stock

- Level of performance e.g. milk yield butter content, length of lactation period and calving intervals
- Age of the animal
- Fertility
- Physical fitness
- Health of the animal
- Body conformation
- Suitability of the enterprise-milk or beef

Sheep

- Level of performance e.g. maturing ability, growth rates, wood quality, carcass quality and twining rate age
- Suitability to the enterprise- wood or mutton
- Health
- Flocking instinct
- Inheritable defects
- Fertility

Goats

- Fertility
- Maturing ability
- Growth rate
- Twining rate
- Carcass quality/ dressing percentage
- Health
- Age
- Suitability to the enterprise e.g. milk/ mutton

Camels

- Health
- Age
- Temperament
- Foraging ability
- Fertility
- Level of performance, (e.g.) meat, milk, fur and transport

Pigs

- Carcass quality
- Maturing ability
- Prolificacy
- Number of teats
- Body formation
- Heredity defects
- Growth rate
- Temperament
- Age

1.2. Breeding methods are identified according to intended breeder outcome

a) **Inbreeding:** Mating of related animals up to 4-6 generations

b) **Line breeding:** In line breeding, two parents are crossed whose desired characteristics complement each other as much as possible. The parents are more distantly related but can be traces back to common ancestor e.g. cousins.

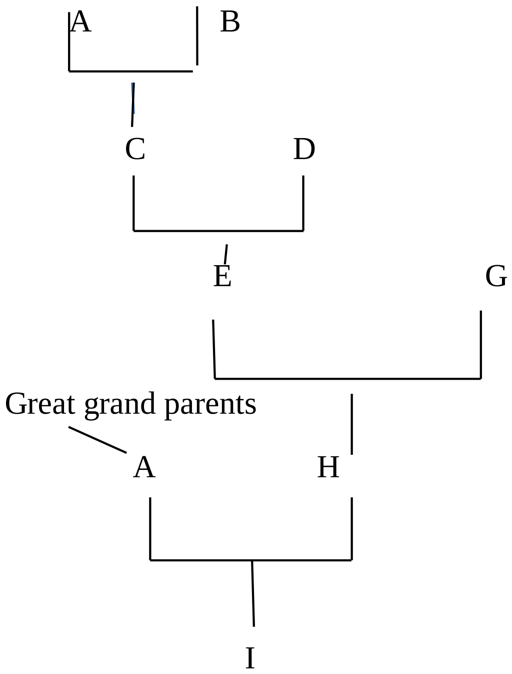

Figure 6: Line Breeding

Advantages of line breeding

- Genetically pure breeds are produced
- There are lower heredity defects experienced in the off springs

Disadvantages

- Reduced gene pool
- Decreased hybrid vigor
- Appearance of genetic faults

c) **Close breeding:** Mating between very close related animals (e.g.) sib mating and parents sib mating

d) **Out breeding:** Involves crossing between different breeds no common ancestors. Out breeding id relevant in introducing unrelated genetic material into a breeding line.

Reasons for out breeding

- To introduce new genes in an existing breeding heard
- To exploit heterosis resulting from a cross between two breeds
- To develop a new breed or a grade animal

System of out breeding

a) Cross breeding

Mating of animals from two different pure breeds to attain hybrid vigor/ heterosis e.g. higher production rate, high growth, disease resistance and heat tolerance.

b) Out breeding

Mating of unrelated animals from the same breed e.g. Fresian cow in Kenya with semen of Fresian bull from Britain

c) Upgrading/Grading up/ Back crossing

A female of a local grade is mated with a pure breed sire, to produce a high grade. If the same sire mates with the filial generation of its heritors, it will attain a pure breed character

Advantage of out breeding: Hybrid vigor/ heterosis is increased.

1.3. Tools and equipment are chosen and prepared according to the requirement of the breeding operation.

Tool: It is a device or implement especially one hold in the hand, used to carry out a particular function**.**

Equipment: Set of particular tool and resources for a particular operation or purpose.

Examples of breeding tools and Equipment

- Thermometer
- Syringes
- Burdizzo
- Elastrator and rubber ring
- Bull ejaculator
- Mate insemination gun

Factors considered when selecting breeding tools and equipment

- **Efficiency of the equipment:** The equipment must conform and be relevant with task required
- **Availability of the equipment:** The equipment chosen should be within the area of the operation
- **Cost of the equipment:** The equipment should be cheap enough not to cause extra costs
- **Relevant skills and knowledge required:** The equipment should be chosen depending on the skill of the personnel
- **Ease of transport:** The selected tools should be flexible in terms of transport

Preparation of the breeding tools and equipment

i. Proper cleaning and disinfection of sensitive tools e.g. syringes, using anti-bacterial chemicals
ii. Oil of the movable parts of some tool e.g. burdizzo for efficiency
iii. Check for accurate readings like the thermometer

1.4. Breed selection is done according to the standard selection methods.

Selection: Process of allowing certain animals to be the parents of future generation while culling others.

There are three major types of methods used in selecting animals;

1. **Mass selection:** Animals with superior characteristics (highly) heritable breed are selected from a herd and then allowed to mate among each other at random. The offspring will show higher performance than their parents.

   Advantage

Increase the desirable gene in population

2. **Progeny testing:** A group of progenies (off springs) are used as an aid to increase accuracy in the selection of a breeding stock. The method is applied where the character to be selected is of low heritability and expressed by one sex only

   Limitation

Time consuming (up to nine years of the results to be seen)

3. **Contemporary comparison:** Contemporaries heifers in the herd sire by the same bull. It involves comparison of average production of daughters (heifers) of each bull. The other heifers are referred to as contemporaries.

Assumption

The different between the heard of the same breed are non-genetic in origin

Advantages of contemporary comparison method

- It is possible to compare heifers of different ages in different locations world wide
- It eliminated differences brought about by the environment
- It is possible to make direct comparison of the stunt bull at different artificial insemination centers
- It is accurate because herd of animals are used

1.5. Breeding is done according to the set criteria in the livestock production manual.

Breeding is the process of mating selected males and females to produce off springs with the desired characteristics

Reasons for breeding

- To expand the inherited potential of the animal
- To improve production by improving new genes
- To overcame production problems selected by the environment
- To satisfy consumers taste
- For economic reasons e.g. fast growth rate to reach marked early

Criteria for breeding animals

Age of the animal: Young animal that have not part rated for more than 3 times should be selected. Young animals have a longer productive life and a higher breeding and production efficiency.

Level of performance: Animals with highest production level should be selected by show of the records e.g. high milk yield, good mothering ability and high prepotency.

Physical fitness: The selected animals should be free from physical defects e.g. moneyed limping yield, irregular number of teats, scrotal hernia, deficiency and weak backline.

Health of the animal: Animals selected should be resistant to diseases and pass the characteristic to the off springs.

Body conformation: Dairy cows should be wedge shaped with a large udder tuin legs and long neck.

Temperament/ behavior: Animals with bad behaviors should be culled e.g. cannibalism egg eating aggressiveness and kicking.

Quality of products: Select animals that give products of high quality e.g. meat, wood egg milk.

Mothering ability: Animals with good natural instincts towards their young ones should be selected so as to rear their young ones up to wearing.

Adaptability: Animals should be well adapted to the prevailing climate condition in the area e.g. arid and semi-arid areas.

Prolificacy: Animals with the ability to give birth too many off springs at a time (large litter) should be selected. E.g. in pigs and rabbits. Necessary records should be used.

Conclusion

This learning activity has covered choosing of breeding stock, breeding methods as per the breeding standards. Choosing of tools and equipment according to breeding operation, breeding according to the set criteria in the livestock production manual among the related knowledge that is relevant and useful

Further Reading

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3. https://peda.net-livestock selection and breeding
4. Animal breeding the genetic basis of animal breeding economic considerations, modern methods in bio technology artificial insemination
5. Domestic anima diversity information

Written assessment

1. The following are methods of selecting breeding stock, which one is not?
    a) Mass selection
    b) Random selection
    c) Progeny testing
    d) Contemporary comparison

2. Which one of the following is a tool for breeding animals?
    a) Knapsack sprayer
    b) Syringe
    c) Ear notcher
    d) Needle

3. The following are systems of out breeding which one is not?
    a) Crossing over
    b) Back crossing
    c) Out crossing
    d) Cross breeding
4. Which one is the odd one out?
    a) Sheep
    b) Goat
    c) Cattle
    d) Pig
5. Which one is not a factor to consider when selecting animal for breeding?
    a) Prolificacy
    b) Adaptation
    c) Body temperature
    d) Age
6. Which of the following is not a term used in breeding?
    a) Epistasis
    b) Hybrid vigor
    c) Selection
    d) Inheritance
7. Which of the following is a breeding system?
8. Explain the meaning of the term breeding stock
9. Give an example of breeding tool
10. Give the limitation of progeny testing as a method of selecting breeds
11. Name a product obtained from farm animals
12. State any system of in breeding

Oral Assessment

1. Differentiate between and breeding stock
2. State two criteria for breeding animals

Case Study Assessment

Visit the university farm and carry out the following activities

1. Identify the type of cattle breed kept
2. Identify the animals used as the breeding stock and note their characteristics
3. Identify the main method of breeding practiced and state its relevance and limitations as per the farm
4. Give your recommendations on what should be done to improve performance and yield in the farm through breeding

3.3.2.4 Tools, Equipment, Supplies and Materials.

- Convectional and non- convectional livestock breeds
- Animal breeder' s manual
- Artificial insemination equipment
- Zero grazing unit

3.3.2.5 References

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3.3.3 Learning Outcome No 2: Design and construct farm structures.

3.3.3.1 Learning Activities

Learning Outcome No 2: Design and construct farm structures.	
Learning Activities	**Special Instructions**
2.1. Design animal structures according to animal housing plan. 2.2. Identify structures and maintenance materials gathered according to animal housing plan. 2.3. Construct animal structures according to animal housing plan in accordance to livestock production manual.	Giving lecturer on the learning outcome. Discuss the structures according to animal housing plan

2.3.3.2 Information Sheet No3/LO2: Design and construct farm structures.

Introduction

The learning outcomes to be covered include: types of animal structure, animal structure designs, livestock housing plan and construction of animal structures.

Definition of key terms

Livestock: Domesticated animals raised in an agricultural setting to produce labor and commodities e.g. meat, milk, fur etc.

Structure: These are housings of different types of animals with different parts with different function.

Designs: These are structures or housing of livestock to provide the required environment, protect them from harsh weather and also attack from pests and diseases and the housing should be done for a healthy product from livestock**.**

Content/procedures/methods/illustrations

2.1 Animal structures are designed according to animal housing plan.

Animal structures and farm structures are different types of physical constructions that are put in a farm for the purpose of livestock and crop production. Farm structures are existing buildings or facilities previously for non-agricultural uses but which are either converted to be used for an agricultural purpose. Farm structures are classified based on materials of construction.

These structure help increase efficiency of agricultural production. Farm production process are carried out under co trolled environment in order to maximize the output example, animals must be protected from rain and dirt to avoid illness and improve better health. Farm machinery should be kept in shelters to avoid rusting, its depreciation level to minimum. Crops harvested are protected from rain and Sitting of the farm structures should be located in suitable areas for a farmer's ease.

Factors considered when site selected

- **Topography:** The land selected should be slightly slopping. Too sloppy land can cause chances of landslide while a flat land leads to poor drainage thus leading to floods.
- **Prevailing winds and rainfall:** The construction of the building should be perpendicular to the direction of wind and rain. This is to prevent the high velocity of wind from destroying the building and to reduce chances of water entering the building.
- **Soil type:** The soil should be firm and well drained. This is to determine its availability to withstand stress exerted by a building.
- **Security:** The area selected should be out of theft, vermin intruder's trespasses and even fire.
- **Accessibility:** It should be accessible by the farm and also near a public road for fast market being reached.

Parts of farm building

Parts of the animal structures should have the following:

a) **Foundation:** The foundation is laid a depth of about 1-2m depth depending on the soil type. It should be strong enough to carry the whole building.

b) **Walls:** These can be made of stones, bricks, timber and blocks.

The types of materials used to construct the wall is determined by the following factor:

- Availability of the materials
- The use of the building
- Weather condition of the place
- Strength of the soil in the area

c) **Roof:** It provides protection of the animals or stored crops from damage by adverse weather conditions.

Features of a good roof

- Must be leak proof
- Should be able to withstand the load of the roofing material
- It should be durable
- Should be fire proof

Types of farm buildings

Livestock buildings and structures

These are structures used for handling livestock during various routine management practices. They include crushes, dips, dairy shed, poultry houses, rabbit hatches, piggery/pigsty, fish ponds, silos, zero grazing unit and beehives.

Crushes

These are used for restraining an animal when carrying out certain livestock routine practices e.g. spraying and milking.

Parts of a crush

- Holding yard
- Head rail
- Horizontal split and vertical bars help in fixing the animals head during dehorning
- Top bar at the front to allow exit of the animal

Examples of crushes

- A three-post crush normally used in handling one animal
- A crush for scarce farmers, it is longer than three post crushes
- A crush for holding many animals.

Dips

This is a farm structure designed to accommodate a chemical dip wash where animals are dipped for the purpose of controlling ticks

Parts of a dip

- **Collecting yard:** Used for holding animals before dipping.
- **Foot bath:** Animal's hooves are washed to be free from mud.
- **The sump:** A narrow entrance with short steps.
- **Dip tank:** It contains acaricide solution and animals are immersed here.
- **Drainage race:** Helps in recovery of the excess dip wash back to the dipping tank.
- **Silt trap outlet:** Helps in reducing siltation of the dipping tank.
- **Soaking pit:** It is a covered, porous-walled chamber that allows water to slowly soak into the ground.

Types of dips

- Plunge dips
- The Machakos dip

Advantages of plunge dip

- Many animals can be dipped in a single time
- It can be used several because of replacement
- Requires less technical skills and labour

Disadvantages

- There is a high risk of excessive dilution of the dip wash due to evaporation.
- It cannot be used on sick heavy and even pregnant animals.
- Initial capital of construction is high

Dairy shed

A dairy shed is part of the dairy unit that is used during milking

Parts of a dairy shed

- A night shades
- A calf 's pen
- A feeding and watering area
- The milking sections

There are two types of milking sheds

- **Permanent milking shed:** It has milking machine permanently installed at the milking section.
- **Movable milking section:** These units are fitted with small wheels which facilitate their movement to different sites.

Factors to consider in the construction of a dairy shed

Resting area

- It should be spacious enough to allow room for exercise enhancing proper physiological body functioning.
- It should have adequate feeding body functioning.
- It should separate milking area from the feeding, watering and exercise area.
- Calf pens should be near the dairy shed.
- Provision for proper waste disposal.
- The dairy shed should be built with concrete for easy cleaning.

Calf pen: The calf pen can be either communal or individual. The individual calf pens are, more suitable because:

- Provide better individual attention given to the calves
- There is minimization of disease spread

Features of a good calf pen

- It should provide complete separation of calf from other calves.
- It should be easy to clear
- It should be spacious
- It should be well ventilated
- It should allow the calf to have access to the mother.

Poultry houses: These are housing structures used for poultry production.

- These structures should be sited in free drainage areas and away from the house
- All the structures must provide warmth
- They should be damp free
- They should be well ventilated
- They should be properly lit.

They include:

- Poultry shed run
- Deep litter
- Battery cage
- Fold lark

Poultry shed and run: The run is enclosed with chicken wire. It has doors for use by the keeper to gain entry in the run. The shed is made of wooden walls to provide protection against bad weather and predators.

Battery cage system: These are structures used to house birds under the intensive systems of poultry production.

Advantages

- Less spread of parasitic diseases.
- Less feeding cost
- Culling is easy
- No broodiness in hens
- Farmers gets clean eggs.

Disadvantages

- High initial capital
- Higher maintenance cost
- Birds may get fatigue due to lack of exercise.

Coops: These are specialized types of cages that are used for rearing hens that are brooding, commonly used in small scale.

Fold lark: It has both run shelter section. It provides birds with space for exercise

Rabbit hutches /rabbitry

These are houses for keeping rabbits. The rabbit houses should be painted white to reflect much of solar radiation that might cause sunburn. A rabbitry unit is divided into two parts, the feeding and watering area and the resting and exercising area. The hutch should be in a site protected from prevailing wind direction. It is fitted on stands about 60cm above the ground.

Features of a good rabbitry

- Adequate ventilation and well-lit but protected from direct sunrays
- It should be spacious, space required 80-115cm.
- The floor of the hatch should have chicken wire mesh.
- It should be raised off the ground.

Piggery /pig sty

Pigs are very sensitive to extreme weather conditions therefore a piggery provide warmth and as well as ventilation.

Features of a piggery

- **Farrowing pen:** It is used for farrowing and ensuring the safety of the piglets. The pen is provided with a farrowing crate to prevent the sow to protect from lying on the piglets and a heat source to protect the piglets against chilliness.
- **Weaner's pen:** This is where weaned pigs are kept**.** It should have a feeding, watering, and resting section

Boar pen
This is where breeding boars are kept. It allows room for sow to be served during the breeding season.
Gilts pen
It is used for keeping young female pig's put on the age of service.
Fish ponds.
These are structures that are constructed in the farm for rearing fish. Fish ponds require a large amount of water therefore it is important to construct them near a water source e.g. river. The water should come from a higher ground so that it flows downhill into the fish pond and be drained out easily.
Procedure of establishing a fish pond

i. Site selection: Select a place where water flows from a source
ii. Site marking: After selecting the site, use pegs to mark the channel from the river, the entrance and exit of the pond and the channel to take water back into the river.
iii. Clearing the land: All vegetation is cleared off the site of the pond area.
iv. Digging the pond: Soil is dug out, the top soil is placed in a particular place as it will be reused. The upper side of the pond is dug 0.5m deep and lower side 1.5m.
v. Construction of the dyke: The dyke is the wall constructed all around the pond.
vi. Pond floor: A core is established by digging a trench 0.5m wide and lower than the dyke.

Parts of a fish pond

- **Inlet**
  This is a canal that brings water into the fish pond. A screen of fine mesh is filled across the inlet to prevent entry of undesirable species into the pond.
- **Outlet**
  It is made on the deeper part of the pond. It's fitted with mesh to prevent fish from escaping out of the pond. Used to drain water back into the river during harvesting.
- **Spill way**
  It is channel that allows removal of excess water from the pond. It is made of the top of the dyke on the lower side of the pond.

Factor considered when sitting fish pond

- Topography should be gently slopping
- Accessibility of the area
- Security of the area
- Free of pollutants from sewage and dumping site
- Nearness to water source
- Soil types

2.2 Structure and maintenance materials are identified and gathered according to animal housing plan.

This is how the different types of animal structures are maintained. Each and every structure will be discussed under the livestock structure.

The crush

Maintenance of a crush

- Repair any broken or worn out posts and rails.
- Apply old engine oil on the post made of timber to prevent destruction by termites.
- Carry out regular checks for any loose farmers.

The cattle dip

Maintenance of the dip

- Regular testing of the dip wash by use of a dip-testing kit to keep the chemical strength at the correct concentration**.**
- Clean foot bath before and after dipping.
- Lock the entire entrance to prevent access by intruders
- Drain away the dip wash carefully to avoid the contamination of pastures and nearby water sources.
- Ensure the roof of the dip is leak proof to keep off rain water.
- Repair any cracks in collecting guards, foot baths, dipping tank.

Dairy shed

Maintenance of the dairy shed

- Repair worn out or broken parts immediately they are noticed
- Clean the dairy shed regularly with detergents and disinfectants.
- Ensure proper drainage in the surrounding area.
- Ensure proper ventilation.

Calf pen

Maintenance of the calf pen

- Clean the calf pen regularly
- Repair leaking roof to prevent wetness of the floor
- Repair any worn out parts
- Paint the wall white to keep off flies
- Ensure proper ventilation.

Under the poultry structures

- Regular cleaning and disinfecting the poultry houses
- Ensure roofs are leak-proof.
- Minimize entry of dust into the poultry because dust is a predisposing factor to respiratory in birds.
- Dusting should be done to control external parasite.
- Repair broken parts of the structures.

Under rabbit hatch

- Repair broken parts
- Repair leak roof to prevent dampness
- Paint the wooden posts to long last
- Clean regularly

Under piggery

- Repair broken parts.

2.3 Animal structures are constructed according to animal housings plan in accordance to livestock production manual.

Proper housing and management of animal facilitate are essential to animal well-being. A good management program provides the environment housing and care that makes animals to grow, mature and reproduce and maintain good health.

Factors to consider in the livestock production.

- **Population management:** In this case identification is important. This is done by notching, putting tags, tattooing, colour staining, toe clipping, having identification cards where the different species are recorded. Record keeping is useful e.g. clinical records for individual animals. These help in identifying animals and knowing how they perform in the form, how they produce and also their health status.
- **Sanitation:** The housing should be clean to prevent attack the animals by pest that may cause diseases. This might reduce their production.
- **Husbandry Food:** Animals should be fed palatable, non-contaminated and nutritional food daily. The housing should be having a feeding trough to enable these animals have food for good product of the input products.
- **Environment:** The environment should have the best temperature and humidity not too cold or hot. There should not be noise to avoid disturbance of the animals.
- **Illumination and ventilation**: The housing plan should have light to help in physiological, morphological and behavior of the animals. The animal housing should provide sufficient illumination and ventilation to help in exhalation and inhalation.

Conclusion

This learning outcome has covered various animal structures and housing plan, maintenance of materials and construction of animal structures according to livestock production manual.

Further Reading

1. Agricultural information Centre, livestock development Nairobi.

2.3.3.3 Self-Assessment

Written assessment

1. Below are factors to consider while selecting a site. Which one is not?
    a) Soil type
    b) Security
    c) Type of material to use
    d) Topography
2. Which one is not a part of a farm structure?
    a) Animal
    b) Roof
    c) Walls
    d) Foundation
3. The following are structures used for handling livestock during routine management. Which one is not?
    a) Crush
    b) Dip
    c) Zero grazing unit
    d) Fold ark
4. Three except one is not a feature of a good calf pen?
    a) It should be easy to clean
    b) It should be spacious
    c) Should be far from the mother's house
    d) Should be accessible.
5. Parts of a poultry house include the following. Except which one?
    a) Poultry shed and run
    b) Poultry deep litter
    c) Chicken mesh
    d) Fold lark
6. Which one is not an advantage of having battery cage system?
    a) There is less spread of parasite diseases
    b) Less feeding cost
    c) Farmers gets clean eggs
    d) Higher maintenance cost
7. Which is not a part of a dip?
    a) Collecting yard
    b) Foot bath
    c) Soaking pit
    d) Coop's
8. List 5 parts of a dip.
9. What is the meaning of farm structure?
10. Discuss 5 advantages of a plunge dip.

11. Give 5 maintenance of crush in livestock structure.
12. Name out different types of animal structure.

Oral Assessment

1. Give out the factors considered in animal housing influencing their production.
2. List maintenance practices in rabbitry.

Case Study Assessment

1. Describe how roofing is done.
   Procedure for roofing
   i. Positions of the post are marked
   ii. Supports per the joints are prepared
   iii. Firming piece to be fixed on the joints to provide the required fall
   iv. Tongues or grooved boards are fixed on the joints covering the whole roof surface.
   v. Fascia boards are nailed at the lower and sloping edges to the joints.
2. Parade the milking bucket, a rope, a milking jelly, part of boots and dusting coat and demonstrate how milking is done.

Practical Assessment

3.3.3.4 Tools, Equipment, Supplies and Materials

- Cattle crush
- pig sty
- rabbit hutches
- battery cage
- zero grazing unit
- deep litter house
- fish pond
- fold lark
- poultry shed and run

3.3.3.5 References

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3.3.4 Learning Outcome No 3: Install and maintain livestock tools, equipment and machines

3.3.4.1 Learning Activities

Learning Outcome No 3: Install and maintain livestock tools, equipment and machines.	
Learning Activities	**Special Instructions**
3.1. Assemble tools, equipment and machines as per manufacturers manual. 3.2. Tools, equipment and machines are fitted as per the housing plan and requirement. 3.3. Clean tools, equipment and machines as per manufacturers manual. 3.4. Sharpen tools, equipment and machines as per manufacturers manual. 3.5. Grease or oil tools, equipment and machines as per manufacturers manual. 3.6. Replace tools, machines and equipment as per work policy	Describe the process of assembling tools in groups. Discussion groups Procedure of tools and equipment in groups

3.3.4.2 Information Sheet No3/LO3: Install and maintain livestock tools, equipment and machines

Introduction

Livestock tools and equipment are tools and equipment used for routine management practice in livestock. They are used for identification, castrations, dehorning, disease and parasite control, breeding, milking and restraining animals depending on the type of the tool. Livestock tools and equipment are maintained to manage durability of the user; there are several reasons for maintenance of farm tools and equipment which will be discussed below.

Definition of key terms

Livestock: It is commonly defined as a domestic animal which are kept in agricultural surrounding to provide labor and products.

Livestock tools: These are livestock items that are mainly used to achieve a particular goal.

Livestock equipment: Set of tools that are to achieve a particular livestock objective.

Machines: Mechanical structures that use power to apply forces and control movements to apply forces and control movement to perform an intended action

Content/procedures/methods/illustrations

3.1.Tools, equipment and machines are assembled as per manufacturers manual
Assembling of tools, equipment and machines should be done by experienced crew or personnel to cut off equipment setting cost which may arise is they are wrongly assembled. For example, during cleaning of machines, some parts need to be removed so that cleaning is effectively carried out.

Reasons for assembling tools

- To carry out maintenance practices
- For salvage purposes
- To put or store them according to their specific functions

N/B: The equipment is put together and the intended purpose for assembling is carried out. Assembling area should be near the store

3.2.Tools, equipment and machines are cleaned as per manufacturers manual.
Cleaning tools regularly is essential to their proper functioning. After day of work, machines and equipment will be dirt and should be cleaned after use to maintain long shelf life. During cleaning it's advisable to use manufacturer's guidelines for proper cleaning and maintenance. Extremely harsh chemical should be avoided when cleaning them.

To clean and maintain tools, the operator needs the following tools

- Cleaning supplies: They include detergents sprayer, sponge, old rags or towels
- Cleaning tools: For example, steel wool, scrub brush and a rotary wire brush attachment for drill
- Sandpaper used to work on both wood and metal works
- Lubricating oil: Such as boiled in seed oil, tang oil, lane oil or cooking oil the best preferred oil are in seed and tang oils
- Safety equipment: Wearing protective devices e.g. gloves, eye protection and dust mask when cleaning.

How to clean livestock tools, equipment and machines

Step1. Clean tools: Start by giving tools a good scrubbing to remove mud and grit from the blades and handles, dry them with old towels and set them aside overnight so that they dry completely, e.g. milking tools and equipment. If they are machines to be cleaned the cleaning site should have the following conditions:

- Close to the working are to minimize further contamination
- Accessible in all weather
- Contained for safe disposal of waste
- A way for water sources and public drains
- Flat for safety when working and to reduce run off

- Stable surface to prevent pre-contamination access to suitable cleaning equipment
- Identifiable for monitoring and controlling any pest that may establish on the site

Step2. Oil or grease metal parts: This will rust of the metal parts of the tools and equipment. Oiling the moving parts makes the easy to work with and increases the efficiency of the tool and equipment

Step 3. Waste disposal: Waste in the form of contaminated water, debris, dust of chemical will often be left on the cleaning site

Step 4. Hang tools and equipment: Tools and equipment should be hanged to prevent rusting while which may arise if placed on the floor

Step 5: Sterilization: Tools and equipment, machines for livestock should be sterilized especially for treating animals to control spread of diseases

Step 6. Store in their original cases: Tools and equipment should be in specific cases to protect them from damage. Machines should be packed or stored under shade

Reasons for cleaning tools, equipment and machines

- To last longer when maintained
- To make them work more efficiently
- To reduce the risk of injury to the people
- To reduce cost of maintenance

3.3.Tools, equipment and machines are sharpened as per manufacturers manual

Sharpening is done for tools used in cutting e.g. castrating knife, hoof trimming knife and tooth clipping knife to avoid injury to the animals.

Steps followed when sharpening tools and equipment

Step 1: Clean the blades

Clean the blade with stiff brush and soapy water to remove any dirt rush or debris. Dry them and wipe the blades with light coat of motor oil e.g. hoof trimming knife

Step 2: Examine the sharpness

Check first the manufactures guidelines and instructions for specific sharpening and cautions. Examine the blade edge to determine the correct sharpening angle

Step 3: Begin grinding the blades

Place the grinding stone in either water or vegetable oil to make it wet and act as a lubricant. Press the blade against the concave side of the stone while sharpening to maintain the correct angle. Keep the stone wet by periodically applying lubricant

Step 4. Smooth the edges

Use finer grain stone and continue sharpening until you achieve a razor-sharp edge after you have achieved proper sharpness and angle in step 3 above. Do not reduce the leveled edge to prevent breakage

Step 5: Test the sharpness

Holding the cutting edge onto a light source if bits reflecting the light it's not ready. retest sharpness until it is achieved

Step 6: Finish sharpening

Finish sharpening the blades by rubbing a light coat of oil on them to prevent rusting. Remove any dirt that has accumulated during the sharpening. Finally fix the tools to their store

Reasons for sharpening

- To prevent injury to the animal during operation
- To increase efficiency of the tool
- To safe time

Materials for sharpening

- Wire brush
- Sand paper
- Oils
- Sharpening stones
- Files
- Bench vise
- Grinding wheel
- Scissor sharpeners

Tools and equipment should be sharpened when they become blunt because work will be inefficient. In case of an injury to the animal, it may predispose it to secondary infections

3.4. Tools, equipment and machines are greased or oiled as per manufacturers manual

Steps followed during greasing /oiling

i. Start by choosing the grease gun loaded with grease as per manufacturer's instructions and precautions
ii. Locate the greasing points on the tool so that it will be easy to locate each day
iii. Quick inspection is to ensure grease nipples are not damaged
iv. If they are hand tools grease the blade and oil the rotating parts to prevent wear and tear
v. Wipe down the grease points with a rag to ensure there is no dirt accumulation
vi. Attach your grease nozzle and give a few pumps until you see grease exiting

Reasons for greasing /oiling

- To prevent wear and tear of livestock tools, equipment and machines
- To control rusting
- To reduce cost of maintenance
- To make the tool last long
- To increase efficiency
- Used to minimize power loss and heat generation

Tool used for greasing and oiling

- Greasing gun
- Fluids; oil and grease

Type of base oils groups

- Mineral base oils

These are derived from crude oil. They are used as lubricants in the automotive industry as well as industrial applications.

- Synthetic base oils

They are derived from the chemical reactions of several components. They are higher in viscosity components compared to mineral base oils. They require additive to improve viscosity?

Greases

They consist is base oil of base oil additives which increase viscosity of the lubricants. Greases creates a water proof barrier against external elements e.g. water

Types of greases

- Silicon greases
- Food grade lubricants

3.5. Tools, equipment and machines are replaced as per the work policy

Replacement is done when part or whole of the equipment breaks down. The tools can be repaired if possible because the replacement cost is high. There should be a data driven decision to determine whether to repaired or replace a piece of equipment.

Factors to consider during repairing and replacement

Analyze the cost

If it's new tool, consider its purchase cost, profit it will earn, salvage value, operating cost and service life. If the cost or replacement is higher than its value, the farmer should leave it.

Consider the age of the equipment

If the equipment is old, it requires a lot of maintenance, which is costly. Its effective to replace the old equipment with a newer and technology advanced model will give better efficiency and longevity.

Consider the cost of repair

The farmer should have a documenting asset repair events to provide information of repair. Its assist in making firm decisions.

Consider downtime

If the equipment takes a lot of time to repair, it will lead to low productivity? Decision should be made whether to repair or replace it

Consider safety

Old machinery may pose as hazard during operation if it malfunctions, the equipment will eventually wear out and therefore a decision should be made.

Reasons for replacing the equipment

i) Deterioration

It is caused by decline of performance due to wear and tear or misalignment indicated by;

- Increase in maintenance cost
- Increase in labor cost
- Loss of operating time due to breakdown

ii) Obsolesce

Equipment become obsolete due to advancement in technology and unwanted manufacturing cost.

iii) Inadequacy

If the equipment cannot meet, the demand it was designed for replacement is required.

iv) Working conditions

If the machine or equipment leads to increased accidents, it should be replaced.

V) Economy

If the existing equipment have outlived their effective life and it is not economical to continue with them.

Parts to repair

- Old equipment and machines should be replaced to increase productivity
- Broken parts
- Bend blades should be strengthened

Conclusion

This learning outcome covered on assembling, fitting, cleaning, sharpening greasing and replacing of tools, equipment and machines as per manufacturers manual. Failure to follow such instructions and precautions will lead to high maintenance cost and productivity will be low.

Further Reading

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https://garden solutions .ifas.ifl.edu/care/tools-and-equipments
Peak revision K.C.S,E AGRICULTURE Chapter 4

3.3.5.3 Self-Assessment

Written assessment

1. Which one of the following is a sharpening tool?
   a) Burdizzo
   b) Milking churn
   c) Files
   d) Stir cup
2. The following lubricants are used as equipment and machinery. Which one is more effective in lubrication?
   a) Oil
   b) Grease
3. Which one of the following reasons for replacement refers to the replacement of outdated equipment due to technology?
   a) Deterioration
   b) Obsolete
   c) Inadequacy
   d) Working condition
4. The following factor are considered when analyzing cost of replacement
   a) Salvage value
   b) Purchase cost
   c) Operating cost
   d) Technology
5. Which one of the following describes best the replacement of a tool or equipment?
   a) Age of the machine
   b) Cost of the equipment
   c) Cost of replacing the higher than the value of the equipment
   d) Salvage value
6. Which one of the following is not a tool of lubrication?
   a) Oil
   b) Grease
   c) Petrol
   d) Greasing gun
7. Greasing lubricants contains the following components except one. Which one is the odd one out?
   a) Additives
   b) Base oil
   c) Natural oil
   d) Gelling agent
8. What do you understand by the term lubrication?
9. Differentiate between a livestock tool and equipment.
10. Name two type of oils.

11. Give one reason for maintaining tools and equipment.
12. Give one reason for sharpening tools.
13. Name two types of livestock.

Oral Assessment
1. Give two examples of lubricants.
2. Give examples of sharpening tools.

Case Study Assessment
Visit the school farm store on the livestock tools, equipment and stationery section.
   a) Observe and identify each equipment state the function of the equipment.
   b) What do we mean by maintaining the tools?
   c) Give general reasons for maintain tools.

Practical Assessment
1. You have been provided with the following tools after they have been used in a livestock production unit; Burdizzo, wool shear, ear tagging, tattooing machine, disbudding wire and hoof trimming knifes.

Questions
   a) Perform the cleaning of each of the above tools
   b) Store them properly

2. You have been provided with the following blunt equipment;
wools shear, hoof trimming knife and teeth clipping knife and grease
Grease the above tools appropriately
3. On the above tools provided in questions 2 above. For each of the above tool carry out sharpening techniques in each

3.3.4.4 Tools, Equipment, Supplies and Materials
- Hoof trimming knifes
- Burdizzo
- Wool shear
- Ear tagging machines
- Hammer
- Tattooing machines
- Trocar and Canulla
- Teeth clipping knife
- Pig restraining
- Equipment feeding troughs
- Disbudding iron dehorning wire
- Milking pails
- Sieve
- Ropes
- Bolus guns
- Dewormers

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3.3.5 Learning Outcome No 4: Breed farm animals

3.3.5.1 Learning Activities

Learning Outcome No 4: Breed farm animals	
Learning Activities	**Special Instructions**
Identify livestock routine management practices based on animal type and category. Prepare livestock for breeding as per livestock production manual. Breed livestock in accordance with livestock production manual.	Provide materials for preparation of colostrum as per the students' requests. Take learners on a field visit to the school farm.

3.3.5.2 Information Sheet No4/LO4: Breed farm animals

Introduction

Animal breeding is aiming at the improvement of animals by changing their genetic make-up for important traits. Modern farm animals are managed as populations. Therefore, knowledge on the behaviors of genes in population is important. The learning outcomes to be covered include: Mating systems, feeding, breeding, Artificial transfer, Embryo transfer, Grading up program and Selection.

Definition of key terms

Animal breeding: The selective breeding of domestic animals with the intention to improve desirable qualities in the next generation.

Natural selection: The process whereby animals that are better adapted environment have a higher chance to survive and produce more offspring than less adapted animals.

Artificial insemination: Is the process of evaluating sperm cells from a male animal and manually depositing into reproductive tract of a female animal.

Embryo transfer: This is the transfer of embryo from a female to the recipient females, to achieve pregnancy.

Mating systems: The way in which individuals are grouped in relation to sexual characteristics of mate acquisition and mating behaviour.

Content/procedures/methods/illustrations

4.1 Livestock routine management practices are identified based on animal type and category.

Colostrum feeding: This is the first milk after parturition

Procedure: Allow the calf to feed in the first 15-30 minutes after parturition. This is done by allowing the calf to stay with its mother.

Importance of diestrum feeding:

- Helps the calf develop a strong immunity.
- Creates a tough coating in the baby's stomach and intestines to keep germs away.
- Has a laxative effect on the calf.

Preparation of artificial colostrum

Ingredients: An egg, half liter of fresh warm water, half liter whole milk, one teaspoonful of castor oil and one teaspoonful of cod liver oil and a bucket.

Procedure

i. Mix the ingredients in the bucket to make a paste like substance.
ii. Feed it to the calf 3 times a day.

Weaning

Separation of a calf from its mother

Process of weaning

i. The calf is housed separately and feeding is done artificially.
ii. The cow is milked out and some milk is fed to the calf.
iii. The calf is trained to feed from the pail.

Disbudding

This is discouraging of the growth of horns at a young age in calves.

Reason for disbudding

- To make handling of the animals easy.
- To reduce space requirement for the animals.
- To avoid inflicting injuries to another animal.
- It is less painful.

Process of disbudding

Removing by use of a hot iron

i. Ion wire is heated.
ii. The calf is restrained by tying down.
iii. The heated iron is placed on the horn from one side.
iv. The horn area is disinfected to avoid entry of diseases.
v. Use of chemical method
vi. Caustic potash is the chemical used. The hair around the horn buds and surrounding area.
vii. The chemical is rubbed over the buds until bleeding occurs.

Ear tagging

This is a method used for identification of farm animals.

Reasons for ear tagging

- Facilitates easy supervision.
- Makes record keeping easy.
- Enables easy selection for breeding.

Process of ear tagging

i. Assemble tags and tagging forceps.
ii. Locate the position of the tag between the base and the tip.
iii. Puncture the ear with the forceps.
iv. Apply the tag.

Castration: This is the destruction or removal of the testes, epididymis and a part of spermatic cord for a female animal.

Castration using a Burdizzo: A Burdizzo is held in hand and used to crush the sperm cord.

Castration using an elastrator and rubber ring

i. A rubber is stretched by using an elastrator.
ii. The rubber is placed just above the testicles and left until the sperm duct is cut.

D**isinfection**

This is the destruction of pathogenic micro-organisms from the animal's environment so that the place becomes free from infections.

Methods of disinfection

i. **Chemical disinfection:** They include the following: sodium hydroxide, calcium hydroxide, boric acid and copper sulphate.

Uses of chemical disinfectants

- Formaldehyde, is used for washing animal structures, such as floor
- Ammonium is used for washing to remove grease and all organic products from surfaces.
- Calcium oxide is used in disposing the animal's carcass during burial.
- Calcium hydroxide is used for washing white walls of farm houses.
- Chlorinated lime is used for water treatment.

ii. **Physical disinfection:** This includes, cleaning of animal structures by sweeping floor and changing the animal's beddings. Burning of waste materials is also a disinfection practice.

iii. **Isolation:** The process of segregation of affected animals from contact with other animals, the healthy ones. Such segregated animals should be housed differently from other animals. The person attending to the sick animals should be different from the one attending the healthy ones.

Deworming: This should be started from the first week of the calf

Factors to consider;

1. It should be done under the recommendation of a veterinary officer.
2. Should be done every 3 months and every month for the first months.
3. Over dose or under dose should be avoided to prevent side effects.

4.2 Livestock are prepared for breeding as per livestock's production manual

Selection

This is the process of allowing certain animals to be parents of future generations and cutting others

Factors to consider in selection

- **The fertility of the animal:** This is the ability to reproduce.
- **Mothering ability:** This is the ability to produce healthy and vigorous young ones.
- **Growth rate:** The growth rate of the parents is considered.
- **Body measurements:** The animal should have a normal body size and shape according to the species.
- **Feed efficiency:** The ability to absorb nutrients in feeds and produce properly is considered.
- **Carcass merit:** The ability to produce quality beef products; this is the weight of the animals considered.

Methods of selection

Methods of selection for single traits

i. **Individual selection:** Selection of their own performance that is selecting those characters that is shown by an animal and is desired.

ii. **Family selection:** Selection of traits based on the known characters of that lineage. For example, if a mother was a good milk producer, then it is selected for this reason.

iii. **Pedigree selection:** This is selection basing on the closely related ancestors. Useful when considering the same sex.

iv. **Progeny testing:** This is observing the performance of the offspring after several mating processes.

Methods of selection in Tandem selection

This is focused on multiple traits, but observing one at a time. After the performance of one is achieved, then move to the next trait.

i. **Independent culling:** A standard is set for more than one trait. After observation, those that do not meet the minimum standards are culled.

ii. **Culling:** This is a process of separating some animals from a group according to desired characteristics.

Process of culling

i. Those animals that have undesirable traits for instance, poor feed conversion, are removed from the rest.
ii. They are then either sold or kept for other purposes.
iii. The process is repeated until the trait is lost in the population.

4.3 Livestock are bred in accordance with livestock production manual.

Mating systems

Pure breeding: This is where parents of the same type mated to produce the same kind of offspring.

Out breeding. Allow those animals that are unrelated within a breed to mate and produce an offspring.

Line breeding: These animals that share a common ancestor and are mated. This allows desirable traits to remain in the population inbreeding. The organisms should not be more than 50% related.

Inbreeding: Those organisms that shore a common ancestor and closely related that is more than 50% related, are mated to produce offspring.

Cross breeding: Those organisms which belong to different breeds are allowed to mate. This allows introduction of new traits to the breeds. This also improves performance of the offspring.

Points to note from cross breeding

- Good cross breeds are due to good pure breeds.
- Hybrid vigor does not compensate for poor genetics.

Artificial insemination: This is the technique in which semen with sperm is collected from the male and introduced into female reproductive tract.

Methods of semen collection

i. Use of artificial vagina
ii. By electro-stimulation method
iii. By massaging the ampullae of the male

Process of semen collection

i. Sterilize and wash properly all the instruments; the insulating bag, rubber liner and rubber bands.
ii. Assemble the instruments to make an artificial vagina.
iii. Fill the artificial vagina with hot water at temperature of 45 degrees c.
iv. Lubricate the inner parts of the artificial vagina.
v. Restrain the bull and bring in a female cow, before the bull mounts of the teaser cow, grab the penis and insert it into the artificial vagina.

Methods of insemination

- Recto vagina method
- Vagina method

- Spectrum method

Process of insemination

i. When a cow is on heat insemination is done. The inseminator gets ready by putting on an apron, gumboots, and gloves.
ii. The semen is placed in warm water to make it liquid.
iii. The inseminator lubricates his hands and inserts them into the vagina, handing an AI gun loaded with semen.
iv. The inseminator deposits the semen by injecting the gun in the cervix.

Advantages of artificial insemination

- It prevents spread of diseases
- It is cheap because it does not require keeping a bull
- Breeding can be controlled
- Progeny testing can be done at an early age
- Increases the rate of conception
- Heavy sires can be used
- Semen collected can be used to serve many females

Disadvantages of artificial insemination

- Requires skill and proper training
- Requires more than natural services
- Improper cleaning of instruments may lead to fertility

Embryo transfer: This refers to a step in the process of assisted reproduction in which embryo are placed in the uterus of a female animal to achieve pregnancy.

Types of embryo transfer

- Fresh embryo transfer
- Frozen embryo transfer

Steps in embryo transfer

i. Selection of a donor
ii. Selection of a recipient
iii. Olestras stimulation of donor and recipient
iv. Ovulation of the donor with high quality semen
v. Artificial insemination of donor
vi. Embryo collection
vii. Evaluation of embryo
viii. Transfer of embryo to the recipient animal

Table 3: Evaluation of the Embryo

Grade	Type	Characteristics
1	Excellent	Symmetrical, compact, distinct outline and neither light nor dark
2	Good	Granulated with distinct outline, asymmetrical.
3	Fair	Hazy outline, extruded cell, asymmetric
4	Poor	Uneven granulation, hazy outline.
5	Degenerated	Developmental stage difficult to determine

Advantages of embryo transplant

- Increases the number of offspring sired from superior females
- Increases the frequency of desired mating
- It is possible to obtain offspring from incapable animals
- Importation and exportation are easier

Disadvantages of embryo transfer

- Can be expensive compared to natural processes
- It is costly to maintain
- Requires skilled personnel

Mutations: This is the sudden change in the genetic makeup of the population.

Why should the learner get the concept?

Most mutations are harmful and the process of induction of improvement of animals is not realistic.

Conclusion

This learning outcome covered on routine livestock management practices identified based on animal type and category. Breeding of livestock in accordance with livestock production manual.

Further Reading

1. Bourdon, Richard, M. (2000). Understanding animal breeding, 2nd edition, prentice hall. (sf 105)
2. Nicholas F.W. (2000). Introduction to veterinary Genetics, oxford university press.
3. Van Vleck, L.D, E.J. Pollak and Oitenacu (1987). Genetics for the animal sciences.

4.3.5.3 Self-Assessment

Written assessment

1. Which one of the following is not a type of mating?
    a) Selective mating
    b) Individual Mating
    c) Tandem Selection
2. Which one of the following statements best describes cross breeding?
    a) It is the mating between 2 closely related organisms
    b) It is the mating between 2 unrelated organisms
    c) It is the process of mating organisms with a common ancestor.
    d) None of the above
3. Identify a management practice in animals.
    a) Weaning
    b) Mating
    c) Weeding
4. Pick the odd one out.
    a) Milk
    b) One teaspoonful of castor oil
    c) Sugar
    d) Banana
5. Which statement describes budding?
    a) It is the removal of teeth in young pigs
    b) It is the removal of horns from young animals
    c) It is the process of separating animals in population
    d) None of the above
6. Which chemical is not used in disinfection?
    a) Formaldehyde
    b) Calcium oxide
    c) Titanium paste
    d) Lime
7. Select one practice that is used in single trait selection.
    a) Family selection
    b) Progeny testing
    c) Tandem selection
    d) Natural selection
8. State 2 methods of multiple trait section.
9. State the factors to consider in selection for breeding.
10. State 3 mating systems.
11. State the tools used in construction.
12. State 2 advantages of cross-breeding.

Oral Assessment

1. Discuss the advantages of artificial insemination.
2. Comment of the success of animal breeding.

Case Study Assessment

Considering the type of animal in your home or school, study the mating systems and observe the general level of breeding.

Practical Assessment

1. Using locally available material, prepare artificial colostrum.
2. Visit the school farm or a nearby farm and select the animals that you would use as sires.
3. With the guidance of your tutor, collect semen from a bull to be used in artificial insemination

4.3.5.4 Tools, Equipment, Supplies and Materials

- Artificial insemination kit
- Livestock breeds

1.3.5.5 References

Albert's, G., (2001). Lezing voor de workshop breeding and feeding for animal health and welfare in organic livestock systems. NAHWOA, 24-27 marts Wagenigen.

Bourdon, Richard, M. (92000). Understanding animal breeding, 2nd edition, prentice hall. (sf 105 B67200)

Bras comp E.W, (1998). The development animal breeding enterprise in the next decades: Reasons to change breed programmes. Acta. Agric. Scand. Section A, animal science Suppl. 28, 61-67.

3.3.6 Learning Outcome No 5: Practice Livestock husbandry

3.3.6.1 Learning Activities

Learning Outcome No 5: practice livestock husbandry.	
Learning Activities	**Special Instructions**
5.1. Adhere to livestock structures according to animal species in LPM. 5.2. Housing of livestock based on LPM. 5.3. Disinfection and cleaning of livestock structures as per LPM 5.4. Adhere to personal protective equipment as per occupation safety and health standards. 5.5. Adhere to biosecurity measure according to animal disease handbook and LPM.	Prepare learners to visit school farm Provide animal structure according to availability Prepare livestock and structures to carry out routine management

3.3.6.2 Information Sheet No3/LO5: Practice Livestock husbandry

Introduction

Animal husbandry deals with the feeding, shelter, health and management of domestic animals.

Definition of key terms

Bio- security: These are the procedures and measures designed to protect animal population from harmful biological or biochemical substances.

Shelter: This is a place where animals that have been treated badly, lost and not wanted by other animals are kept and catered for.

Disinfection: The process of cleaning animal structures and equipment in order to destroy bacteria.

Content/procedures/methods/illustrations

5.1. Livestock structures requirement are adhered to according to animal species specified in LPM

Importance of livestock structures

- Increase efficiency in livestock production
- Protects animals from rain, wind, and sun in order to keep them healthy.
- Animal feeds and products can be kept to avoid contamination and wastage.

- Farm machinery is protected from rain and dirt to keep them durable.

Siting of farm structures

This is the location of a particular area where a farm structure or building is to be established.

Factors to consider when siting farm structures

- **Type of soil:** Erect structures on firm well compacted and properly drained soils.
- **Prevailing weather condition:** Depending on the rainfall winds direction, a choice on the direction of the structure is made.
- **Topography:** Select a gently sloping land to ensure longevity of the structures
- **Security:** The site should be secured**.**
- **Ease of cleaning:** The area should have space for waste disposal to make cleaning easy.
- **Accessibility:** They should be located near the roads to make transportation easy. It should also be near the place of use.

Materials used in Construction

Factors to consider in selection of construction materials

- Availability of materials: Materials that are available are used.
- The use of the building.
- Weather conditions prevailing in the selected area.
- Strength of the soil in the area.
- The cost of materials.
- The type of technology used.

Parts of a structure construction

a) **The foundation:** Dig down about 1-2m deep. Excavate the trench at least 1m wide to allow working. Trim the side to straight vertical sides.

b) **Walls:** Vertical parts of a building. It can be made of stones, bricks, timber or blocks. Lay out the materials in a vertical way and ensure they are strong.

c) **Roof**: The roof protects the animals.

Requirements for Management practices

i. A crush

This is used when carrying out some routine livestock practices such as spraying and milking. During hand spraying, artificial insemination, milking and vaccination in cattle, they are held in a crush to make this practice easy.

Management of animals in a crush

Animals are arranged in a single row.

Those of the same age and size should follow one another.

Animals should move in one direction to make movement easy.

Dangerous animals should be restrained.

ii. **Dips**

These are farm structures constructed to hold acaricides, which animals are immersed for controlling ticks.

Livestock management at a dip

Animals are dipped once or twice in a week depending on the tick infestation. Provide animals with drinking water before dipping to avoid drinking acaricide Dipping is done in the morning. Animals should enter the dip in a straight line. Sick or injured animals should not be dipped.

All cattle should be dipped on the same day.

iii. **Dairy parlour**

This a diary shed used during milking.

Factors to consider when constructing a dairy shed

- Space: It should be spacious to allow space for comfort of the animal.
- Feed store and milking equipment should be available.
- Calf pen should be near a dairy.
- Waste disposal: Should have space for proper waste disposal.
- Resting area: The area should have a resting place to allow the cow to rest and chew cud.

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5.2Livestock are housed based on LPM/ Housing Livestock based on LPM

Factors to consider when choosing a livestock housing.

- The houses should allow for proper circulation of air.
- Should be affordable to the farmer and may be constructed using locally available materials.
- The houses should protect the animals from cold, rain and wind.
- The houses should be easy to clean.

Housing of cattle

Since goats are browsers, they are provided with a raised house to allow to allow them to exercise. The house should be well ventilated to allow free air circulation. Since goats are prone to pneumonia, the houses should be protected from cold. The floor should be raised to allow droppings and urine not to be accumulated. The house should allow goats to get direct sunlight.

Housing of rabbits

Rabbit hatches should have wide doors to allow the handlers to reach out to the animals. The height from the ground should averagely 1m to keep away from predators. The floor should be slated to allow droppings, urine and fodder to be drained off. The hatch should have a run to allow the rabbits to exhibit their natural instincts. Roof and wall materials should keep the interior free from rain and wind.

Poultry housing

Poultry housing selection

i. A structure that allows for easy composing of manure should be selected.
ii. Should be well lit to create a natural environment.
iii. Should be well aerated to avoid stress.
iv. Should be easy to clean; use of removable litter is recommended.
v. Wet floors should be avoided as chicken are sensitive to cold.
vi. Should provide recommended space per bird with a run for exercise.

Types of Poultry housing systems

a) **Free range:** Birds here are kept free during the day but housed at night.
b) **Deep litre system**: Birds here are kept together in in house with litre provided. Litre should be 5-10 cm deep.

Table 4: Stocking rate in a deep litter

Type of chick	No. per square meter
Mature layer	3-4
Layers chicks	20-25
Layers growers	4-6
Young broilers less than four weeks old	2-5
Boilers 4-7 weeks old	10-12

c) **Fold system**

Birds are kept in movable houses.

Figure 7:Fold system

https://www.thehappychickencoop.com/chicken-tractor/

Fish pond

Factors to consider during siting

Water should be available and flowing by gravity. The soil should be moderate clay that is not easily eroded and can hold water. The pond should be close to the markets to increase profitability. Site should be free from predators.

Structural Requirements

Inlet: This allows water to flow into the pond. It should be at an elevation.

Outlet: It allows water drain out of the of the point. This is located on the lower side of the pond.

Sloping bottom: The shallow end should be 50-60 cm deep while the deep end should be 100-120 cm on average.

Slopping sides: Sides should be slopping to allow weeds to provide food for fish to grow.

5.3. Livestock structures are cleaned, disinfected or fumigated as per LPM

Cleaning of Livestock Structures

A crush

Cleaning and disinfection

Brush off as much loose dirt and organic matter as possible then rinse the crush with clean water. Apply a high-quality foaming detergent to kill bacteria, allow to work for 20-30 minutes. It is then rinsed with clean water and leave to dry. Disinfect with a product such as Cyclex.

A milk parlour cleaning

It is advisable to perform a hot wash routine after milking for effective cleaning. External surfaces of milking equipment in the parlour are disinfected to kill mastitis pathogens and bacteria. Residual milk is drained from the pipes into the bulk tank, hot water is poured after it to ensure all residues are drained. Use of Sodium hydroxide as a disinfectant is advisable. Spread Calcium Carbonate at the entrance of shed area to disinfect the shoes of staff. Dung is removed and replaced with a bedding.

Poultry house

Since poultry production requires a high level of cleanliness and proper hygiene, cleaning tools such as broom, rakes and scrubbing brushes are vital. The poultry wastes are collected, put in a wheelbarrow and taken to the farm.

Fish ponds

The fish pond water should be allowed to flow out once a year to reduce accumulation of disease-causing organisms. Weeds that grow in the pond should be controlled by use of hand or mechanically in case of a large-scale production.

Rabbitry

Watering and feeding equipment should be cleaned regularly using clean water.

The bedding should be changed regularly and a new bedding provided. After cleaning the stoke the hatch should be disinfected using Sodium hydroxide.

5.4.Personal protective equipment is adhered to according as per occupation safety and health standards.

Protective clothing during handling of animals

- **Hard leather shoes:** A worker should put on shoes when disinfecting surfaces with chemicals such as acids and alkalis.
- **Apron:** Worn when handling potentially contaminated materials to avoid contamination.
- **Lab coat:** Worn over the other clothes to avoid contamination. For instance, by veterinary officer.
- **Face mask:** Worn to protect the face from injury. For instance, during harvesting of honey.
- **Gloves:** Worn to protect the hands from animals and animal products. For instance, droppings of birds.
- **Gumboots:** Worn to protect legs from injury and contamination. For instance, when cleaning farm structures.
- **Respirator:** Worn when handling chemicals that are volatile and also during spraying of livestock.
- **Veil:** Worn to protect the persons handling bees from stings.

Preventive measures to exposure to danger

a) Avoid wearing street clothes when working with animals.
b) Keeping cages and animal areas clean to avoid sliding and falling down.
c) Avoid skin contact with animal or animal products such as urine.
d) Training workers to recognize signs and symptoms to protect themselves from contact with the sick animals.
e) Keeping the recommended number of animals per square meter for easy and safe handling of the animals.

5.5.Bio- security measures are adhered to according to animal disease handbook and LPM.

Benefits of biosecurity

- Helps reduce disease and infection in animals
- Reduces the risks of losses
- Helps to keep out diseases
- Improves overall health of the animals
- Reduces mortality rates due to diseases
- Increases profitability of farm enterprises

General Biosecurity Measures

- Prior to entering a facility employees and visitors should wear protective equipment such as overalls.
- Equipment and other materials should be disinfected to prevent disease causing organisms and pathogens.
- Foot baths should be placed on the door, they contain disinfectants that kill pathogens.
- The younger animals should be handled followed by the older ones because they are more prone to infections.
- Those animals in the farm should not be allowed to be in contact with those from outside.
- Ensure the animal houses are clean at all times, to avoid breeding of vectors that carry diseases.
- Provide proper housing structures.

Biosecurity Measures for poultry

- Farmers should restrict visitors from entering the poultry unit.
- Workers of the poultry units should limit visiting other farms as they may bring pathogens.
- Other animals should be kept out of reach of poultry units because they may be carriers of some diseases.
- When there are new birds, they should be kept separate for seventy-two (72) hours.
- The feed should be free from contamination. For example, salmonellosis is transmitted through feed.
- Proper vaccination should be done to prevent disease infection, by boosting immunity.

Why are biosecurity measures are carried out for poultry?

This is because poultry are highly susceptible to diseases. During an outbreak, a farmer can lose the whole stock.

Conclusion

This learning outcome covered cleaning, disinfection, adherence to livestock structures, personal protective equipment, biosecurity measures as per the LPM.

Further Reading

1. Swine diseases transmission and prevention by Amass and Bay singer
2. Animal husbandry by A. Kumar.

3. Consumer attitudes towards the development of animal friendly husbandry systems by Frewer and A.Kole

5.3.6.3 Self-Assessment

Written assessment

1. Which of the following is not an importance of livestock structures?
    a) Efficiency
    b) Protection
    c) Feeding
    d) Security
2. The following are factors to consider when siting a structure. Which one is not?
    a) Topography
    b) Weather conditions
    c) Security
    d) Land availability
3. Which statement best describes disinfection?
    a) Cleaning structures and equipment to destroy bacteria
    b) Preventing effects to organism by routine practices
    c) Keeping farm machinery safe
    d) None of the above
4. Which of the following is not a farm structure?
    a) Crush
    b) Calf pen
    c) Farm
    d) Dip
5. Pick one factor that is considered in constructing a dairy shed.
    a) Space
    b) Land available
    c) Location of the farmer
    d) Type of the structure
6. A deep litter is a housing structure for which livestock?
    a) Poultry
    b) Rabbits
    c) Goats
    d) Fish
7. Pick a statement that describes a bio-security measure.
    a) Measures to protect the animals in a farm.
    b) Farm management process of biological agents
    c) Measures to protect animals from harmful biological substances
    d) None of the above
8. What do we mean by the term bio-security?
9. What is a shelter?

10. What are the structural requirements of a fish pond?
11. State four general Biosecurity measures.

Oral Assessment

1. Discuss the aspects of biosecurity that should be considered in pig husbandry?
2. What is the importance of animal structures?

Case Study Assessment

Visit a farm next to your school and observe the type of structures. State the factors considered in construction of the structures.

Practical Assessment

Construct a livestock structure of any animal of your choice.

Construct a guide to constructing a fish pond.

Visit the school farm and carry out one routine management practice of your choice and do it.

5.3.6.4 Tools, Equipment, Supplies and Materials.

- Zero grazing unit
- Pig stay
- Rabbit hitches
- Farrowing crates
- Feeding troughs waterers
- Milking pails

4.3.6.5 References

Julia Rothma.(2011), Farm Anatomy.ISBN.

L.J. Frewer, A.Kole., V.D. Kroon. (2006) Consumer attitudes towards the development of animal friendly husbandry systems.

M.Oesterheld,SJ McNaughton(2008), Effect of Animal Husbandry on Herbivore. Prentice Hall.

3.3.7 Learning Outcome No 6: Manage young and growing stock

3.3.7.1 Learning Activities

Learning Outcome No 6: Manage young and growing stock	
Learning Activities	**Special Instructions**
6.1. Weighing of young stock as per the manufacturer's specifications. 6.2. Feed young stock as per guidelines in LPM. 6.3. Wean young stocks following procedures stipulated in LPM 6.4. Housing young stocks according to breed and age as per LPM. 6.5. House young stock separately as per LPM. 6.6. Feed growing livestock according to the feeding standards as per feeding standards tables. 6.7. Assess fully grown stocks for breeding in accordance with LPM	Organize per student to visit the farm Provide some feeds for students to identify Set a written cat on the weaning procedure

3.3.7.2 Information Sheet No3/L06: Manage young and growing stock

Introduction

This learning outcome entails; weighing of young stock, feeding young stock, wean young stocks, housing young stocks, housing young stock, feeding growing livestock and assessing fully grown stocks for breeding in accordance with LPM.

Definition of key terms

Growing stock: A group of animals that have not attained the maturity age or state.

Parturition: Process of giving birth in cattle.

Weaning: Process of gradually introducing food to the young animals other than the mother's milk while withdrawing the supply of its mothers' milk.

Content/procedures/methods/illustrations

1.1 Weighing of young stock as per the manufacturer's specification

Weighing of young stock

Process of finding how heavy the young animals are using scales. Weighing of young animals is done regularly.

Reasons for weighing young stock

- Helps in determining feed quality to be given to the animal.
- Helps in picking the wearing time
- Helps in easy monitoring of the animal's health
- Helps in identification of the optimal breeding time
- Evaluates to identify best breeds for your firm
- Helps in measuring the correct dose of the rapeautic pharmaceutical to treat animal diseases.

Types of scales used for weighing

- **Pen like scales**

Used to weigh animals that are difficult to rule.

- **Flat scale**

Weighing large animals.

- **Square/rectangular scales**

Used for weighing heavy animals.

Factors to consider before buying a weighing scale

- Waterproof
- Durable
- Kind of animals
- Efficiency of the scale

Things to consider before weighing the animal

- Choose the right livestock scale
- Determine the weighing set up
- Use a stable weighing surface
- Check for interferences
- Minimize stress and livestock shrinking

How to get the animal weight

- Measure the girth of the animal in relation to the location of the animal's heart
- Measure the length of the animal's body

- Using the measurements from top 1 and 2, calculate the body weight using the following formula.

$$w \text{ (pounds)} = \frac{\text{Heart Girth} \times \text{Heart Girth} \times \text{Body weight}}{300}$$

Example;

$$\frac{1000 \times 80100 \times 300}{300}$$

=1,000,000 pounds

6.2. Feed young stocks as per the guidelines LPM

Feeding

Process by which young animals obtain feeds**.**

Factors to consider when feeding young animals

- Nutrient contents
- Particle size
- Quality of the feed
- Health condition of the animal
- Physiological condition of the animal

Water, protein and calcium are needed for all young animals to survive but some species have specific requirements that contribute to optimal health.

Feeding young animals

Feeding calves, lambs, kids

These animals can satisfy most of their dietary needs by foraging for nutrient rich vegetations, though most pastures do not contain large enough quantities of edible plants to provide the nutrients required for healthy development. Supplemental sources of nutrition are necessary to maintain the well-being of animals and support growth. Newborn calves must be fed colostrum from their dam immediately after birth because it carries immunoglobulins that are absorbed by the gut to help the immune system resist disease. This passive transfer of immunity has proven to improve growth rates and decrease costs associated with calves.

Piglets

Piglets rely on careful management to survive because they are born without anti body protection. Their bodies cannot regulate internal temperature and they only have enough fat energy for one day. The piglets must be given colostrum immediately after birth in order to strengthen their immune systems. Short and medium chain fatty acids stimulate the gut health of suckling piglets, achieving eubiosis. The nutritional requirements for pigs differ according to their various developmental stages where essential minerals, vitamins and amino acids are carefully added to support optimum performance.

Equines

Foals need a well-balanced intake of nutrients to develop properly and prevent disease or sickness from setting in. Nursing foals receive most of their nutrients from their mothers' milk where proteins, calcium, phosphorus and many others are provided. Newborn foals need to be fed colostrum to receive a high concentration of nutrients and antibodies from the dam. Colostrum also helps the foals to pass fecal excrement which would otherwise cause constipation.

Ducklings, goslings and chicks

They require constant access to amino acids, vitamins, minerals and antioxidants that contribute to healthy energy, metabolism and other necessary functions. A variety of physiological and morphological changes occur in young poultry immediately after hatching that affects their ability to digest food. During the post-hatch stage, nutrient transporters in young poultry are controlled by the level of protein they receive in their diet, as well as the quality and composition of feed.

6.3 Weaning of young stock following LPM procedures

Weaning in calves

There are two phases of young stock management on any dairy farm;

- The milk feeding calf phase from birth to weaning at 2-4 months of age.
- The weaned Leifer-rearing phase from weaning to point of first calving.

The milk feeding calf phase

The key principles of milk-rearing herd replacements;

- Ensuring healthy cows can give birth to healthy calves in a clean and comfortable environment.
- Providing suitable colostrum to allow adequate transfer of immunity.
- Supplying milk, fresh water, appropriate and finitely supplements
- Providing appropriate and clean housing
- Minimizing the risk of diseases and spread
- Managing the weaning process
- Instigating practice that reduce the risk of antibiotic and chemical residues.

Pre-calving

- Select sires for ease of calving
- Manage the transition period before and after calving to minimize metabolic diseases
- Ensure that the target mating weighs are achieved by joining heifers
- Implement a farm-specific vaccination program
- Prepare facilities for calving, concentrating on space and hygiene.

- Identification, target and recording
- Record all details of the birth
- Permanently identify each calf
- Set targets for feeding weaning and disease control
- Decide on a protocol for calling very sick calves

Colostrum feeding management

Consider vaccinating the cows for local diseases to improve the colostrum quality
Preferably separate the cow and calf within a few hours and administer the colostrum by hand.

Ensure an adequate colostrum feeding program;

- The quality of colostrum
- Quantity of colostrum feed
- The method of feeding colostrum

Milk feeding and access to drinking water

- Select the type of milk
- Beware of the potential problems with very cheap comply
- Do not dilute milk or colostrum with water
- Provide clean drinking water
- Use hot water, detergents and sanitizes when washing feeding equipment.

Solid feeds

- Provide good quality concentrates
- Understand the importance of adequate protein in the concentrates
- Decide on formulation
- Provide appetite from first week of age
- Do not mix concentrates with water
- Feed limited amount of forages

Preventing and treating scours

- Be aware that good colostrum feeding management is the key
- Be consistent with all feeding and herd management
- Minimize stresses on calves
- Understand scours and age when they can occur
- Understand how to assess degree of dehydration in sick calves

Health and herd management

- Dip the calf's navels in iodine solution soon after birth
- Understand calf behavior
- Be confident with veterinarian support
- Be aware of how to assist the veteran with follow up treatments of sick calves

- Minimize exposure to infections and faucal contamination of the calf rearing area
- Record all instances and degree of health problems for later reference
- Ensure newly introduced stock are kept in separate quarantine area
- Ensure all staff are aware of farm health protocol

Managing weaning

- Weaning must be carefully planned
- Decide on weaning protocol
- Immediately remove milk from the diet
- Note whether concentrate intakes quickly increase following weaning
- Minimize early post-weaning stress such as vaccinations and disbudding
- Move weaned calves to other pens only after a few days
- Continue feeding concentrates for many months even if forage quality is good

Environment management

- Protect stock from climatic stresses
- Consider sprinklers and fans in very hot climates
- Maintain a clean environment to minimize the disease risk
- Ensure the rearing facilities do not cause undue stress on newborn calves
- If cold weather is likely to be experienced, ensure the walls are solid to calf height.
- Provide artificial heating for sick calves in cold conditions

6.4 Housing young stock separately as per LPM

- Consider individual calf cages for rearing calves for the first weeks of life
- Ensure each pen has containers for fresh water, milk, concentrates and if being fed forages.
- If using group pens, ensure no more than six calves per group; with sufficient floor space for each calf.
- Ensure good spacing in the calf shed
- Provide adequate lighting in the shed for nighttime activities
- Ensure hot water is readily available for cleaning purposes

The weaned heifer phases

The key principles of rearing weaned replacement heifer are;

- Ensuring they grow well to achieve target live weights for mating and calving
- Basing the ration on high quality forages with concentrates specially formulated for growing heifers
- Suppling fresh water at all times
- Providing appropriate and clean housing
- Minimizing the risk of disease and disease spread

- Ensure welfare requirements are met for any calves sold

The aim of heifer rearing is to achieve maximum growth and development and earliest puberty at least cost.

Early post-weaning management

- Minimize stress immediately before and after weaning.
- Avoid moving calves out of milk-rearing pens for several days after weaning.
- Monitor individual concentrate intake after weaning to ensure rumen development is adequate.

Targets and recording

- Routinely weigh to monitor changes in live weight during heifer rearing every 3months.
- Use target live weights to modify feeding management if required
- Use body condition as an extra guide to heifer feeding management
- Record animal health treatment until first calving
- Plan mating at target mating weights
- Decide on protocol for calling very sick heifers

Forage quality

- Ensure the forage is of good quality
- Provide adequate forage
- Chop forages into small lengths
- Consider wilting fresh grass to increase forage intakes

Feeding of concentrates

- Feed concentrate until puberty depending on forage quality
- Ensure concentrates contain adequate proteins
- Decide on the formulation
- Provide fresh drinking water all times

Mating management

- Ensure target weights are achieved before joining heifers
- Seriously assess the benefits of synchronizing estrus in large groups of heifers
- Select bulls and semen on ease of calving
- Consider access to bulls for natural mating following several cycles of AZ.
- Ensure heifers are well fed and gaining weight during the mating period

Health and herd management

- Understand stocks behavior
- Plan for disease prevention rather than treatment
- If selling stock, ensure they are fit for travel and sale
- Ensure staff are aware of farm health protocol
- Newly introduced stock should be kept in separate quarantine area

Environmental management

- Minimize heat and cold stress as with milking cows
- Protect stock from climatic stress
- Consider sprinklers and fans in very hot climates
- Maintain clean environment to minimize the disease risk
- If cold weather is likely to be experienced, ensure walls are solid to calf height

Housing and facilities

- Heifers should have adequate space in their pens
- Good ventilation in the heifer shed
- Provide adequate lighting in shed for nighttime activities
- Provide small refrigerator for storing vaccines and other drugs in a secure area
- Devise a good efficient disposal system for regular cleaning of facilities

Pre-calving management

- Manage the transition period before and after calving to minimize metabolic diseases.
- Implement a farm specific vaccination program
- Prepare facilitate for calving, concentration on space and hygiene

Weaning pigs

Piglets are weaned any time after they have received the protection provided by colostrum. Diets have been formulated that permit piglet to wean 1 or 2 days after farrowing. However, not many pigs are weaned at this early age because of the exceptional management necessary to achieve it. Those weaned at 1 or 2 days are placed on milk replacer.

Milk replacer

Pigs up to 7-10days of age have a limited digestive enzyme capacity.

After 7-10 days, the piglet's enzyme system is mature enough to digest more common feedstuffs e.g. corn, soybean.

Pre-starters (8-14 days)

It is used for pigs that have been weaned prior to 3 weeks of age but have nursed for up to 14 days.

Total intake for a pre-starter is not high and probably will average 3.5lb per pig.

Starters (12-28 days)

This program will follow the pre-starter diet and can develop it by a couple of days.

It can begin for pigs that have been nursed for up to 2-3 weeks. The diet differs from pre-starters diet.

Early weaning

It's not a common practice. There is an advantage on early weaning of pigs. Once the baby pig has received colostrum diets are available that are superior to sows' milk. The pigs that are successfully weaned early will be uniformly heavier at 8weeks of age. The disadvantage of early weaning the pigs will need more sophisticated diets, more careful management and increased equipment.

Weaning at 8weeks

Many swine procedures wean pigs at 7, 8, 9 weeks of age. Such pigs have had access to simple creep diet e.g. coins.

Weaning of lambs and kids (sheep/goats)

There are factors considered when weaning lambs and kids. They include; age, season of birth, parasite problem, predator risks and forage resources.

Early weaning

It eases the lactation stress of high producing females and other females that may be highly stressed due to age and physical condition. It helps prolific females raise their offspring's. The females return to breeding condition earlier.

Advantage of early weaning

- It is less expensive to feed lambs and kids; young animals convert feed very efficiently.

Disadvantages of early weaning

- On the other hand, early weaning causes stress to both female and their offspring's.
- There is high risk of mastitis attack
- It requires more degree of management and more posture fields.

Late weaning

It is more natural and less stressful to lambs and kids

It allows producers to take advantage of available forage to finish their lambs and kids.

Management is simpler; female and offspring are maintained in a single group for a longer time.

Late weaning can become parasitized or killed by predators

6.6. Housing of Growing stock according to LPM

Factors considered when planning for appropriate environment for growing stock

- Individual characteristics e.g. sex, age, size, behavior and health.
- The ability of the animals to form social groups with conspecifics through sight, smell and possibly contact, whether the animals are maintained singly or in groups.
- The design and construction of housing
- Availability or suitability of enrichments
- Project goals e.g. production, breeding, research and testing

- Duration of the holding period
- Presence of hazardous or disease-causing materials
- Intensity of animal manipulation and invasiveness of the procedures conducted.

Individual Animals

Beef cattle

Housing requirements depend on season and age. As cattle mature, they are moved to what is known as feed lot. In feed lot, cattle are able to roam in large fenced areas, they allow for their free access to food and water.

Dairy cattle

The female calves (heifers) are placed in individual pens, e.g. hutches or together in groups, where they are fed milk replacer, grain, water and hay. At about seven weeks, calves are weaned, taken off milk and moved into group housing with other dairy heifers. The heifers then grow and once they have a calf, they begin producing milk and move into a barn with other cows.

Pigs

When the sow is almost calving, it is moved to the farrowing crate (gestation). The pens have metal bars that prevents the mother from the piglets when they are born. It prevents the mother from accidentally laying on the baby pigs and crushing them. It is easier to control temperatures and diseases in the farrowing crate.

Sheep

The type of housing necessary for sheep depends on the type of kind of production system and the time of the year the lambs are born.

Broilers

As the birds grow, the farmers will take the dividers down and let the chickens move around the entire barn. The chickens will be kept in this barn until they weigh about six pounds and are ready to go to market.

Layers

At 17 weeks old, the layers are moved into a laying house where they begin laying eggs. On larger farms, laying houses are connected by a series of conveyor belts that transfer the eggs from each.

6.6 Feeding of growing stock

Cattle

Calves over one year are fed on high quality roughage. A judicious mixture of roughage and concentrate is essential for obtaining optimum growth without undue fat deposition.

From six months onwards, calves can be given the same type of concentrate mixture (14-16%), Digestible Crude Protein and about 70% Total Digestible Nutrients as used for adult cattle house to a central building.

6.7 Assessment for breeding for fully grown stocks

Breeding: It is mating of the selected animals.

Methods used

- **Progeny testing**

Used when a high level of accuracy is needed for selecting a sire to be used extensively in artificial insemination. It involves choosing the sires and dams in the population based on an animal model evaluation.

The best 1-2% of the cows are chosen as bull's mothers and the best progeny tested bulls are chosen to produce generation of sires.

The parents are mated to complement any individual deficiencies.

- **Accuracy and selection**

Involves ranking candidates for selection depending on their performance record to a statistical model. A performance record (y) can be expressed as;

$y=g + e + \Sigma$

where, g stands for genetic effects

e stands for environmental effects (categorized)

Σ stands for random environmental effects

Conclusion

The learning outcome covered weighing, weaning feeding and housing of young stock based on LPM. It also covered housing and feeding of growing stocks and assessment of fully-grown stocks for breeding.

Further Reading

1. Merck manual October 2014, Nutritional Requirements of Beef Cattle Accessed March 18, 2015.
2.

4.3.7.3 Self-Assessment

Written assessment

1. Which one of the following is not a type of animal weighing scale?

a) Square
b) Flat
c) High
d) Pen

2. Which one of the following is a type of animal feed?
   a) Forage
   b) Nutrient
   c) Protein
   d) Carbohydrate
3. Which one of the following is not a ruminant?
   a) Sheep
   b) Cow
   c) Goat
   d) Pig
4. At what age are the pigs weaned?
   a) After two weeks
   b) 7-10 days
   c) Two weeks
   d) Two months
5. Why are calves fed with colostrum immediately after birth?
   a) Immunity
   b) Temperature
   c) Growth
   d) Breeding
6. What is the main reason for feeding young animals with high nutritive feeds?
   a) Growth
   b) Selection
   c) Breeding
   d) Parturition
7. Which one of the following is not a young one?
   a) Equine
   b) Piglet
   c) Lamb
   d) Foal

Short answer questions

1. What do you understand by the term parturition?
2. What is the meaning of the term weaning?
3. Name any type of weighing scale
4. State any factor considered when weighing the animal
5. Give any factor considered when feeding young animal

Oral Assessment

1. Differentiate between parturition and farrowing
2. State two methods of Breeding assessment

Case Study Assessment

1. Visit the university farm and carry out the following activities;
2. Identify the type of animals kept there and ages
3. Identify the type feeds given to them
4. Identify their housing depending on the ages
5. Calculate the body weight for each breed of animal kept

Practical Assessment

3.3.7.4 Tools, Equipment, Supplies and Materials

- Convectional and non-convectional livestock.

3.3.7.5 References

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CHAPTER 4: MANAGE SOIL AND WATER RESOURCES/ MANAGING SOIL AND WATER RESOURCES

4.1 Introduction

The unit specifies competencies required to manage soil and water resources. It involves aspects like assessment of area topography, conserve soil fertility, farm water conservation, design soil and water conservation structures, lay out soil and water structures, carry out farm irrigation, carry out farm drainage, farm water harvesting, waste water disposal, manage water supply and prepare soil and water resources management. The knowledge and skills gained on soil and water resources management will be critical in conservation of scarce water and soil resources.

The critical aspects of competency to be covered include; ability to test soil fertility, ability to design and construct farm water structures. Demonstrate understanding of soil nutrients, ability to asses area topography, ability to calculate fertilizer requirements, ability to manage waste water disposal, ability to prepare soil and water resources management report, demonstrate understanding of drainage systems, ability to harvest farm water, ability to irrigate farm and ability to manage water supply. Basic resources required include; Topography mapping tools, measuring tape, notebooks, levelling board, shovels, jembes, panga, water tanks, gutters, rope, soil auger, soil sample packaging bag and soil science laboratory and equipment.

The unit of competency covers eleven learning outcomes. Each of the learning outcome presents; learning activities that covers performance criteria statements, thus creating trainee's an opportunity to demonstrate knowledge and skills in the occupational standards and content in curriculum. Information sheet provides; definition of key terms, content and illustration to guide in training. The competency may be assessed through written test, demonstration, practical assignment, interview/oral questioning and case study. Self-assessment is provided at the end of each learning outcome. Holistic assessment with other units relevant to the industry sector workplace and job role is recommended.

4.2 Performance Standard

Manage soil and water resources as per; soil and water conservation manual, environmental management plan, waste water management manual, soil laboratory manual, soil and water conservation handbook and water supply and maintenance manual.

4.3 Learning Outcomes

4.3.1 List of learning outcome

a) Assess area topography
b) Conserve soil fertility
c) Conserve farm water
d) Design soil and water conservation structures
e) Lay out soil and water structures
f) Carry out farm irrigation
g) Carry out farm water drainage
h) Harvest farm water
i) Manage waste water disposal
j) Manage water supply
k) Prepare soil and water resources management report

4.3.2 Learning Outcome No 1: Asses area topography

4.3.2.1 Learning Activities

Learning Outcome No 1: Asses area topography	
Learning Activities	**Special Instructions**
1.1 Map area topography according to guidelines stipulated in soil and water conservation manual. 1.2 Asses area topography according to soil and water conservation manual 1.3 Document area topography as per soil and water conservation manual 1.4 Asses area topography for land use viability according to soil and water conservation manual	Demonstrate one soil and water conservation method using A- Frame

4.3.2.2 Information Sheet No4/LO1: Assess area topography

Introduction

This learning outcome covers; area topography, area topography mapping, assessment methods, land survey, land use systems and agro-ecological zones.

Definition of key terms

Topography: This refers to the arrangement of the natural and physical features of an area.

Land survey: It is the technique, profession, art and science of determining the terrestrial or 3 dimensional positions of points and the distance and angles between them.

Content/procedures/methods/illustrations

1.1Area topography to be assessed is mapped out according to guidelines stipulated in soil and water conservation manual

Mapping out area topography: The method for topography mapping involves:

- Using aerial photographs to determine distances, elevations and areas
- The distance, elevation and location measurement are taken in the field
- Record the measurements obtained in a field book
- Plot on paper in the office

The procedure for carrying out mapping or topographical survey includes the following steps:

- Determining enough horizontal location and elevation called side shots of grounds which will provide enough data for plotting during map preparation.
- Locating natural and man-made features that may be required for purposes of survey.

Topography mapping tools include: 3D surface view. Convert vector topographic maps, Raster DEMs and DEM extraction.

1.2 Area topography is assessed in accordance to soil and water conservation manual

Area topography assessment refers to mathematical measuring elevations and stream flow. It is also involves defining various geologic and geographical variables to describe a region. A topography assessment involves two steps;

- Measuring the elevations of the mountain peaks or raised services on the area under consideration. This is done as follows:

Using tools like transits with which the angle between measuring vantage and the sighted summit is taken at two points.

Construct a triangle with those two angles as corners and geometrically calculate the mountain heights.

- Taking measurements of streams.

Streams measurements include aspects such as width, depth, discharge volume and speed.

Methods of area topography assessment

It involves modern day remote sensing and satellite imagery analysis. An older survey is however used in on-the ground survey.

1.3 Assessed area topography is documented as per soil and water conservation manual.

Topography documentation involves the following procedure

i) Interpreting the colored lines, areas and other symbols, e.g. blue shading or coloring on maps usually represents water bodies while green shadings or shaded regions usually represent forested regions.
ii) Show features as points, lines or areas depending on their size and extent e.g. individual houses may be shown as black squares. Clusters of such small squares may be therefore representative of several houses.
iii) For large buildings, actual shapes are mapped as opposed to black squares.

Methods of documenting area topography

The following methods are used when documenting area topography: mapping, pictorial representations of topography. In mapping method, a key is provided which explains the symbols and features used in the map.

1.4 Area topography is assessed for land use viability according to soil and water conservation manual

Land use planning or Land use viability consists of a logical decision-making process in which the available resources are evaluated in the context of objectives and potentials are then identified which can be implemented by the user. Resource evaluation is carried out by a set of systematic technical procedure which will guide choice of sustainable options that will satisfy objectives of the land user. Procedure for assessing land use viability involves the following steps which aid in decision making:

i. Identifying stakeholders, their goals, needs and stake
ii. Establishment of multidisciplinary task force
iii. Collecting date and information
iv. Preliminary identification and screening of option
v. Negotiating and deciding upon options-Set up the plan
vi. Monitoring and evaluation of options.

Methods of land use viability: It involves 3 methods;

i. **National land use policy:** Refers to long term development objective formulated for allocation of the natural resources in the whole country
ii. **District land use plan:** It is based at district levels and has objectives which aim at development in the district level. It conforms to national land use policy.
iii. **Community land use plan:** People formulate objectives relevant to their community. The objectives should consider short- and long-term aspects and be focused on sustainable development of the community and its land resource

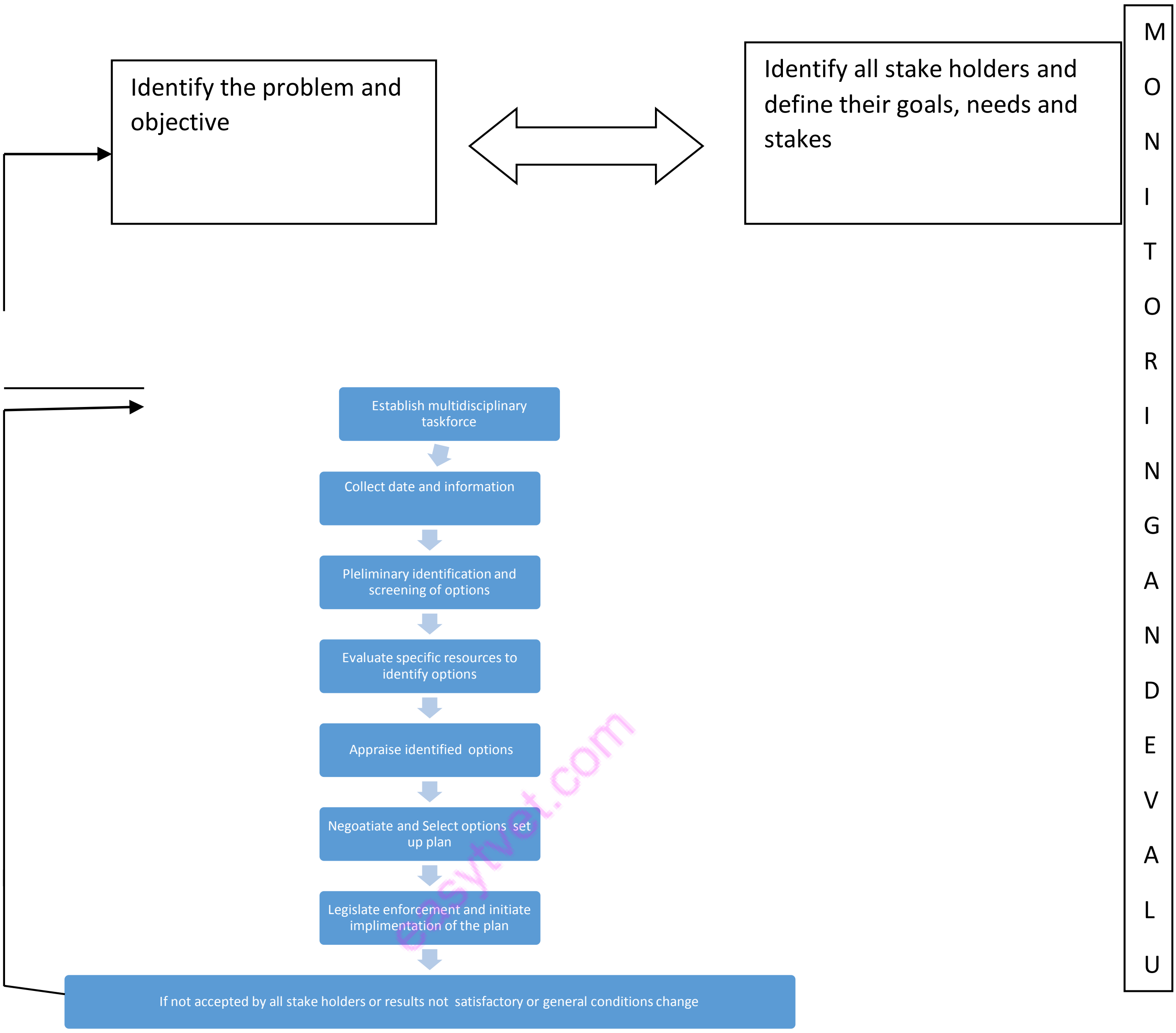

Figure 8: Planning Method

Conclusion

This learning outcome covered; area topography mapping, area topography assessment methods, land survey, land use systems, and agro ecological zones.

Further Reading

1. Journal of topography and land survey volume 8. Land surveying simplified. Paul L. Gay 2016

4.3.2.3 Self-Assessment

Written assessment

1. The following are area topography mapping tools except.
    a) 3D surface view
    b) Convert vector topography maps
    c) Topography instrumentation auger
2. The following aspects are focused about in land use viability except?
    a) Decision making process
    b) Soil degradation
    c) Resources evaluation
3. The following are agro ecological zones in Kenya except.
    a) Semi-arid
    b) Hot and wet regions
    c) Medium potential
4. The following aspects are assessed in measuring area topography except?
    a) Elevation of mountain peaks
    b) Flood water control
    c) Taking measurement of river’s depth, height and discharge
5. The following are steps involved in topographical survey procedure except
    a) Locating natural and man-made features
    b) Determining ground side shots
    c) Developing topographical map key
6. What is land survey?
7. Give two methods of land use viability
8. What is topography?
9. What do you understand by the term land use viability?
10. Give two steps in topography documentation.

Oral Assessment

1. How are symbols and features explained in a topographical map.
2. Give two steps involved in logical decision-making process

Practical Assessment

1. Carry out a topographical survey/mapping of an identified area.

4.3.2.4 Tools, Equipment, Supplies and Materials

- Topography mapping tools
- Measuring tapes
- Notebook
- Jembes
- Shovels
- Pangas
- Soil Auger
- Soil sample packaging bags
- Soil science laboratory and equipment
- Shovels

4.3.2.5 References

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4.3.3 Learning Outcome No 2: Conserve soil fertility

4.3.3.1 Learning Activities

Learning Outcome No 2: Conserve Soil fertility	
Learning Activities	**Special Instructions**
2.1. Sample Soil for fertility test following the procedures as per soil conservation handbook. 2.2 Test soil for nutrients elements as per soil laboratory manual 2.3 Record soil test results as per soil laboratory manual 2.4. Improve soil fertility through organic farming as per organic farming manual 2.5 Recommend soil fertility improvements given as per soil laboratory manual.	Demonstrate how to carry out soil fertility test in the farm

4.3.3.2 Information Sheet No4/LO2: Conserve soil fertility

Introduction

This learning outcome covers; basic soil science, soil nutrition, soil fertility management and improvement, fertilizer requirements and soil conservation systems.

Definition of key terms

Soil science: This is the scientific study of the soil including; soil formation, physical, chemical and biological properties of soil, classification and mapping of soils and these properties in relation to use and management of soils.

Soil nutrition: This is the prevention of soil loss from erosion or prevention of reduced fertility caused by over usage, acidification, salinization or other chemical soil contamination.

Content/procedures/methods/illustrations

2.1 Soil is sampled for fertility testing following procedures as per soil conservation handbook.

Soil sampling; this refers to the process of taking a small quantity of soil from the field to act as a representative sample of the soil in that particular field.

Significance of soil sampling

Analysis of the sample gives the farmer information about fertility status of the soil in order to:

- Optimize crop production
- Aid in diagnosis of plant culture problems
- Improve nutritional balance of the soil
- Protect the soil from contamination by leaching of excess fertilizers
- Saves money and conserve energy thus protecting the environment

Factors to consider in soil sampling

- Size of the land. The larger the size of the land, the higher the land, the higher the number of samples to be collected.
- Cropping systems. For most soil tests, the sampling depth is the tillage depth (6 inches).

For the deep rooted non legumes such as wheat, sorghum and cotton, a separate sample representative of the subsoil should be taken in addition to the tillage depth sample.

i. Past management: Fields used for production of cultivated crops may be sampled any time after harvest or before planting.

Non cultivated fields should be sampled during dormant season.

In either case, do not sample immediately after lime, fertilizer or manure applications.

ii. Sampling tools: They include:

- Soil auger, panga or spade
- Clean plastic bucket for collecting soil sample
- Sampling bags- for packaging of soil samples for submission to the testing Laboratories.

iii. Unusual areas during soil sampling: The following unusual areas should be avoided: dead furrows, terrace stands, old fence lines and manure heaps, swampy areas, near trees and boundaries and between slopes and bottom lands. These areas may not be representative of the field as they may give misleading information.

iv. Procedure for soil sampling

i. Divide the field into different homogenous units based on visual observation and farmer's experience.
ii. Remove surface litter at the sampling spot.
iii. Drive the auger to a plough depth of 15cm and draw the soil auger.
iv. Collect at least 10 to 15 samples from each sampling unit and place in a bucket or tray.
v. If the auger is not available, make a V-shaped cut to a depth of 15cm in the sampling spot using spade.
vi. Remove thick slices of soil from top to bottom of exposed face of the V-shaped cut and place in a clean container.

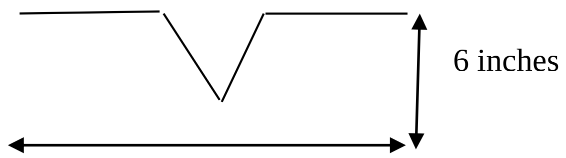

Figure 9: Sampling spot

vii. Mix the collected samples thoroughly and remove foreign materials like stone, pebbles and gravel.

viii. Reduce the bulk to about half a kg to one kg by quartering or compartmentalization. Quartering is done by dividing their ugly mixed sample into 4 equal parts. The two opposite quarters are discarded and the remaining two remixed.

The process is repeated until the desired sample size is obtained. Compartmentalization is done by uniformly spreading the soil over a clean hard surface and dividing into smaller compartments by drawing lines along and across the length and breadth. From each compartment, a pinch of soil is collected.

ix. To both samples obtained after quartering and compartmentalization, collect in a clean cloth or polythene bag.

x. Label the bag with information like: name of famer, location of the farm, survey number, previous crop grown, present crop grown, crop to be grown in the next season, date of collection and name of supplier.

The above procedure applies to shallow and deep-rooted crop.
For tree crops, soil sampling is done from a soil profile.

Procedure of soil sampling from a profile.

i. After the profile has been exposed, clean on efface of the pit carefully with a spade and note the succession depth of each horizon.

ii. Prick the surface with a knife or edge of the spade to show up structure, color and compactness.

iii. Collect samples starting from the bottom most horizon by holding a large basin at the bottom limit of the soil while the soil above is loosened by a khurei.

iv. Mix the soil sample and transfer to a polythene bag.

v. Label the polythene bag with information same as the one provided in sampling for shallow and deep-rooted crops.

Methods of soil sampling

There are two methods of soil sampling. These are:

i. Traverse method

ii. Zigzag method

i. **Traverse method**

In traverse method, four corners of the field are determined and sampling is done diagonally as illustrated below

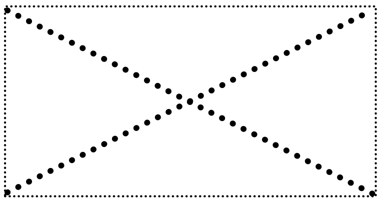

Figure 10: Illustration on traverse method

ii. **Zigzag method**

In the zigzag method, locations are arranged in such a way that they are in zigzag form. It is also referred to as random sampling method

The zigzag method is as illustrated below

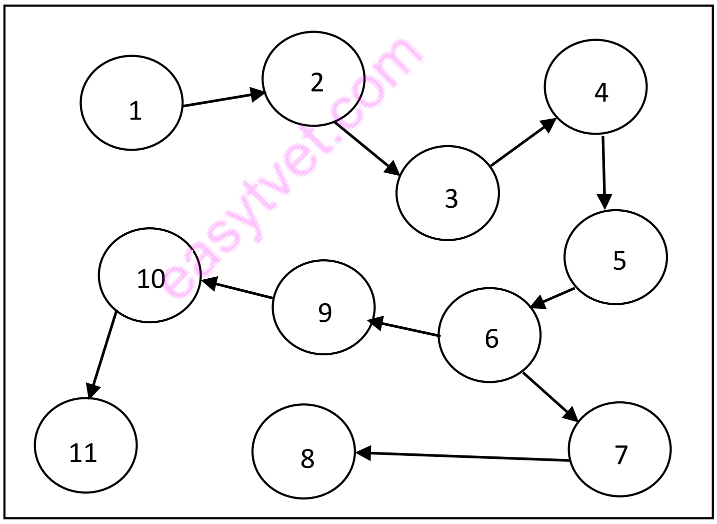

Figure 11:Zigzag Method

2.2 Test soil for nutrients elements as per soil laboratory manual.

Soil test: This refers to the analysis of a soil sample to determine nutrient content, composition and other characteristics such as the acidity and basicity.

In testing for soil nutrients elements, the soil test focuses on macro elements i.e. nitrogen, phosphorus and potassium.

Importance of soil nutrient testing

It may be carried for various purposes. Its main use includes:

- Monitoring of soil fertility levels
- Providing guidelines as to the type and amount of fertilizers to be applied for optimum plant growth on that particular field.

- As a diagnostic tool to help identify reasons for poor plant performance.
- Identifying and quantifying soil constraints. In order to obtain meaningful results, the following basic steps must be taken:
    a) Take a representative sample of soil for analysis.
    b) Analyze the soil using the accepted procedures that have been calibrated against fertilizer experiments in that particular field.
    c) Interpret the results using criteria derived from this calibration experiments.

Each of these steps may be under the control of a different person or entity e.g. soil samples may be taken by a farm manager or by a consultant agronomist then sent to an analytical laboratory for interpretation by an agronomist.

Procedure for testing nutrient elements

The three macro-nutrients i.e. nitrogen, phosphorus and potassium have same procedures for testing. The procedure is referred to as nutrient extraction filtration and is performed for all three analytes (nitrates, phosphates and potassium). Nutrient extraction filtration involves the following steps:

i. Secure one end of the funnel hose onto a vacuum jet.
ii. Secure the other end of the funnel hose onto the vacuum side arm of the flask.
iii. Assemble the funnel by snapping together the cylinder and perforated top disk.
iv. Place 1 clean filter paper on top of the funnel.
v. Turn on the vacuum jet.
vi. Slowly pour soil extract solution into the funnel allowing the extract to drain away from the soil and into the bottom of the funnel.
vii. Pour filtered extract into a new labelled 50 ml beaker. This filtrate will be analyzed as it is.
viii. Remove funnel, discard filter paper and rinse funnel and flask with deionized water. Use air jet to dry funnel and flask

Methods of testing for soil nutrients

These methods isolate each nutrient from the soil into a solution that can be analyzed using turbidity and color to determine the concentration of nutrients present in the soil sample. The analytical methods used by the soil test laboratory must be applicable to your region of soil testing to meet your specific needs. To determine available (and total) levels of specific nutrients present, a prescribed amount of extract is added to a fixed amount of soil and shaken for prescribed time before filtering to recover the extract (now dissolved nutrients) for testing.

2.3 Soil test results are recorded as per soil laboratory manual

After soil testing has been done, the results need to be documented well and in a precise manner. Accurate recording of results ensures efficient interpretation which then leads to appropriate recommendations about the soil test. The results can be tabled or recorded in chart forms. The table has a result section and an interpretation section box.

Procedure of recording results

- At the far left of the result section is a box labelled “sample/ field number” which contains the identifying number or name you attached to the soil sample when you sent e.g. 5.
- To the right of “sample/ field number” is “estimated soil texture.” Texture is determined by an experienced lab technician on the basis of how a moist sample feels when it is felt between the thumb and fingers. In this case, soil texture is classified as medium and if you go up to the soil texture code box in the interpretation section you will see this means that your soil sample. “organic matter” is 3.5%, “pH” is 5.5, “buffer index” is n6.2,” bray 1 phosphorus” is 10 parts

2.4 Soil fertility improvements recommendations are given as per soil laboratory manual

Soil fertility improvement: This basically refers to the process, techniques or ways of boosting amount of soil nutrients. Soil fertility depletion and soil degradation presents the most serious problems to African soil hence making them poor. African soil loses an annual average of 48kg/ ha of nutrients, the equivalent of 100kg/ year of fertilizer. To compensate for this loss, they receive a partly 10 kg of mineral fertilizer which cannot adequately cater for the loss. Maintaining or increasing soil fertility therefore is one of the most importance things farmers have to do to increase output. In maintaining and improving soil fertility, farmers have to know the characteristics and constraints of their soils and use sustainable agricultural practices and methods for conserving and making them fertile.

Causes of low soil fertility

- Loss of top soil due to erosion
- Uptake of nutrients by plants without replenishing/ adding absorbed nutrients to soil
- Increased acidity or basicity of soil leading to loss of some nutrients e.g. in increased acidity, nutrients e.g. nitrogen, phosphorous and sometimes potassium are low

Methods of soil fertility improvements

As a general consideration, the method to be used should be environmentally friendly and sustainable in the long run.

Some of the methods used in soil fertility improvements include:

i. **Use of organic fertilizers: manure, compost and crop residues**

Organic fertilizers are materials derived from plants and animal droppings e.g. weed residues, tree pruning, urine, green manure and crop residues. These are used to fertilize the soil. Plants contain three substances that determine their quality when their residues are used as organic fertilizers; these are:

- Nitrogen: Leguminous plants contain a lot of nitrogen fixing bacteria that fix atmospheric nitrogen into the soil through root nodules. Leguminous plants are therefore preferred for use as organic fertilizers as opposed to non-leguminous crops.
- Phenols: These are substances in the plants that make them rot slowly. Plant residues to be used as organic fertilizers should rot and decompose faster hence plants with less phenols are suitable for use as organic fertilizers.
- Lignin: This is a tough tissue like fiber which make up a plant stem. Plants with a lot of lignin are woodier hence rot slowly compared to herbaceous plants. Herbaceous plants therefore are highly recommended for use as organic fertilizer compared to woody plants since woody plants will rot slowly.

ii. **Liming**: This is the application of agricultural lime to soils so as to lower acidity. Acidic pH values of under 4.5 to 5.0 can severely damage the plants by causing nutrient deficiencies e.g. potassium, magnesium and toxicities of aluminum, manganese and iron. To neutralize acidity, lime must therefore be applied in the soil.

Advantages of Liming

- Neutralize acidity hence higher yields are obtained
- Prevents molybdenum deficiency
- Ensure water solubility and availability of phosphates to crops
- Improves the structure of heavy soils
- Promotes activities of soil microorganisms hence improving decomposition rotting of residues to release nitrogen, phosphorus, sculpture and other micro elements

iii. **Vermiculture/ vermicomposting:** Vermiculture refers to the growth of earthworms in organic wastes while vermicomposting refers to the processing of wastes using earthworms. Earthworms play an important role in improving soil fertility since they feed on dead and decaying materials, digest then excrete nutrients-rich dung.

iv. **Use of fertilizer trees e.g. Calliandra and Pygeum cefricana**

v. **Intercropping legumes with cereals**: Legumes will aid in improving nitrogen content of the soil since in their root nodules, there are nitrogen fixing bacteria e.g. rhizobium which fix nitrogen into the soil for plant cereals use.

vi. **Crop rotation**: This refers to the practice of growing different crops on the same piece of land at different seasons. Crop rotation prevents uptake of one nutrient by same plant species hence preventing loss of such nutrients. Rotating heavy feeder crops with light feeder crops also help in retaining crop nutrients.

vii. **Fallowing**: This refers to allowing the soil to rest for some period of time without crop establishments. It helps maintain and improve soil fertility since there is no nutrient uptake by plants during the fallow period.

viii. **Controlling soil erosion**: Soil erosion leads to loss of top fertile soil hence lowering fertility hence when soil erosion control measures are put in place, soil fertility is maintained.

ix. **Use of commercial fertilizers**: This refers to the application of artificial fertilizers e.g. calcium ammonium nitrate (CAN) and diammonium phosphate (DAP) to the soil.
However, the use of fertilizers must consider the chemical properties of the local soils, the crops planned and the required output. Farmers must also pay attention to environmental conservation i.e. they should not use ready-made fertilizers that have been designed for other regions. They need mixtures that have been especially formulated to address the deficiencies of that particular soil.

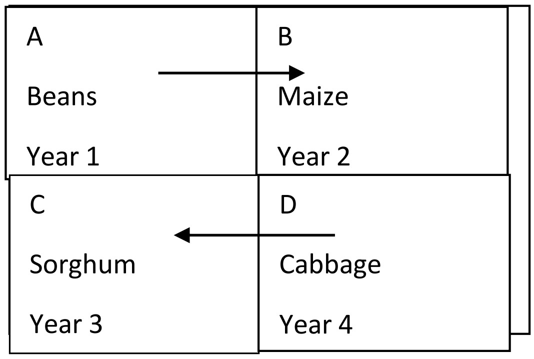

Figure 12: Crop Rotation

The field is divided into section and the crops are grown differently during different years on a rotational basis as shown using the arrows.

Conclusion
This learning outcome covered; basic soil science, soil nutrition, soil fertility management and improvement, fertilizer requirements, soil conservation systems.

Further Reading

1. Gichuru, M.P, Batiano, a Bekunda, Nyati, P. and Swift, M.J (2003) soil fertility management in Africa; A regional perspective. Academy science publishers, Nairobi, Kenya.

2. Carrow, R.N, Waddington, D.V and Rioke, P.E (2001). Turf grass soil fertility and chemical problems: Assessment and management, Ann Arbor Press, Chelsea

4.3.3.3 Self-Assessment

Written assessment

1. All of the following tools are used during soil sampling except
   a) Soil auger
   b) Dagger
   c) Sampling bags
   d) Soil testing kit
2. Which of the following best define soil sampling?
   a) Analysis of a soil sample to determine nutrient availability
   b) The study of soil and its properties
   c) Process of collecting representative samples in a particular
3. The following factors are considered in soil sampling. Except?
   a) Availability of funds
   b) Size of land
   c) Post management
4. The following are soil sampling methods. Except?
   a) Complete randomized block design
   b) Zigzag method
   c) Traverse method
5. The following are importance of soil testing. Except?
   a) Identifying and quantifying soil constraints
   b) As a diagnostic tool to help identify reasons for poor plant growth
   c) To prevent soil erosion
6. What do we mean by the following terms?
   a) Soil science
   b) Soil nutrition
7. Outline three basic steps to be taken during soil test to obtain meaningful results
8. Briefly outline the soil sampling procedure
9. Give 2 importance of liming
10. Mention three nutrients that are tested for in a soil test

Oral Assessment

1. What is the use of a sampling bag during soil sampling?
2. Mention any 2 areas to avoid during soil sampling

Case Study Assessment

Nduigula, a farmer in Meru while inspecting his farm, discovered his crops were withering despite the fact that he has been watering. He therefore consulted an agro-mist to assess the situation. Briefly explain what could be the probable findings of the agronomical assessment.

Practical Assessment

1. On a given piece of land, conduct soil sampling from a profile
2. Construct a vermicomposting bed-technique

4.3.3.4 Tools, Equipment, Supplies and Materials

- Note book
- Jembes
- Soil sample packaging bags
- Soil science laboratory and equipment
- Soil auger
- Topography maps

4.3.3.5 References

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Savala, C.E.N (2003). Using Earthworms to make vermicompost. Chapter 11

Schroth, G and Sinclair, F.L (2003). Trees, crops and soil fertility. CAB publishing.

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4.3.4 Learning Outcome No 3: Conserve farm water

4.3.4.1 Learning Activities

Learning Outcome No 3: Conserve farm water	
Learning Activities	**Special Instructions**
3.1 Identify farm water sources as per soil and water conservation manual 3.2 Identify farm water conservation methods as per soil and water conservation manual 3.3 Construct farm water conservation structures as per soil and water conservation manual 3.4 Care of conserved farm water to minimize wastage as per soil and water conservation handbook	Discussion Field excursion Constructing farm water conservation structure

4.3.4.2 Information Sheet No4/LO3: Conserve farm water

Introduction

This learning outcome covers; sources of farm water harvesting methods, water conservation systems and water conservation method.

Definition of key terms

Water conservation: This refers to the preservation, control and development of water resources, both surface and ground and prevention of pollution

Water harvesting: This refers to capturing rain water where it falls and capturing the runoff from catchment, streams etc. and collecting the run off for productive purposes.

Content/Procedures/Methods/Illustrations

3.1 Farm water sources are identified as per soil and water conservation manual.

Sources of water in the farm

There are three typical sources of agricultural water in the farm. These include:

- Surface water: Rivers, streams, irrigation ditches, open canals, impounded water such as ponds, lakes and reservoirs
- Ground water from wells and boreholes
- Rainwater: Locally collected water such as cisterns, rain barrels and water storage tanks

Factors to consider when choosing or identifying sources of farm water.

The following guidelines or procedures are followed when settling on a source of water in the farm.

i) **Soil type:** The soil type should support the lay down of structures which will be used when conveying water to the farm. The soil type should also support construction of a particular source for example in ground water sources when drilling of wells.

ii) **Land topography:** The topography of the land is considered especially when choosing surface water e.g. rivers. This is because for the farm, the land should be gently sloping.

iii) **Availability of capital:** Different sources of farm water have different capital requirements e.g. ground water sources require a lot of capital to construct wells and boreholes as opposed to surface water where rivers or streams provide farm water.

iv) **Water quality:** Rainwater has a better quality hence preferred as a source of water.

Farm water sources

Surface water: This is rain water running off from land surface into rivers, lakes, seas and which can be collected, stored and utilized through rain water harvesting. The runoff is collected by use of ponds and earth dams e.g. charcoal, hillside and valley dams. The method depends on some factors e.g. type of landscape available like;

a) **Charco dams:** Suitable for flat land, preferably with road catchment to supply rain water run off

b) **Hillside dams:** Best option for slightly slopping land in places where rain water flows

c) **Valley dams:** Built on valleys flooded with low floods catchment.

Charco dams: Are built in a way which reduces evaporation losses but deepening water reservoirs and minimizing their surface area. Trees, shrubs are grown on the windy side of the dams to function as wind breaks and reduce evaporation

Site selection for charco dams: The best sites for construction are in natural depressions where runoff water flows or accumulates during rainy seasons.

Best soils

Deep clay soil or black cotton soil. Coarse sand should be avoided as they lead to high seepage loss through permeability. Seeping can also be controlled through plastering clay soils and use of compactors made of tree trunks. The site should be located near a gully or a natural water way that carries water during and after rainfalls as the water can easily be diverted into the dam.

Size of charcoal dams

The sizing depends on:

i) Area available for construction

ii) Expected volume of runoff water catchment

iii) Farmers capacity to hire laborers to assist in excavation

Hill side dams

Are small earth dams with curved walls. The curved heap becomes dam wall while the excavated pit will be the water reservoir. The size of the dam wall and its reservoir depends on the capacity to remove soil from the reservoir and placing it on the dam wall. The gradient of the sides of the dam should be 2:1 i.e. 2m width for every 1m height.

Figure 13: Hill side dams

https://www.researchgate.net/figure/10-Example-of-a-hillside-dam-in-the-Darwin-catchment-Photo-CSIRO_fig38_329828621

Valley dams

An earth dam built in a valley is the cheapest way to create water storage since the excavation work is less than hillside and charco dams. However, the gain in cost per volume can be lost easily due to one heavy thunderstorm or shower. The washout of a dam wall can be very serious and endanger the lives of both livestock and man hence experienced technical help should always be sort to design and construct valley dams.


Figure 14: Valley dams

https://www.elanvalley.org.uk/discover/reservoirs-dams/6-dams

Ground water

Ground water is rainwater that has percolated into the ground. There are two main types of ground water namely:

- **Shallow ground water**: This refers to ground water that can be reached by means of hand dug well in areas where rainwater has been trapped in the underground e.g. seasonal water courses, river Sand lakes.
- **Deep ground water:** It is rainwater that has percolated deep into the ground during centuries or thousands of years. Deep ground water can only be reached by drilling deep boreholes from where water is extracted using electric powered submersible pumps. Deep boreholes often suffer from sinking water level and high salinity hence deep ground water is not an efficient farm water source.

How to identify places with shallow ground water tables

Water: Indicating vegetation and trees. This involves use of tree species which have their tap roots reaching the water tables.

Table 5: Shallow ground water tables

Botanical name	Kiswahili/kikamba names
Cyperus rotundus	Kiindium
Delonix elota	Muiru kikomoa
Vangueria tomentosa	mwangi

In this method of identification; the height of the tree is found by measuring the length of the shadow the tree is casting on the ground and comparing it with the length of a shadow of a stick 100 centimeters long. Both measurements should be taken in the sunshine of early morning or late afternoon when the shadows are longest.
An illustration is shown below

Figure 15: Sticks' Shadow

E.g. if the sticks shadow is 80cm long, the ratio is 100/80 =5/4 of the tree's shadow. If the tree's shadow is 12m long, then the tree is 12m x 5/4=15m high and the tap root and water level is at 15m x ¾=11.25 depth. The tap root of a tree has a depth equal to about ¾ of the height of the tree

Rainwater harvesting

Rainwater harvesting running for land surface can be harvested, stored and utilized using a technique called rainwater harvesting instead of being washed in rivers, lakes and seas. Rainwater harvesting consists of 5 methods of rainwater harvesting

i) Catchment areas also called watersheds onto which rainwater falls
ii) Gutters or conveying channels to bring rainwater from a catchment area to storage reservoir
iii) Storage reservoirs can be tanks, ponds, dams
iv) Retrieval water is extracted from reservoirs either by gravity or by pumps and lifts

3.2 Farm water conservation methods are identified as per soil and water conservation manual

Farm water conservation is a key component in production of both crops and livestock. Water conservation in the farm entails strategies that ensure efficient utilization of available farm water, preservation and storage of farm water for future use.

Methods of farm water conservation

The following techniques or methods can be used in conservation of farm water. These methods not only optimize water usage but also produce healthier crops with less water. They include;

i) **Organic farming:** Organic farming conserves soil moisture, add more groundwater and prevent pesticides from going into streams and other bodies of water. This conserves water bodies by preventing pollution. Application of organic manures instead of artificial fertilizers help in conserving soil moisture since organic manures buffer the soil cushioning it against excess moisture loss.

ii) **Installing better water systems:** Some irrigation methods e.g. basin and furrow irrigation require a lot of water which at times leads to wastage of run off. Such water intensive methods also lead to soil erosion leading to pollution of water sources when silt is deposited in the water sources. Better watering systems e.g. watering through drip irrigation instead of the traditional overhead spray method can decrease evaporation and save up to 80% of water.

Advantages of drip irrigation as a water conservation method

- Field levelling is not necessary.
- Fertilizer and nutrients loss are minimized due to localized application and reducing leaching.
- Water is directly applied to the plant roots thereby minimizing water loss when water is applied to other parts of the field where crop is not growing.

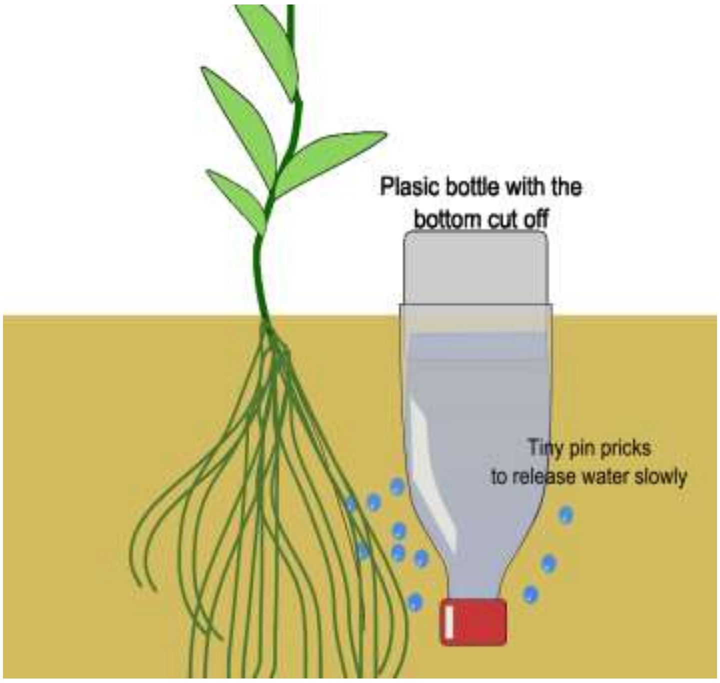

Figure 16: Drip irrigation

https://www.google.com/search?rlz=1C1CHBF_enKE847KE847&sxsrf=ACYBGNQGUjRwKxqjgOLGVo3O9cBw0kY23Q:1572855488013&q=diagram+of+drip+irrigation&tbm=isch&source=univ&sa=X&ved=2ahUKEwi4nZWlj9DlAhUNCxoKHTYmDLcQ7Al6BAgHED8&biw=1366&bih=608

Choosing more drought tolerant crops

Different crops have diverse water requirements i.e. some crops require a lot of water for healthy growth while others require little water for growth. In dry regions therefore it is recommended that farmers consider growing crops that are adapted to periods without enough water. This can help cut down on watering. Example of drought tolerant crops to consider include cassava, millet and sorghum instead of growing maize, beans and other horticultural crops.

Harvesting and storage of rainwater

Harvesting rainwater not only prevents run off wastage but also help in putting the rainwater into productive use. The harvested rainwater can then be stored and used in future when there is insufficient rainfall.

Irrigation scheduling

Smart water management and conservation is not just about how water is delivered but also when, how often and how much water is supplied to crops. To avoid under or overwatering their crops, farmers carefully monitor the weather forecast as well as soil and plant moisture and adopt their irrigation schedule to the current conditions. An example of irrigation scheduling is carrying out flood irrigation in orchards at night to slow down evaporation allowing water to seep down into the soil and replenish the water table.

Rotational grazing
This is the process in which livestock are moved between fields to help promote pasture re-growth. Good grazing management decreases the run off and rotational grazing also conserves water by increasing soil organic matter when animals drop dung. Further it conserves water by improving forage cover hence preventing soil water evaporation and erosion.

Compost and mulch
Mulch refers to materials spread on top of the soil to conserve moisture. Mulch can be either organic or inorganic. Organic material e.g. straw or wood chips when used as mulch break down into compost, further increasing the soils ability to retain water. Inorganic mulch e.g. black plastic mulch when used as soil cover suppresses weed and reduces evaporation. Compost or decomposed organic matter used as fertilizer; has been found to improve soil structure, increasing its water holding capacity thereby conserving soil water.
A simple mulching technique is illustrated bellow;

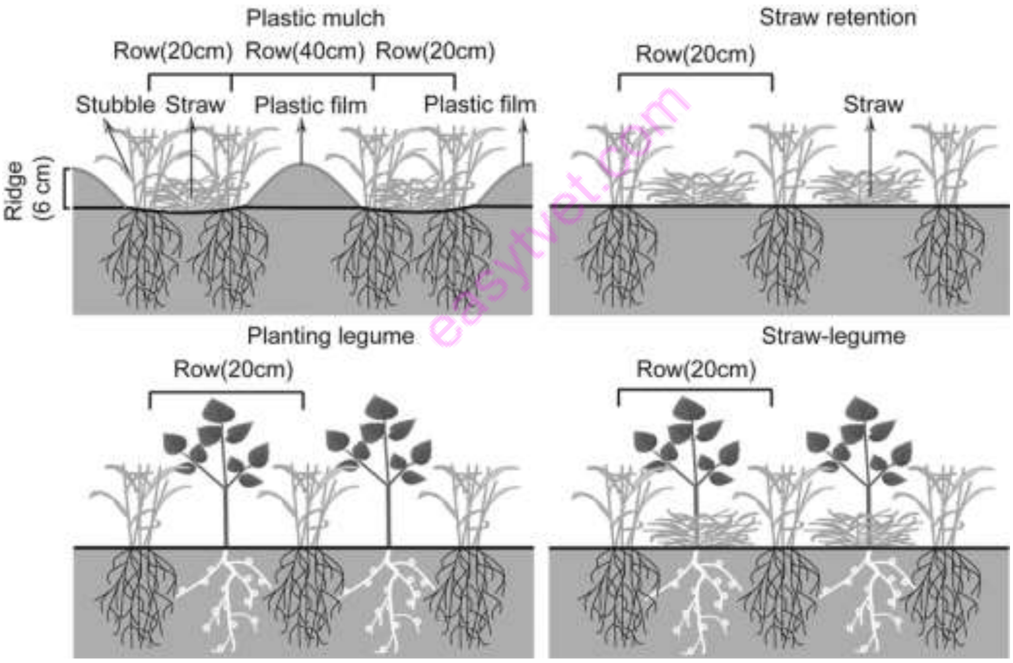

Figure 17: Simple mulching technique

https://www.researchgate.net/figure/Schematic-diagram-showing-the-treatments-of-plastic-mulch-straw-retention-planting_fig1_298724105

Conservation tillage
This refers to application of tillage methods that cause least disturbance of soil and causing minimum loss of soil vegetation cover. Cover cropping as an example of conservation tillage technique increases water absorption and reduce evaporation, erosion and compaction

3.3 Farm water conservation structures are constructed as per soil and conservation manual

Soil and water structures includes all mechanical or structural measures that control the velocity of surface runoff and thus minimize soil erosion and retain water when it is needed. These structures can be constructed to either conserve or discharge water safely. The suitability of soil and water conservation structure depends on the following guidelines:

i) Climate and the need to retain or discharge run off
ii) Farm sizes
iii) Soil characteristics (textures, drainage and depth)
iv) Availability of an outlet or water way
v) Labour cost and availability
vi) The adequacy of existing agronomic or vegetative conservation measures

Methods of constructing soil and water conservation structures

These structures are physical soil conservation structures which are permanent features made of earth stones or masonry to protect the soil from uncontrolled run off and retain waterhence conserve the water when needed. They include:

i. Cut off drains
ii. Retention ditches
iii. Infiltration ditches
iv. Water retaining pits
v. Broad beds and furrows
vi. Terraces- fanya juu, fanya chini, bench and stone terraces

i) Cut off drains

They are dug across a slope to intercept surface run off and carry it safely to an outlet such as a canal or stream.

ii) Retention ditches

These are dug along the contours to catch and retain incoming runoff and hold it until it seeps into the ground. They are an alternative to cut run off. They are often used to harvest water in semi-arid areas.

iii) Infiltration ditches

This is a structure designed to harvest water from roads and other surfaces run off. They consist of 0.7-1.5m deep, dug along the contour up slopes from a crop. Water is blocked at one end after being deviated from the roadside into the ditch. The trapped water seeps into the soil.

iv) Broad beds and furrows

In a broad bed and furrow system, runoff water is diverted into the field furrows (30cm deep and wide). The field furrows are blocked at the lower end when water fills up, it overflows into the next compartment.

v) Terraces

Fanya juu terraces (converse terraces)

Are made by digging a trench along the contour and throwing the soil uphill to form an embankment. The embankment is stabilized with fodder grasses in between cultivated portions. They are useful in semi-arid areas to harvest and conserve water.

An illustration of fanya juu terrace.

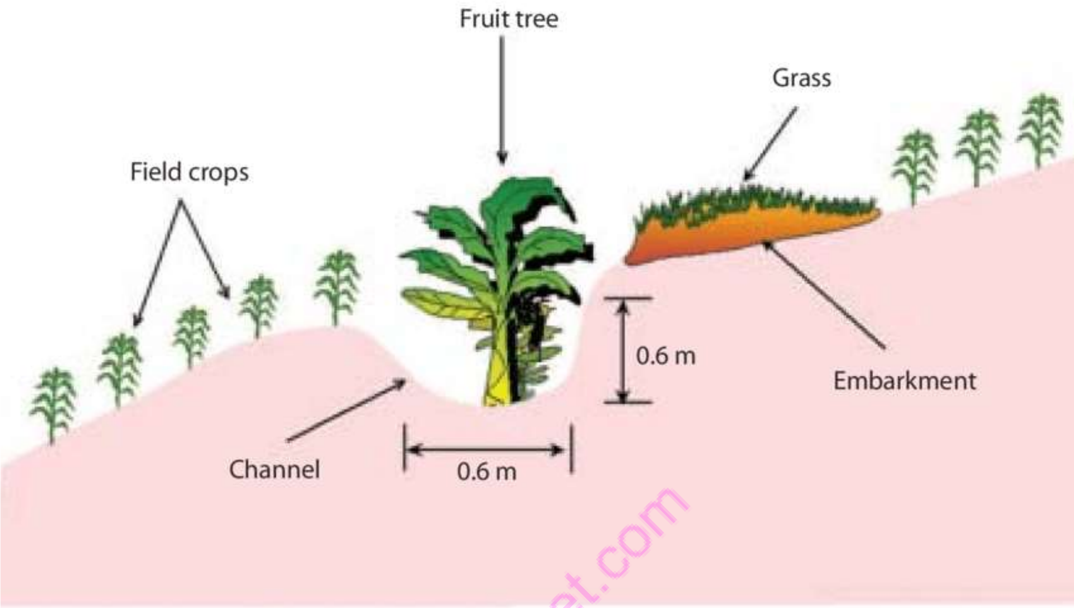

Figure 18:Fanya juu terrace

https://www.researchgate.net/figure/Illustration-of-a-fanya-juu-terrace_fig2_254426136

Fanya chini terraces

They are made by digging a trench along the contours and soil is put on the lower side of the contours trench.

Bench terraces

These are leveled or nearly leveled steps constructed or formed on the contour and separated by embarkments known as risers. They are formed by excavations or developed from grass strips.

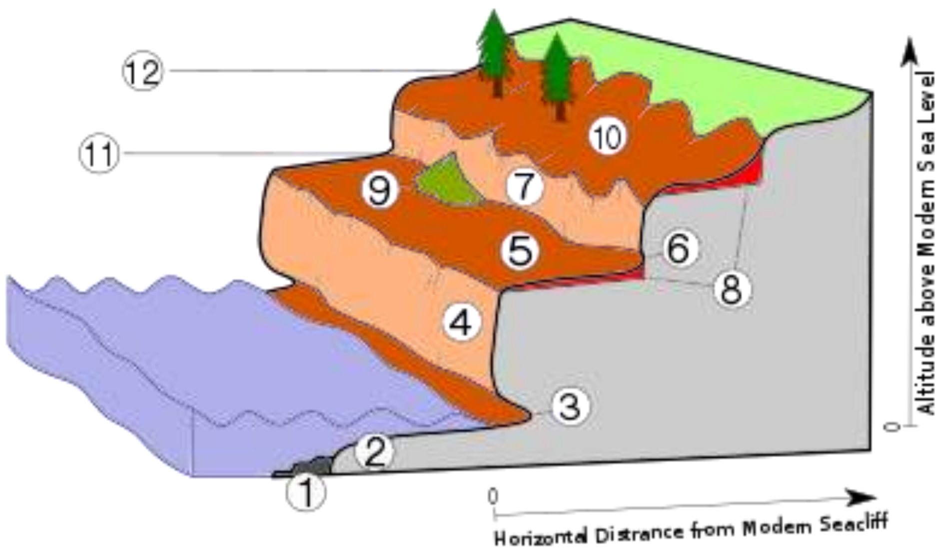

Figure 19: Bench Terraces

https://en.wikipedia.org/wiki/Raised_beach

3.4 Conserved farm water is taken care of to minimize wastage as per soil and water conservation handbook

Caring for farm water: This involves strategies and techniques that prevent contamination of conserved water, increase efficiency of water use and reduce water losses which could lead to water wastage.

Methods of caring for conserved water

The methods generally include those that;

- Prevent water pollution or contamination
- Prevent water loss
- Ensure maximum utilization of water resources

These methods include:

i. Reducing use of fertilizers and pesticides: Excessive use of fertilizers and pesticides pollute conserved water when these chemicals dissolve in the soil and are washed into conserved water sources polluting them hence leading to wastage. Reduction of use of fertilizers and other agrochemicals therefore prevent wastage.

ii. Efficient storing of water: Conserved water can be stored for future use when there are water shortages. In the farm, water can be stored in the following ways.

- Water tanks

These are usually used in storing harvested rainwater from roof catchment. Water from underground sources e.g. wells can also be pumped for storage in water tanks.

- Dams and reservoirs

These are used to collect excess flood water which could otherwise go to waste, destroying crop farms and human settlement. Dams are constructed along river channels by blocking the river channels and then directing the flood water into a river.

- Soil at moisture

Water stored in form of soil moisture involves carrying out practices that minimize water loss from the soil. Examples of such practices include mulching whereby organic or inorganic mulch is used to cover the soil.

- Use of containers

Containers e.g. jerry cans are used when storing little volumes of conserved water in the farm especially for domestic purposes. The storage containers must be clean and have a means of covering/ concealment to prevent contamination of water by dirt and dust particles.

Benefits of storing water

Water storage simultaneously serves multiple purposes such as irrigation, energy generation and flood control.

Make irrigation efficient

To reduce amount of water used in agriculture as well as prevent water wastage, irrigation must be made as efficient as possible. Irrigation methods that lead to water wastage e.g. basin irrigation that require high amount of water should be avoided at all costs. Strategies/ methods on how to make irrigation efficient include:

- Irrigation systems can be optimized to water
- Existing irrigation systems must be efficient and free frame leakages contain no leaks that waste water
- Soil moisture can be directly measured to determine the current water needs of individual plants.
- Drip irrigation lines can be used only to water a plant's roots instead of the surrounding soil.

Perm culture farming methods

Many perm culture farming methods such as swales built on contour inherently hold water on the landscape, reduce (or even eliminate) the need for supplemental watering of crops and helps to restore aquifers.

Conclusion

This learning outcome covered; sources of farm water, water harvesting methods, water conservation systems and water conservation structures

Further Reading

1. Soil erosion site www.soilerosion.net

4.3.4.3 Self-Assessment

Written assessment

1. The following are typical sources of farm water except?
    a) Local government
    b) Surface water
    c) Underground water
2. Which of the following terms best describes water harvesting?
    a) Collecting water from any source
    b) Collecting rainwater from where it falls and capture the runoff from catchment and collecting it for reproductive purposes
    c) Construction of dams
3. The following are methods of caring conserved farm water except?
    a) Terracing
    b) Storing of water
    c) Reducing agro-chemicals usage
4. The following are soil and water conservation structures except?
    a) Climate
    b) Available farm water
    c) Preservation and storage of farm water for future use
5. What do you understand by water conservation?
6. Outline methods of farm water conservation.
7. Outline the procedure of identifying places with shallow ground water using water indicating vegetation and trees.
8. Outline 3 types of dams.
9. Outline 5 components of rainwater harvesting.

Oral Assessment

1. Give any two types of terraces
2. Give any two advantages of drip irrigation

Case Study Assessment

A farmer noticed that after a heavy downpour on his sloping farm land, the soil was heavily washed downstream. Describe soil and water conservation structures that he can use to correct this.

Practical Assessment

On an identified piece of land, conduct both "fanya juu" and "fanya chini" terraces. Outline the detailed procedure for construction in both cases

4.3.4.4 Tools, Equipment, Supplies and Materials

- Jembes
- Soil auger
- Machetes
- Measuring tape
- Topography mapping tools
- Note books
- Soil sample packaging bags
- Soil science laboratory and equipment

4.3.4.5 References

Constable, Greg, Danny Llewellyn, Lewis Wilson, and Warwick Stiller. "An industry transformed-the impact of GM technology on Australian cotton production." (2011).

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Raju, KCB (1983). Subsurface dams and its advantages. Ground water board India.

Soil erosion site www.soilerosion.net

4.3.5 Learning Outcome No 4: Design soil and water conservation structures

4.3.5.1 Learning Activities

Learning Outcome No 4: Design soil and water	
Learning Activities	**Special Instructions**
4.1 Identify soil and water conservation structures as per soil and water manual	Group discussion
4.2 Design soil and water conservation structures as specified in soil and water conservation manual	Field excursion

4.3.5.2 Information Sheet No3/LO4; Design soil and water conservation structures

Introduction

This learning outcome covers; soil and water conservation designs, soil and water conservation structures.

Definition of key terms

Soil and water conservation: Are those activities at the local level which maintain or enhance the productive capacity of the land including soil, water vegetation in areas prone to erosion through prevention or reduction of soil erosion of drainage water and maintenance or improvement of soil fertility.

Content/procedures/methods/illustrations

4.1 Soil and water conservation structures are identified as per soil and water manual

There exists a variety of soil and water conservation structures also referred to as soil and water conservation measures. Procedures for identifying soil and water conservation structures. Soil and water conservation measures are identified and classified based on:

Purpose and type

Based on the above two parameters there are three types of soil and conservation structures as listed below:

- Physical measures
- Biological measures
- Agronomical measures

Methods of identifying soil and water conservation structures

i. **Physical measures**

For structures built for soil and water conservation, some principles should be considered. They should aim to:

- Increase the time of concentration of runoff, thereby allowing more of it to infiltrate into the soil.
- Divide a long slope into several short ones and thereby reducing amount and reduce the velocity of surface runoff, this is evidenced when terracing is done.
- Protect the environment against damage due to excessive runoff.

The following are physical soil and water conservation measures:

Stone/ Earth terraces

Terraces: Are earthen embarkment installed at right angles to the steepest slope to intercept the surface runoff. Run off embankment usually consists of two parts.

An excavated channel: A bank or ridge on the downhill side of the channel which is formed with the material excavated from the channel.

NB: Different types of terraces exist based on the design and shape of the channel and the ridge. The different types of terraces should be selected in accordance with the local conditions and problems.

Types of earth terraces

1. **Bench terraces**

This type of terraces is practiced on areas of steep slope.

Building only walls that reduce slope length is not sufficient here to reduce the power of runoff. It is therefore necessary to modify the degree of slope by excavating half way and half- filling a bank. The original ground will be converted into levels step-like fields.

Functions of bench terraces

- To control erosion by reducing the degree and length of the slope.
- To increase infiltration of rain water
- Maintain soil fertility
- Allow improved irrigation where necessary

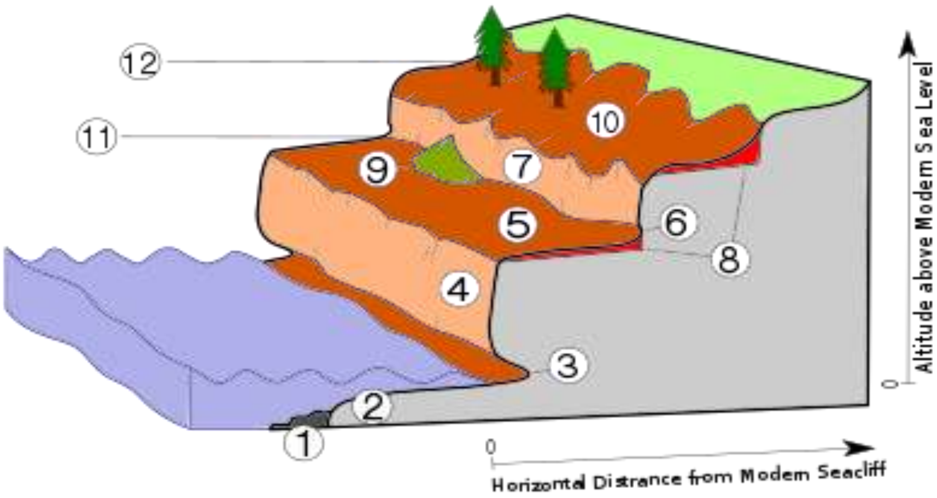

Figure 20: Bench Terraces

https://en.wikipedia.org/wiki/Raised_beach

Fanya Juu Terraces (converse terraces)

Are made by digging trenches along the contour and throwing the soil uphill to form an embankment. The embarkment is stabilized with fodder grass in between cultivated portions. They are useful in semi-arid areas to harvest and conserve water. They not only conserve water but rampant in arid and semi-arid areas due to flash floods.

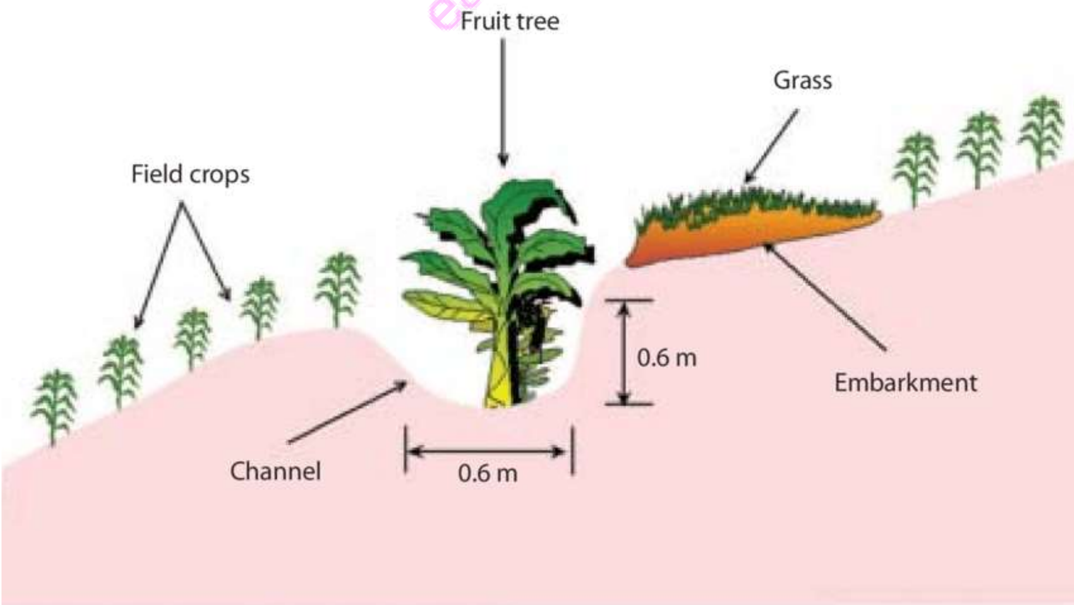

Figure 21: Fanya juu terraces

https://www.researchgate.net/figure/Illustration-of-a-fanya-juu-terrace_fig2_254426136

2. Grassed water ways

Are broad shallow and typically sauce water –shaped channels designed to move surface water across farm land without causing soil erosion. The vegetative cover in the water way slows the water flow and protects the channel surface from the eroding forces of runoff water.

3. Retention reservoirs

A retention basin, sometimes called a wet pond, wet detention basin or storm water management pond is an artificial pond with vegetation around the perimeter

4. Biological measures

Biological measures for soil and water conservation work by their protective impact on the vegetation cover. A dense vegetation cover conserves soil and water by;

- Preventing splash erosion
- Reduces the velocity of surface runoff
- Facilitate s accumulation of soil particles
- Increases surfaces roughness which reduce run-off and increases infiltration.
- The roots and organic matter stabilize the soil aggregates and increase infiltration.
- Biological measures are an effective method of soil and water conservation especially since they are low in cost.
- In addition, this method can be used with structural and agronomical measures.

Types of biological measures

- Protective bush land
- Reforestation
- Live fences
- Vegetative strips

Reforestation

It is used in highly degraded regions for regeneration of the soil and water balances.

Factors to consider before carrying out reforestation

- Climatic factors e.g. rainfall
- Biotic factors e.g. human activities
- Soil factors. e.g. soil fertility

Agronomic soil and water conservation measures

Agronomic soil and water conservation measures conserve soil and water by:

- Reducing the impact of rain drops through interception and thus reducing soil erosion.
- Increasing infiltration rates and thereby reduces surface runoff and erosion.

Agronomical measures can be applied together with physical or biological soil and water conservation measures. Agronomic conservation measures however are often more difficult to implement compared with structural ones as they require change in familiar practices.

Methods of agronomic soil and water conservation measures
They include;

i. Strip cropping
ii. Mixed cropping
iii. Intercropping
iv. Fallowing
v. Mulching
vi. Contour ploughing
vii. Grazing management
viii. Agroforestry

Fallowing

This refers to the practice of allowing the soil to rest for some period of time without crop establishment. During the fallowing period soil surface remains undisturbed encouraging vegetation growth. This vegetation growth provides soil cover hence conserving soil water by preventing evaporation of water from the soil.

Mulching

This refers to the practice of spreading material on top of the soil

Types of mulches

a. **Organic mulch**: This includes organic materials e.g. straw wood chips, dry grass and plant residue which can be spread on top of the soil.
b. **Inorganic mulch:** This includes inorganic mulching techniques e.g. black plastic polythene sheets which are spread on the soil surface.

Importance of mulching in soil and water conservation

- Provide soil cover hence preventing direct sun from hitting the soil surface. This reduces evaporation of water from the soil hence conserving soil moisture.
- Organic mulch decomposes to release organic matter which improves the soil structure hence improving its water holding capacity thereby conserving soil water.
- Mulch reduces the intensity with which raindrops hit the soil. This prevents splash erosion hence conserving soil.
- Mulch reduces runoff velocity hence preventing the soil from being washed away.

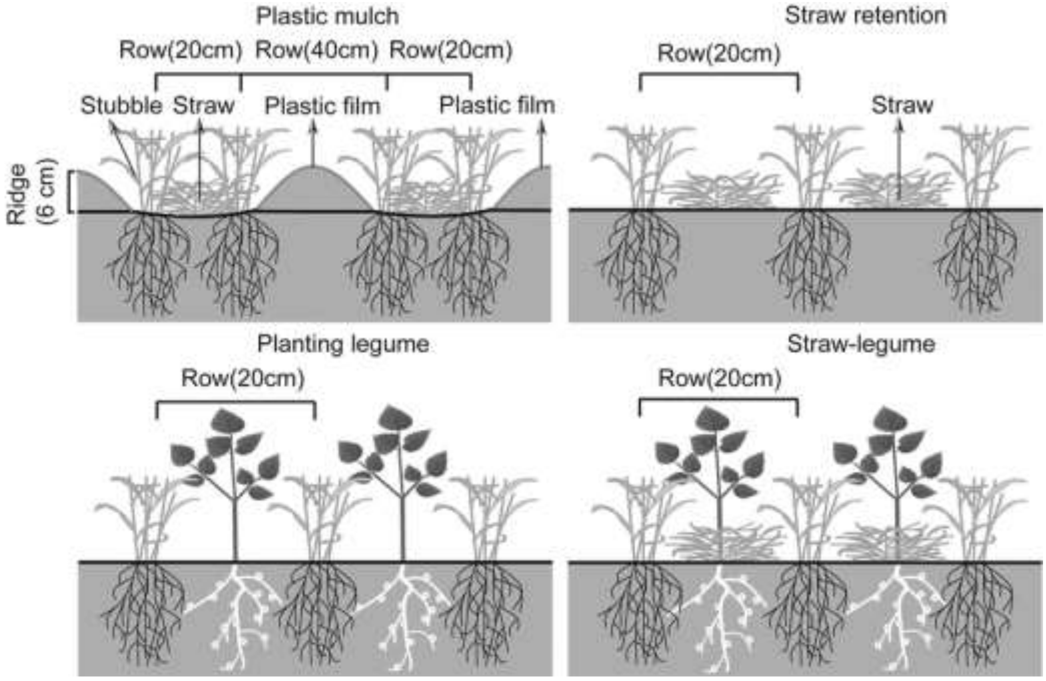

Figure 22: Mulching in Soil

https://www.researchgate.net/figure/Schematic-diagram-showing-the-treatments-of-plastic-mulch-straw-retention-planting_fig1_298724105

Grazing management
This refers to adoption of strategies of controlled grazing to prevent either under grazing or overgrazing on pasture lands e.g. rotational grazing

Rotational grazing
This is grazing method in which livestock are moved between paddocks in the field on a rotational basis. When properly managed, it conserves water by increasing soil organic matter from animal dropping grazing process. The dung helps in improving soil structure thereby conserving soil as well as its soil moisture content hence conserving soil water. Rotational grazing also allows for pasture regrowth which improves forage cover. This prevents soil water evaporation hence conserving soil water.

Contour ploughing
It is widely used agronomic measure and when well established, immensely contributes to soil and water conservation. The soil is ploughed along the contour install of up and downward. This decreases the velocity of runoff and thus soil erosion by concentrating water in the downward furrows.

Role of contour ploughing in soil and water conservation
Contour ploughing conserves soil and water by building a barrier against rain water runoff which is collected on the furrows hence conserving runoff water. Increases infiltration rate hence boosting underground water reserves thereby conserving runoff

water. Protects the soil from being washed down slope if the so contour was to be ploughed upward- downward. The effectiveness of contour ploughing decreases with increase in:

- Slope gradient and length
- Rainfall intensity
- Erodibility of the soil

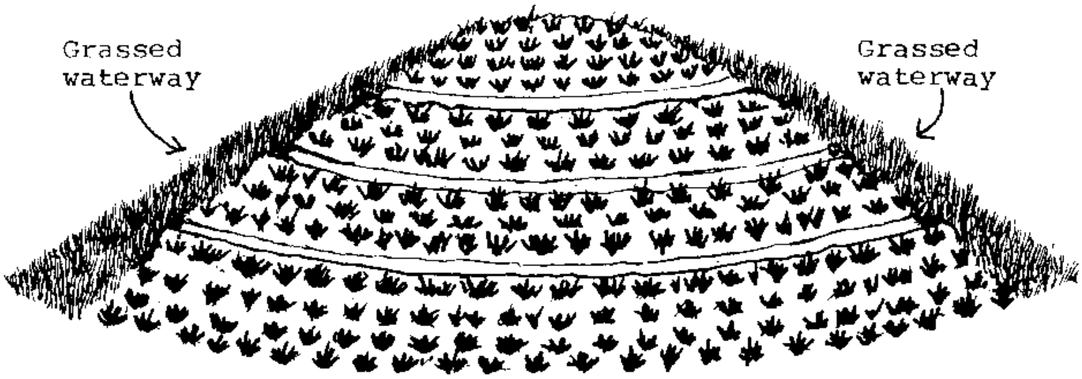

Figure 23: contour ploughing

http://www.nzdl.org/gsdlmod?e=d-00000-00---off-0hdl--00-0----0-10-0---0---0direct-10---4-------0-1l--11-en-50---20-about---00-0-1-00-0--4----0-0-11-10-0utfZz-8-00&cl=CL1.16&d=HASH412cd503b5262205ac14c6.5&gt=1

Agroforestry

This refers to the practice of growing trees with crops on the same piece of land. It conserves soil and water by:

Trees act as wind break hence protect the soil from being blown away by wind. The roots of large trees hold soil particles together preventing water erosion. Trees increase the infiltration rate of the water into the soil thereby conserving soil water.

Intercropping and mixed cropping

This refers to a type of agricultural technique that involves planting two or more plants simultaneously on the same piece of land, interdigitating the crops so that they grow together.

Roles of intercropping and mixed cropping in soil and water conservation

- Prevents soil depletion
- Increase soil fertility
- Reduces soil erosion

Strip cropping

This is a method of farming which involves cultivating a field portioned into long-narrow strips which are alternated in a crop rotation system. It conserves soil and moisture by:

- Creating natural dams for water
- Helping to preserve the strength of the soil.

Figure 24: Strip cropping

https://www.youtube.com/watch?v=FhB1pZLK4Gc

4.2 Soil and water conservation structures are designed as specified in soil and water conservation manual

Soil and water conservation structures are designed as specific in soil and water conservation manual. Soil and water conservation structures includes all mechanical or structural measures that control the velocity of surface runoff and thus minimize erosion and retain water where it is needed. They consist of physical structures which reduce the effect of the slope length and angle. Soil and water control structures can be designed to either conserve water or safely discharge it away. The suitability of a design for soil and water control structure depends on the following factors:

- Climate and needed to retain or discharge runoff
- Farm sizes
- Soil characteristics (texture, drainage and depth)
- Availability of an outlet or waterway
- Labour availability and cost
- The adequacy of existing agronomic or vegetative conservation measures.

Methods of determining soil and water conservation structures.

N/B: The main method involved in designing soil and water conservation structures is to:

- Determining amounts runoff for design of soil and water conservation structures.

- Determining amounts of runoff for design of SWC structure characteristics of surface Runoff.

Surface runoff (runoff) is the portion of precipitation that makes its way towards the stream channels lakes or oceans as subsurface flow. It occurs when precipitation rate exceeds infiltration rate and is the most distractive component of rainfall.

Factors to consider in determining amounts of run off for designing SWC measures

These factors include;

- Peak runoff rates
- Runoff volumes
- Temporal distribution of runoff rates and volumes.

Factors affecting runoff

These include both catchment factors and rainfall factors.

Catchment factors

Runoff is influenced by catchment factors such as;

- Topography
- Vegetation
- Infiltration rates

Soil storage capacity and drainage pattern. The larger a catchment the more runoff it will generate. Slope steepness is particularly important as soil erosion is more prone on steeper slopes.

Rainfall factors

Rainfall factors associated with surface runoff and erosion include: rainfall amounts storm duration, intensity and distribution as well as seasonal patterns. e.g. dry areas are more prone to erosion than wet areas because prolonged dry spells destroy vegetation cover and rainstorms tends to be of high intensity and thus erosive. The most significant component of rainfall is the intensity which is a function of the energy raindrops impact on the soil. The intensity duration relationship of rainfall gives an indication of expected runoff as illustrated below.

$1=a(t+b)$

Where 1= rainfall intensity

t= duration of rainfall (in minutes)

b and a are constants

For any given duration the graph or equation will indicate the highest average intensity which is probable for a storm of that duration. This is calculated as:

$1=kT^{x}It^{n}$

Where T= is the return period in years e.g. 10years

k, x and n are all constants.

Design storm

This refers to a storm known period and is used as a basis for designing structures e.g. for a 10-year, 1-hour rainfall is the maximum rainfall amount expected in a 1-hour period within a 10-year return period.

Design runoff rates

The capacity to be provided in a structure that must carry runoff may be termed as designed to carry runoff that occurs within a specified return period (Tr) e.g. 10 years for vegetative water ways and 100 years for permanent channels.

Estimation of surface runoff

It is important to know the quantities of water to be handled. If the objective is to impound water e.g. dams, peak volumes are used while, if the purpose is to convey water e.g. channels/ water ways, peak runoff rates are used. Estimation of runoff is necessary to avoid failure due to overlapping. Estimating runoff depends on two processes:

i. Estimating the rate of rainfall.
ii. Estimating how much of the rainfall becomes runoff. The runoff rate is more crucial and is determined using various methods or equations as described below.

a. Runoff coefficient

The simplest method is to use a single coefficient which represents the ratio of rainfall loss. If half of the rainfall is lost by infiltration the other half appears as run off then the coefficient is 0.5

Example of runoff coefficients
Woodland on flat sandy loam, C=0.10
Woodland, flat tight clay C= 0.40
Cultivated fully clay soil C=0.60
Urban, rolling, 50% built up, C=0.65

b. Catchment characteristic or cook's method

The method consists of summing numbers each of which represents the extent to which runoff from catchment will influence a particular characteristic. The effect of four fruiters is considered in method each of which are.

i. The relief
ii. Water infiltration
iii. Vegetation cover
iv. Soil surface storage

Each of these is considered in turn and the condition of the watershed compared with four descriptions i.e. Extreme, high, normal and low.
An illustration is as shown below:
30=10=15=10=65

c. Rational formula

The rational method predicts runoff through this equation

Q=0.028CIA

Where Q = The design peak runoff in M^3/s

C =Runoff coefficient (a function of catchment vegetation, slope, surface culture)

A = Area of watershed in hectares

I = Rainfall intensity in mm/hr. for the design return period and for a duration Equal to the time of concentration of the watershed

The rational method is developed on the assumption that.

- The rainfall occurs at uniform intensity for a duration equivalent to the time of concentration.
- Rainfall occurs at a uniform intensity over the entire area of the catchment.

Conclusion

This learning outcome covered; soil and water conservation designs and soil and water conservation structures

Further Reading

1. www.geo.fu-berlin.de

4.3.5.3 Self-Assessment

Written assessment

1) The following are soil and water conservation structures except?
    a) Grass strips
    b) Terraces
    c) Cut off drains
2) The following are biological measures of soil and water conservation except?
    a) Irrigation of the land
    b) Reforestation
    c) Protective bushland
    d) Live fences
3) Three of the following are agronomical soil and water conservation measure except?
    a) Fallowing
    b) Agroforestry
    c) Mixed cropping
    d) Crop cultivation
4) The following constitute physical measures of soil and water control except?
    a) Terraces
    b) Grassed water ways
    c) Vegetation cover

5) Strip cropping conserves soil and moisture in the following ways except?
    a) Creating natural dams for water
    b) Helping to preserve strength of the soil
    c) Trapping soil particles
6) The following strategies make up farm water conservation except?
    a) Climate
    b) Available farm water
    c) Preservation of farm water for future use.
7) What do you understand by soil and water conservation?
8) Outline factors to consider in determining runoff for designing soil and water conservation structure.
9) Outline 3 ways in which agroforestry conserve soil and water.
10) Outline 4 importance of soil and water conservation measures.
11) Outline role of intercropping and mixed cropping in soil and water conservation.

Oral Assessment

1. Outline methods of estimation of surface run off.
2. State the rational formula?

Practical Assessment

On a provided piece of land, construct the following physical soil and water conservation measures.

1. Bench terraces
2. Fanya Juu Terraces

For both cases, clearly outline the procedure and tools required

.

4.3.5.4 Tools, Equipment, Supplies and Materials

- Soil Auger
- Soil sample packaging bags
- Soil science laboratory and equipment
- Topography mapping tools
- Notebooks

4.3.5.5 References

Benson Mochoge (2002). Sustainable soil and water conservation. Government of Kenya. Nairobi

Fao (2001). An integrated Approach to soil and water conservation ABI Publishing Texas.

Rahma, KCB 1983. Design of soil and water conservation structures for small holder Agriculture Asalcon Kenya

4.3.6 Learning Outcome No 5: Lay out soil and water conservation structures

4.3.6.1 Learning Activities

Learning Outcome No 5: Lay out soil and water structures	
Learning Activities	**Special Instructions**
5.1 Establish area layout as per soil and water conservation manual 5.2 Peg established area as per soil and water conservation manual 5.3 Measure pegged area as per size and type of structure to be constructed 5.4 Excavate area as per structure design 5.5 Maintain soil and water structures are maintained as per good agricultural practices	Demonstrate how to construct different types of conservation measures in the farm.

4.3.6.2 Information Sheet No4/LO5: Lay out soil and water structures

Introduction

This learning outcome covers, soil and water conservation designs, layout / construction of soil and water conservation structures, maintenance of soil and water and conservation structures

Definition of key terms

Soil and water conservation designs: These are activities that maintain on enhance the productivity capacity of land in areas affected by or prune soil erosion.

Soil and water conservation structures: These are mechanical or structural measure that control the velocity of surface run off and this minimize soil erosion and retain water where it is needed.

Content/procedures/methods/illustrations

5.1 Area layout is established as per soil and water conservation manual

General principles for the design of SWC (Soil and Water Conservation)

The design of SWC structure considers severity and extent of erosion damage or risks the factors causing erosion as well as the suitability of land to the identified intervention. Soil and water control measure are directed at protecting the soil from raindrop impact and hydraulic force of run-off.

The process involves areas of attentions;

i) Reduction of raindrop impact on soil
ii) Reduction of overland flows
iii) Increase inflation rate
iv) Slowing run off velocities

Factors considered when laying out SWC

SWC structures are usually made by hand labour or machinery although some terraces develop naturally from vegetative barriers. They are particularly important on steep slopes where annual crops are grown and in marginal rainfall areas where there is a need to conserve rainfall in situ. They include:

i. Climate and the need to retain or discharge runoff
ii. Farm size and system (large or small-scale, mechanized oR non-mechanized).
iii. Cropping patterns (perennial or annual, with or without rotations) slope steepness
iv. Soil characteristic (erodibility, texture, drainage, debt, stoniness and risk of mass movement)
v. The availability of an outlet or waterway for safely discharging run-off away from crop land.
vi. Labour availability and cost
vii. The availability of material e.g. stone.
viii. The adequacy of existing agro-economic on vegetative conservation measures.

Determine amount of run-off for design for SWC structure surface runoff is the portion of precipitation that makes its way towards the stream channels, lakes or ocean or surface and subsurface flow. Runoff occur when precipitation rate exceeds infiltration rate and is the most destructive components of rainfall.

In the design of SWC structure, the important factors used are:

i) Peak runoff rates
ii) Runoff volumes
iii) Temporal distribution of runoff rates and volumes.

Factors affecting Runoff

These include both catchment factors and rainfall factors.

a) Catchment Factors

Runoff is influenced by catchment factors such as topography, vegetation, infiltration rate, soil storage capacity and drainage pattern size of the catchment, its shape, orientation, geology and surface culture also affect run-off.

b) Rainfall Factors

Rainfall factors that are associated with surface run-off and erosion includes rainfall amount, storm duration, intensity and distribution as well as seasonal pattern. e.g. dry areas are prone to erosion than wet areas because prolonged dry spells destroy vegetation cover, and rain storms tend to be high intensity and this erosive. The intensity duration relationship of rainfall gives an indication of expected run-off.

$I=\frac{a}{t-b}$

I= rainfall intensity
t= duration of rainfall (min)
a and b are constant.
For any given duration, the graph or equation will indicate the highest average intensity which is possible for a storm of that duration. It's calculated as
I= KTx/tn
T = Is the return period in years
k, x and n are all constant

c) Time of concentration

The storm duration which correspond with the maximum rate of runoff is known as the time concentration (Tc). It is assumed that during the time of concentrations, all parties of the watershed are contributing simultaneous due to the discharge at the outlet.

d) Design Strom

A design storm is a storm of known period. it is used as a basis for designing structures. For example, 1=hour rainfall is the maximum rainfall amount expected in a 1-hour period with a 10-year return period.

e) Design runoff rates

The capacity to be provided in a structure that must carry run off maybe termed as the design run-off rate. Within a specified return period (Tr) e.g. 10 years for vegetative waterway and 100 years for permanent channel.

5.2 Established area is pegged as per soil and water conservation manual

Established area is marked depending on the types of conservation structure. The main SWC structure measure used on croplands comprises diversion ditches (cut-off drains) retention (inflations) ditches, terraces and waterway. Supportive cultural measures such as grass or vegetative materials for stabilizing the structure are also required for selection of proper species. The design of structure to discharge run off, such as diversion ditches and water ways should not be installed unless there is safe place for disposal of water e.g. a natural or artificial water ways or permanent vegetation. In higher rainfall areas e.g. areas receiving more than 1000 mm of rain per annum, and where crops rarely lack water or where there is risk water. It is necessary to deigns a structure to discharge run-off. However, it would be a mistake to design structures to discharge a run-off if there are no suitable outlets such as natural waterway on artificial water way or grassed slope. In dry areas, it is usually desirable to keep run water in situ and prevent runoff. After putting in considerations of all the above factors right area is pegged awaiting next step.

5.3 Pegged area is measured as per size and type of structure to be constructed

Size of conservation structure

The design of any structure to be attained on discharge runoff should be based on reasonable estimate of the volume of runoff (m^3) to be retained on the peak rate of runoff (m^3/s) to be discharged. A retention structure can rarely be made big enough to capture all runoff during exceptionally wet period unless the catchment areas is very small. One alternative role of retention structure is to incorporate a spillway to take the overflow.

Similarly, the design of a structure to discharge runoff can rarely be based on the heaviest storms possible. Usually, it is based on the heaviest storm that can be expected in a given period (e.g. 10 years) with the knowledge that a heavier storm, a magnitude that occur once in a while could take place.

Measurement of the structure will provide precision on how the excavation will be done in order to manage soil and water.

Reasons for construction conservation structure

- To increase agriculture productivity
- To conserve potentially productive land
- To reduce nutrients loss from the soil
- To conserve environment to improve catchment hydrology of soil profile
- To facilitate drainage especially in water logged areas
- To protect reservoir from sedimentation

5.4 Area is excavated as per structure design

Suitability of SWC structure depends on

- Climate
- Farm size
- Soil characteristic (texture, drainage and debt)
- Availability of a waterway
- Availability of labour and cost
- Adequacy of agroeconomic or vegetative conservation measures

Physical soil conservation measures

Physical soil conservation are permanent features made of earth, stones or masonry, designed to protect the soil from uncontrolled runoff and erosion and retain water of required. They include the following.

a) Cut-off drains

They are excavated across a slope to trap surface runoff and carry it safely to a discharge waterway such as a canal or stream. They divert water from gully hovels.

b) Retention ditches

They are dug along the contours to intercept surface run-off and retain as mush water to improve soil hydrology through seepage. They are used as an alternative for cut-off drains where there is no near discharge waterway, they are commonly used in ASALS.

c) **Infiltration ditches**

As the name suggests, they are constructed to harvest surface runoff from roads and retain it. The ditch measures 0.7-1.5 m in depth, they are dug along the contour, upslope from a crops field. Water is then diverted to the ditch from the roadside. It allows water seep or infiltrate into the ground and provide enough soil water.

d) **Water-retaining pits**

They are dug on the ground on the name run-off areas. They allow the water to seep down like the infiltrations ditch. The soil from the pit is heaped to from a bank so that it can accumulate maximum amount of water. Furrows are also constructed to carry excess water from the pits. The size of the pit depends on the amount of run-off. It measures $2m^2$ by 1m deep.

e) **Broad beds and furrows**

Runoff water is diverted into field furrows which measures 30cm wide and 30cm deep. The field furrows are blocked at the end unit they are filled with water which then moves to the next furrow. (crops are planted on a broad bed measuring 190cm wide).

f) **Terraces-Fanya juu, Fanya chini, bench terraces, stone terraces**

i) **Fanya juu (converse) terrace**

They are constructed by digging a trench along the contour. The solid is heaped on the upper side to form embarkment. The embarkments are items reinforced with a strip of grass between the cultivated areas. As time progresses, fanya juu terraces develop into bench terraces. Bench terraces are useful in ASALS to harvest and conserve water. It is applicable to slope below 20%.

ii) **Fanya chini (narrow based channel) terraces**

It is done in opposite way of fanya juu terraces. They are drug along the contour and the solid is heaped on the lower side as the contour trench. It is used to conserve soil and divert water. The embarkment is used to grow fodder and it is applicable on slopes of up to 20%.

iii) **Bench terraces**

They are leveled steps constructed or formed o the contour which are separated by embarkment known as risers. They are excavation or developed from grass strips on fanya Juu terraces. They are suitable on slopes up-to 55%.

iv) **Stone terraces**

They are constructed on steep slope to intercept runoff water with high population density and scarce land. Terraces raises are made up collected stones from the ground. Others include dams, wells and gabions.

5.5 Soil and water structures are maintained as per good agricultural practices

SWC structures are maintained to ensure the intended functions has been achieved. They require regular maintenance and repair if they get damaged. Grazing should be controlled and restricted in areas where SWC structures have been established to avoid damage of embarkments. The fodder should not be grazed directly but it should be harvested and fed to the animals. Vegetative material should be replaced and lining of the constructions and channels should be done at least every season.

Conclusion

This learning outcome covered: soil and water conservation designs, layout/construction of soil and water conservation structures and maintenance of soil and water conservation structures.

Further Reading

1. Design of soil and water conservation structure for small holder agriculture article by Prof. Bancs M. Mater.
2. www.fao.org/3/To32IE/to312e-10.htm
3. Soil and water conservation manual by sustainable agriculture information initiative

4.3.6.3 Self-Assessment

Written assessment

1. The following are factors used in determining design of SWC structure. Which one is not?
    a) peak runoff
    b) runoff volume
    c) runoff factor
    d) temporal distribution
2. The rainfall factor has the following functions except one. Which one is odd one out?
    a) rainfall intensity
    b) water factor
    c) duration of rainfall
3. The following are types of terraces which one is ideal for slopes of below 20%?
    a) fanya juu terrace
    b) fanya chini terrace
    c) stone terrace
    d) bench terrace
4. Physical SWC structures are used mostly in ASALS. Which one is not suitable in such areas?
    a) cut-off drains
    b) retention ditches
    c) infiltration ditches
    d) water-retaining pits

5. Suitability of SWC structure depends on the following factors except one. Which one?
    a) Run-off rates
    b) climate
    c) farm size
    d) water-retaining pits

6. Rainfall factors are associated with the following conditions except one. Which one?
    a) rainfall amount
    b) storm duration
    c) rainfall reliability
    d) rainfall intensity
7. Catchment factors influence run-off. Which of the following is one of catchment factors?
    a) catchment factor
    b) soil storage capacity
    c) capillarity pattern
    d) contours
8. Define soil and water conservation.
9. Fanya juu terraces are also referred to as?
10. Give one factor considered during laying out SWC structure.
11. Give two factors affecting run-off.
12. Give two reasons for maintain SWC structures.

Oral Assessment

1. Name two examples of terraces.
2. Which type of terraces form bench terraces.
3. Give two reasons for construction conservation structure.

Case Study Assessment

Visit the nearest farmers within the institution and answer the following questions

1. Does the farmer have established terraces?
2. Name different types of terraces practiced by the farmer.
3. On your understanding has the farmer constructed the correct type of terraces depending on the slope? Explain your answer.
4. Draw types of SWC structure practices by the farmer.
5. How does the farmer maintain their SWC structures?
6. What are the challenges faced by the farmer to carry out SWC measure?

Practical Assessment

4.3.6.4 Tools, Equipment, Supplies and Materials

- Topography mapping tools
- Measuring tapes
- Note books
- Soil augers
- Soil sample packaging bags
- Soil science laboratory and equipment
- Jembes

4.3. References

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Young A (1990) agroforestry for soil conservation.CAB international Wallingford. 318.P

4.3.7 Learning Outcome No 6: Carry out farm irrigation

4.3.7.1 Learning Activities

Learning Outcome No 6: Carry out farm irrigation	
Learning Activities	**Special Instructions**
6.1 Carry out identified irrigation methods as per soil and water conservation manual. 6.1 Identify irrigation methods as per soil and water conservation manual	Group discussion

4.3.7.2 Information Sheet No4/LO6: Carry out farm irrigation

Introduction

This learning outcome covers: Irrigation, Irrigation methods, Installation of irrigation systems and Irrigation water requirements.

Definition of key terms

Irrigation: This is the artificial application of water to soil in the correct amounts and frequency, for optimal soil infiltration and plant growth.
It is also defined as any process other than natural precipitation which supplies water artificially to the soil to make up for the deficiency of moisture under natural conditions profitable growth of crops, which otherwise would not be assured.

Benefits of irrigation

- To replace missing rainfall in periods of drought.
- To protect the plants against frost.

Content/procedures/methods/illustrations

6.1 Irrigation methods are identified as per soil and water conservation manual

- To identify an irrigation method, one must know the advantages and disadvantages of the various methods.
- Further, testing of the various methods under prevailing local conditions provides the basis for a sound choice of an irrigation method.
- The identification or choosing an irrigation method guided by the following factors.

Factors that determine the choice of an irrigation method

- Natural conditions.
- Type of technology.
- Previous experience with irrigation.
- Required labor inputs.
- Cost and benefits

1. **Natural conditions**

The natural conditions such as soil type, scope, climate, water quality and availability have an impact on the choice an irrigation method as explained below.

Soil type

Sandy soils have a low water storage and high infiltration rate. They therefore need frequent but small irrigation applications, in particular when the sandy soil is also shallow. Under these circumstances, sprinkler or drip irrigation are more suitable than surface irrigation. Clay and loam soils are suitable for all the 3 methods of irrigation. Clay soil with low infiltration rates is ideally suited to surface irrigation. When a variety of different soil types is found within one irrigation scheme, sprinkler or drip irrigation are recommended as they will ensure a more even water distribution.

Slope

Drip irrigation are preferred above surface irrigation on steeper or evenly sloping land as they require little or no land leveling. An exception is rice grown on traces on sloping lands.

Climate

Strong wind can disturb spraying of water from sprinklers under very heavy windy conditions, drip or surface methods are preferred. In areas of supplementary irrigation, sprinkler or drip irrigation maybe more suitable than surface because of their flexibility and adaptability to varying irrigation demands on the farm.

Water availability

Water application efficiency is generally higher with sprinkler and drip irrigation may be more suitable than surface irrigation and so these methods are preferred when water is in short supply.

Water quality

Surface irrigation is preferred if the irrigation water contains much sediment. The sediment may clog the drip or sprinkler irrigation systems. If the irrigation water contains dissolved salts, drip irrigation is particularly suitable, as less water is applied to the soil than with surface methods. Sprinkle systems are more efficient than surface irrigation methods leaching out salts.

2. Type of crop

Surface irrigation can be used for all types of crops. Sprinkler and drip irrigation, because of their high capital investment per hectare, are mostly used for high value cash crops such as vegetables and fruit trees which will bring return investment.

Drip irrigation is suited to irrigating individual's plant or trees or row crop such as vegetables and sugarcane. It is therefore not suitable for close growing crops. e.g. rice.

3. Type of technology

The type of technology affects choice of irrigation method. Generally, drip and sprinkler irrigation are technically more complicated methods as they require high capital investment per hectare to purchase equipment. Further to maintain them a high level of technological know-how has to be available; a regular supply of fuel and spare parts must also be maintained which together with the purchase of equipment may require foreign currency. Surface irrigation systems- in particular small-scale schemes usually require less sophisticated equipment for both construction and maintenance (unless pumps are used). The equipment needed is often easier to maintain and less dependent on the availability of foreign currency.

4. Previous experience with irrigation

The choice of an irrigation method also depends on the irrigation tradition within the region or country. Introducing a previously unknown method may lead to unexpected complications. Since it is not certain that the farmers will accept the new method. In addition, the servicing of the equipment may be problematic and the costs may be high compared to the benefits. Often it will be easier to improve the traditional method than to introduce a totally new method.

5. Required labour inputs

Surface irrigation often requires a much higher labour input for construction, operation and maintained than sprinkler or drip irrigation. Surfaces irrigation requires accurate and leveling, regular maintenance and high level of farmer's organization to operate the system. Sprinkler and drip irrigation require little land leveling: system operation and maintenance are less labor intensive.

6. Costs and benefits

Before choosing an irrigation method, an estimate must be made of the costs and benefits of the available options. On the cost side, not only the construction and installation, but also the operation and maintenance (per hectare) should be taken into account. These costs should then be compared with the expected benefits (yields) farmers obviously will therefore be only interested in implementing a certain method this economically attractive.

6.2 Identified irrigation methods are carried out as per soil and water conservation manual

Methods of irrigation

There are 3 common methods or carrying out irrigation, each method having its advantages and disadvantages.

The method of irrigation is determined by the following factors:

- **Water source:** Consider the source of water e.g. lakes, rivers, underground dams etc. and their sustainability, its quality, and quantity and its distance from the fields to be irrigated.
- **Type of crop:** Whether this crop has, good returns to meet the cost of carrying out the particular irrigation method and the crops watering requirements i.e. if the irrigation method will supply the crop with enough quality water.
- **Land topography:** The layout design of irrigation and its drainage and soil erosion vulnerability is considered.

The following are the methods of irrigation

i. Surface irrigation system.
ii. Sprinkler or overhead irrigation system.
iii. Drip of trickle irrigation system.

Surface irrigation system

This is defined as the group of application techniques where water is applied and distributed over the soil surface by gravity. Water is distributed over and across by gravity hence no mechanical pump is involved.
It includes irrigation methods such as:

i. Basin irrigation.
ii. Border strip irrigation.
iii. Furrow irrigation.

Basin irrigation

There are 2 types of basin irrigation: Controlled or check basins and uncontrolled flooding.

a) Controlled/ check basins

Basins are also known as check basins, are usually flat areas of land surrounded by low bunds. The bunds prevent the water from flowing to adjacent basins or fields. Basin irrigation is usually used for rice growing and also trees such as fruits, where one tree is normally located in the middle of a small basin.
Basin method is best suited for crops that are unaffected by standing in water for long period.

How to construct basin irrigation

- It is usually constructed on flat lands with a slope of 0.1 or less.
- If the slope is more than 0.1, terraces can be constructed.
- The land is then leveled a little, however the amount of land leveling is considerable.

An illustration is as shown below.

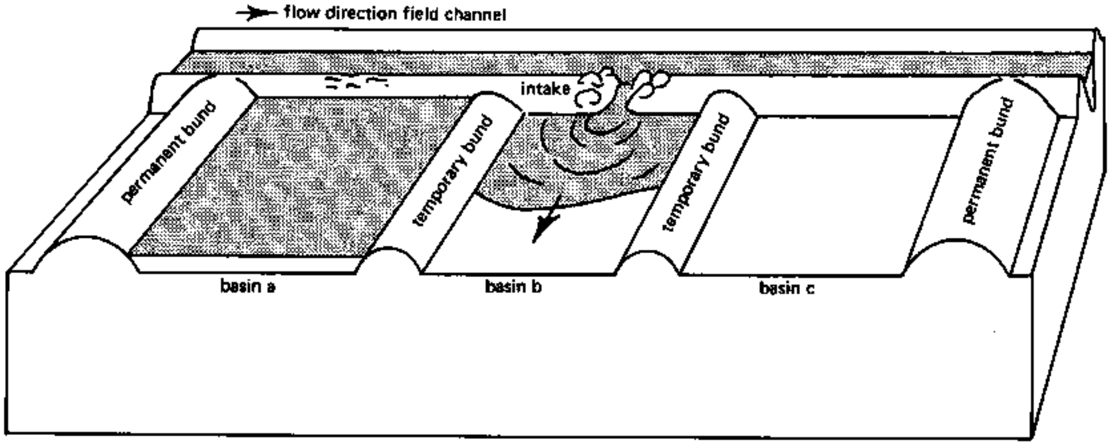

Figure 25:Basin irrigation

http://www.fao.org/3/S8684E/s8684e03.htm

b) Uncontrolled flooding

There are many cases where croplands are irrigated without regard to efficiency or uniformity. Uncontrolled flooding is used when the value of the crop is very small or the field is used for grazing recreation purposes.

Disadvantages of basin irrigation

- Precision and leveling of basin irrigation
- Crusting of soil in most cases unavoidable
- Perimeters dykes need to be well maintained to eliminate breaching and waste

Advantage

- Rapid irrigation is possible
- Low initial cost

Boarder strip irrigation method

This can be viewed as an extension of basin irrigation to sloping, long rectangular or contoured field shapes, with free draining at the lower ends.

How it is carried out.

Water is applied to individual borders from small hand dug checks from the field head ditch. When water is cut off, it recedes from the upper end to the lower end.

Sloping borders are suitable for nearly any crop that require prolonged pounding.

Disadvantages

i. Fair large supply of water is needed
ii. Land must be leveled
iii. Drainage must be provided

Furrow irrigation

It is a type of surface irrigation in which trenches a furrow are dug between crops, rows in a field. Water is made to flow down the furrows by gravity and it seeps vertically and horizontally to refill the soil reservoirs. Flow to each furrow is individually controlled. Furrows are small channels having continuous and almost uniform slope in the direction of irrigation. Water infiltrates through the erected perimeters of the furrows and moves vertically the laterally to saturate the soil. Furrows are used to irrigate the crops planted in rows e.g. maize vegetables and trees. However, furrow method is not recommended for very light soils with high infiltration rate as water is wasted on the upper end of the furrow due to deep percolation. Hence it is most suited for soils having infiltration rate of 0.5 to 2.5 cm /hour.

Advantages of furrow irrigation

In relation to other surface methods, furrow method;

- Does not need extra-drainage structures because its furrows act as drains.
- Its water use efficiency is higher than that of basin and boarder systems

Disadvantages of furrow irrigation

i. Require more labour than any other surface irrigation method.
ii. There is a possibility of an increased erosion

Sprinkler or overhead irrigation

Sprinkler irrigation is a method of applying irrigation water which is similar to natural rainfall. Water is distributed through a system of pipes usually by pumping. It is the sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground. In a uniform patter at a rate less than the infiltration rate of the soil.

Components of a sprinkler;

- Pump.
- Filter.
- Control valves injection unit.
- Pipes.
- Nozzles.

Conditions favorable for sprinkler irrigation

- Lands which have steep slopes and easily eroded soil.
- Irrigation channels which are too small to distribute water efficiently by surface irrigation and lands with shallow soils and undulate lands which prevent proper leveling required for surface methods of irrigation.

Advantages of sprinkler irrigation

- Crops can be saved from frost damage.
- High yields of crops are maintained.
- No soil erosion since water application is regulated.

Disadvantages

- High initial or invest costs that cannot be adopted by ordinary farmers.
- Clogging of filters when water has debris.
- Requires power for running pumping unit.
- Poor application efficiency in windy weather and high temperatures.
- High evaporation losses.
- Maintenance cost is high due to operational and monitoring cost.

Types of sprinklers

1. **Centre pivot irrigation**

Water is distributed by a system of sprinklers that move on wheeled towers in a circular pattern.

2. Lateral move irrigation

Water is distributed through a series of pipes each with a wheel and a set of sprinklers which are rotated either by hand or with a purpose-built mechanism. The sprinklers move a certain distance across the field and then need to have the water hose reconnected for the next distance. This system tends to be less expensive but requires labor than others.

3. Drip or trickle irrigation

Drip irrigation is a method of watering plants with single drops of water at a time.
Components of drip irrigation system. The system comprises main line, sub mains, laterals valves (to control flow) drippers or emitter (to supply water to the plant), pressure gauges, water meters, filters (to remove all debris) e.g. sand, clay to reduce clogging of the emitters) pumps, fertilizer tanks, vacuum breakers and pressure regulators. The drippers are designed to supply water at the desired rate of 1 to 10 l per hour directly to the soil. Low pressure heads at the emitters are considered adequate as the soil capillary causes the emitted water to spread laterally and vertically.
Flow is controlled manually or set to automatically either:

i. Deliver desired amount of water for a predetermined time.
ii. Supply water whenever soil moisture decreases to a predetermined amount.

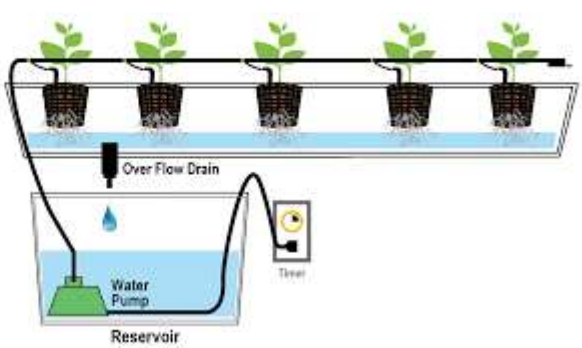

Figure 26: Drip irrigation Source

https://thestempedia.com/project/drip-irrigation-sytem/

Advantages of drip irrigation

- Low water and hence saves time
- No fustigation is possible
- No soil erosion

Disadvantages

- High installation and cost of maintenance
- Not suitable for closely planted crops
- Replacement of emitters regularly due to spacing required by different crops

Conclusion

This learning outcome covered; irrigation, irrigation methods, installation of irrigation systems and irrigation water requirements

Further Reading

1. Panuska, J.S.Sanford and A. Newhouse,2015. Methods to monitor soil moisture, university of Wisconsin.

4.3.7.3 Self-Assessment

1. The following are natural conditions that determine the choice of an irrigation method except?
    a) Soil type
    b) Slope
    c) Type of crop
2. The following factors determine the choice of an irrigation method except?
    a) Cost and befits.
    b) Required labor input.
    c) Topography.
3. The following are advantages of drip irrigation except.
    a) Requires a lot of water.
    b) Fertigation can be applied.
    c) Controls soil erosion.
4. The following are benefits of irrigation except.
    a) Earn farmers income.
    b) Protect crops against first damage.
    c) Ensure crop production even during dry seasons.

5. The following are components of a sprinkler filter system except.
    a) Pump
    b) Filter
    c) Pressure gauges
6. What do you understand by the term irrigation?
7. Outline any 3 components of a drip irrigation system.
8. Outline factors to consider before carrying out an irrigation system
9. Briefly describe how to construct basin irrigation.
10. Outline 3 methods of surface irrigation

Oral Assessment

Describe the maintenance of drip irrigation system.

Case Study Assessment

You have been employed by an irrigation system installing company. Formulate guidelines that will help you know the type of system to be installed for your client.

Practical Assessment

Demonstrate drip irrigation using locally available materials.eg. Bottles.

4.3.7.4 Tools, Equipment, Supplies and Materials

- soil auger
- Soil sample packaging bags
- Soil science laboratory and equipment
- Measuring tape
- Topography mapping tools

4.3.7.5 References

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Lamont,W.J, M.D.Orzolic (2012). Drip irrigation for vegetable production, Pennsylvania state University Park.

4.3.8 Learning Outcome No 7: Carry out farm water drainage

4.3.8.1 Learning Activities

Learning Outcome No 7: Carry out farm water drainage	
Learning Activities	**Special Instructions**
7.1 Identify farm drainage systems as per farm plan 7.2 Construct water drainage systems as per farm plan 7.3 Maintain water drainage systems as per environmental management plan	Demonstrate construction of farm drainage systems

4.3.8.2 Information Sheet No4/LO7: Carry out farm irrigation

Introduction

This learning outcome covers; Water drainage, Farm water drainage systems, Types of drainage systems, Maintenance of drainage systems, Tools and equipment and Operational standards.

Definition of key terms

Drainage: This is the natural or artificial removal of excess water from the surface or sub surface of an area.

Aims of drainage: To remove the unwanted water in order that soil structure and aeration are maintained and that access to the field for cultivation and harvesting is assured.

Importance of farm water drainage

- Reduces soil and nutrient loss from ran off
- Prevents soil erosion
- Drainage on hill slopes helps to reduce the risk of soil slippage
- Farm water drainage facilitates early ploughing and planting of wetland fields.
- Lengthens crop growing season
- Leaches excessive salts from the soils in order to limit salinization and sonification process.
- Ensures favorable soil temperatures
- Provides more available soil moisture and plant feed by increasing the depth of root-zone soil.
- Favors growth of soil microorganisms such as bacteria, fungi and others which are important for microbial activities in soil such as decomposition of organic matter, mineralization process like nitrogen fixation etc.

Drainage system: An agricultural drainage system refers to a system by which water is discharged or in the soil to enhance agricultural production of crops. It may involve combination of storm water control, erosion control and water table control.

Content/procedures/methods/illustrations

7.1 Farm drainage systems are identified as per farm plan

Types of drainage systems

While there are more than two types of drainage systems employed in agriculture, there are two main types:

- Surface drainage
- Sub surface drainage

Surface drainage

The regular surface drainage systems which start functioning as soon as there is an excess of rainfall or irrigation applied operate entirely by gravity. They consist of reshaped or reformed land surfaces and can be divided into:

- Bedded systems which are used in flat lands for crops other than rice.
- Graded systems which are used in sloping land for crops other than rice.

The bedded and graded systems may have ridges and furrows. The checked surface drainage systems consist of check gates placed in the embarkments surrounding flat basins such as those used for rice fields in flat lands. These fields are usually submerged and only need to be drained on certain occasions e.g. at harvest time. Checked surface drainage systems are also found in terraced lands used for rice.

In literature, not much information can be found on the relations between the various regular systems i.e. bedded and graded systems, the reduction in the degree of water logging, and the agriculture or environmental effects. It is therefore difficult to develop sound agricultural criteria for the regular surface field drainage systems. Most of the known criteria for those systems concern the offering of the techniques of land leveling and earth moving. Similarly, agricultural criteria for checking surface drainage systems are not well known.

Sub surface drainage

Like the surface field drainage systems, the sub surface field drainage systems can also be differentiated in;

- Regular systems and,
- Checked (controlled) systems

When the drain discharge takes place entirely by gravity, both types of sub-surface systems have much in common except that the checked systems have control gates that can be opened and closed according to the need. Checked drainage systems save more irrigation water and also reduce the discharge, through the main drainage system thereby reducing construction costs.

When the discharge takes place by pumping, the drainage can be checked by simply not pumping or reduces the quantity of irrigation water needed and does not lead to undue salinization.

Sub surface field drainage systems consist of horizontal or slightly sloping channels made in the soil; they can be open ditches, trenches, field with brushwood and a soil cap filled with stones and a soil cap, buried pipe drains, tile drains, or mole drains but they can also consist of a series of wells.
Modern buried pipe drains often consist of corrugated, flexible and perforated plastic (PE) Or PVC pipe lines wrapped with an envelope or filter material to improve permeability around the pipes and to prevent the entry of soil particles which is especially important in fine sandy and silty soils. The surrounding may consist of synthetic fiber. The field drains (or laterals) discharge their water into the collector or main system either by gravity or by pumping.
The wells (which may be open dug wells or tube wells) are normally to be pumped but sometimes they are connected to drains for discharge by gravity. Sub surface drainage by wells often referred to as vertical drainage and drainage by channels as horizontal drainage but it is clearer to speak of 'field drainage by wells' and 'field drainage by ditches or pipes' respectively.
In some instances, sub surface drainage can be achieved simply by breaking up slowly permeable soil layers by deep ploughing (sub-soiling), provided that the underground has sufficient natural drainage. In other instances, a combination of sub-soiling and sub-surface drains may solve the problem.

Factors to consider in identifying or choosing a farm drainage system

- **Soil properties**

Detailed information about specific soil properties e.g. soil depth, soil type and existence of any soil layers that restrict water movement must be known to properly design and manage a drainage system e.g. Clay soils generally conduct water much more slowly than sand thus to adequately drain water from a clay soil, a surface system could be needed and tile drains will have to be more spaced closely. This will make installation more expensive for sandy soils which are more permeable, both surface ditches and tile drains can be spaced further apart.
Soil depth is another important consideration; there must be adequate soil depth. 3 to 5 feet is generally recommended to install a tile drainage system. In shallow soils, surface systems can be used and tile drains must be closely installed more closely together or close to the soil surface to adequately lower the water table.
The shallow restricting layer reduces the amount of water that a drain can intercept because it cuts off the deeper flow paths that water can flow to the drain. This makes installation more expensive. Sub surface drains should also be deep enough to provide protection against tillage operations, equipment loading and frosts hence all subsurface drains in mineral soils should have at least 2 feet of soil cover over the drain to protect them against overloading from heavy machinery. Organic soils should have at least 2 feet.

- **System outlet**

The location of the drainage system is an important consideration and should generally be located 3 to 5 feet below the soil surface, where gravity is not available, pumping can be considered. Installing and maintaining a pump adds considerable expenses to any drainage system.

- **Topography assessment**

Topography influences water movement and drainage within a field. Steeper field slopes allow excess water to move laterally down slope in the soil, draining more rapidly than flatter fields. Fields with steep slopes tend to require less drainage than flatter fields. Topography also influences where the outlet can be located. An outlet should be hydraulically down gradient of the system it drains, otherwise pumping will be required.

- **Economic analysis**

Before carrying out a drainage system, a cost benefit analysis should be done to determine if the drainage system will be economically viable. Sub surface tile systems are generally more expensive to install than surface ditches due to specialized equipment needed for installation but they can be more economical because a subsurface file system does not remove land from production like a surface ditch system does.

- **Cropping strategies**

Cropping strategies are important to consider because they can change the economic payback period of any drainage system: Higher yielding or higher value crops will benefit more from drainage than lower yielding, lower value crops. Crops that may be intolerant of saturated conditions might require greater drainage intensity than crops that can tolerate wet conditions for longer periods. Deep rooted crops could require drains to be installed at a greater depth that shallow rooted crops.

- **Maintenance needs**

Like any other systems require maintenance for them to perform correctly. The maintenance required depends on the drainage system type. Tile and ditch systems have different needs. Developing a drainage system management plan is a good first step to ensuring that a drainage system continues to function properly. Any drainage system management plan should include good documentation maps of the location of the ditches, outlets and buried tile and should begin with periodic inspection of the systems. Ditch systems should be inspected regularly for any obstructions or impedance to flow in the ditch, bad erosion bank failures. Obstructions should be removed as they are encountered, and any of bad erosions or bank failures should be removed as encountered.

- **Environmental considerations**

While drainage has clear benefits to crop production, there are also negative environmental consequences of drainage. Since conventional drainage management emphasizes the export of water rather than prudent management of local water tables, generally resulting in excessive drainage. There is the possibility of excessive nutrient export from tile drained fields.

In addition, routine ditch management practices including scrapping and vegetation management can minimize the internal cycling of nutrients in ditch vegetation and destabilize ditch walls, resulting in erosion and water quality concerns. The chosen drainage system therefore should help in environmental conservation.

7.2 Water drainage systems are constructed as per farm plan

1. **Construction of subsurface drainage system**

There are three types of sub surfaces systems i.e. open and pipe drains, tube well drainage and mole drainage, each of which has its own construction method. In construction of sub surface drainage system, the following two procedures are involved:

- **Design of sub surface drainage systems**

Depth and spacing of field drains. The depth and spacing of field drains are usually calculated with the help off drainage equations. The data needed for those calculations include the agricultural requirements (depth of water table and root depth). The soil characteristics (hydraulic conductivity and depth to the impermeable layer) and hydraulic factors.

Calculated drain spacing normally show considerable variations due to the variations in input data. If so, the area should be divided into sub-areas of 'blocks' of convenient size e.g. the area served by one collector.

For each of the sub-area or block, a uniform and representative drain spacing can be achieved. An example is as illustrated below:

As an example, suppose that the calculated spacing in a project area vary between 18 and 85m, practical sets of standard spacing could then be:20-25-30-40-50-60-80m or 20-30-45-60-80m. It makes little sense to make the increments too small in view of the many inaccuracies and uncertainties in the entire process of calculating the spacing.

- **Pipes**

The materials used in the manufacture of drain pipes are clay, concrete and corrugated plastics. Important criteria for pipe quality and selecting the most sustainable type of pipe. Availability of raw material. The resistance to mechanical and chemical damage. Longevity and costs. The costs are the total cost for purchase, transport handling and installation.

- **Envelopes in pipe designing**

Sometimes, pipe drains are installed with an envelope. An envelope is the material placed around the pipe to perform one or more of the following functions:

a. Filter function: To prevent or restrict soil particles from entering the pipe where they may settle and eventually clog the pipe.
b. Bedding function: To provide all-round support to the pipe in order to prevent damage due to soil load. Large-diameter plastic pipes are embedded in gravel especially for this purpose.

A wide variety of materials are used as envelopes for drain pipes, ranging from organic and mineral materials and mineral fibers. Organic material is mostly fibrous and includes peanut coconut, heather and sawdust. Mineral materials are mostly used in granular form: they may be gravel, slag of various kinds (industrial waste products) or fired clay granules. Synthetic materials may be in a granular form e.g. (nylon, acryl and polypropylene). Glass fiber, glass wool and rock wool which all are mineral fibers are also used.

Methods of applying envelopes on pipes

There are various ways of applying envelope materials. They can be applied in bulk as thin sheets or as more voluminous 'mats". Bulk application is common for gravel, peat, litter, various slags and granules. It is recommended to place pipes in such a way that it is completely surrounded by the envelope material. In this way, the envelope material will fulfill its filter, hydraulic and bedding function. Thin sheets and mats are commonly used with plastic pipes as pre-wrapped envelope.

2. **Construction of pipe drainage systems**

Construction methods

Pipe drainage systems are generally constructed by specialized contractors. They are solicited after tenders have been called for, usually from a list of contractors drawn up by the authorities in a prequalification process. This type of construction is very complex hence not ideal for farm pipe drainage systems.

The classical method of pipe installation consists of marking the alignments and levels, excavating the trenches by manual labour, placing the pipes, envelop material and back filling the trenches. Nowadays, field drains are installed by drainage machines either trenchers or trenchless machines. Concrete collectors are often installed by excavators. In addition to the mechanics of installation, other important matters are the work planning, the working conditions, supervision and inspection.

Alignment and levels

To make alignments and levels, stakes are placed in the soil at both ends of a drain line with the top of the stakes at a fixed height above the future trench bed. The slope of the drain line is thereby indicated. A row of boning rods is then placed in line (both vertically and horizontally) between the stakes, with an extension at the upstream end of the drain line where the run of the drainage machine ends. The boning lines thus are in a line parallel to the trench bed. The driver of the machine achieves grade control through sighting. The same principle can be applied when drains are installed manually.

Steps in the construction of a sub-surface drainage system include:

- Setting out levels
- Clearing the site
- Installation of pipes
- Backfilling the trench

Machinery used in construction

They fell into two categories:

Trenches and trenchless machines. Trenchers excavate a trench in which the pipe is laid while trenchless machines merely lift the soil while pipe is being laid.

3. **Construction of surface drainage systems**

Open surface drains can be constructed manually or mechanically. Care should be taken that the soil from the drains do not block the inflow or runoff, but is deposited on the correct side of the ditch or is spread evenly on the adjacent fields. Collector drains are usually constructed with different machinery than that used for field drains. (i.e. excavating instead of land planes). The soil is placed near the sides of the drain. Scrappers are needed when excavated soil is to be transported some distance away.

7.3 Water drainage system is maintained as per environmental manage plan

1. **Maintenance of sub surface drainage system**

The maintenance of sub surface drainage system. Three procedural steps:

- Initial inspection and maintenance
- Ongoing inspection and maintenance
- In the field

Initial inspection and maintenance

During the initial period following the installation of the new sub surface drainage system, the soil around and above the drains will still be loose and should be left alone to settle naturally with time and rain. Do not use equipment to pack down the soil over the drain as any pressure on the loose soil could damage or collapse the pipes. Minimize traffic on the field as long as possible, and straddle the laterals and mains with equipment or work across (not parallel to) the drains when working the field in the first year after installation.

Confirm that all surface inlets are filled with a proper guard or grate to keep debris, trash and rodents out of the sub surface drainage system.

Ongoing inspection and maintenance

The sub surface drainage system should be inspected for developing problems and prompt repair of any noted issues to increase its life span.

In the field

Check for any signs of erosion of the drain pipe trench following rain events. If the drainage system is blocked with tree roots

- Reroute the drainage pipe away from the tree(s)
- Remove and replace the section of the blocked drains and remove tree(s) causing the problem.
- Replace the drain using continuous non perforated pipes for a distance of 15m on either side of the tree.

Maintenance of surface drainage systems

Remove any trash, debris or plant material that has accumulated around the inlet to make sure that it functions properly. Look for any signs of reddish-orange slim coming from the outfall. This may indicate the presence of iron ochre which can plug the drainage system.

Conclusion

This learning outcome covered; water drainage, farm water drainage systems, types of drainage systems, maintenance of drainage systems, tools and equipment and operational standards

Further Reading

1. Journals: Agricultural water management- international journal. ISSN 03783774

4.3.8.3 Self-Assessment

Written assessment

1. The following are steps involved in construction of a sub-surface drainage system except?
    a) Setting out levels
    b) Clearing site
    c) Planning the site
2. All of the following are factors to consider in choosing a farm drainage system except?
    a) Soil properties
    b) Environmental conservation
    c) Irrigation method
3. The following activities are involved in farm water drainage systems except?
    a) Water control
    b) Erosion control
    c) Vegetation destruction control
4. The following are types of sub surface drainage. Except?
    a) Open and pipe drains
    b) Mole drains
    c) Crulley control drains
5. Maintenance of sub surface drainage system involve the following procedural steps except?
    a) Construction of discharge ways
    b) Ongoing inspection and maintenance
    c) In the field
6. What do you understand by the term;
    a) Drainage
    b) Drainage systems
7. Outline the maintenance of surface drainage system
8. What do you understand by the term ‘envelope’ as used in pipe installation?
9. Outline three ways in which blockage of a drainage system by tree roots can be corrected
10. Outline 2 methods of applying envelopes on pipe

Oral Assessment

1. Outline importance of drainage
2. Outlines types of drainage systems

Case Study Assessment

1. Visit a water treatment plant; identify the drainage systems carried out

4.3.8.4 Tools, Equipment, Supplies and material

- Soil auger
- Measuring tapes
- Topography mapping tools
- Measuring tools
- Soil science laboratory and equipment
- Jembe
- Shovel
- Note books

4.3.8.5 References

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4.3.9 Learning Outcome No 8: Harvest farm water

4.3.9.1 Learning Activities

Learning Outcome No 8: Harvest farm water	
Learning Activities	**Special Instructions**
8.1 Identify farm water harvesting methods as per soil and water conservation manual 8.2 Construct farm water harvesting structures as per soil and water conservation manual 8.3 Water harvesting structures are maintained as per environmental management plan	Field excursion

4.3.9.2 Information Sheet No4/LO8: Harvest farm water

Introduction

This unit covers; Roof catchment Surface runoff Ground water Rock catchment

Definition of key terms

Water harvesting: This is the gathering of water from an area termed as catchment area and channeling it to the cropping area or wherever required.

Water harvesting structures: These are structures that are used in conserving water for future use or for daily use.

Content/procedures/methods/illustrations

8.1Farm water harvesting methods are identified as per soil and water conservation manual

There are different types of water harvesting methods but the two broad ways are:

- Rooftop water harvesting
- Surface runoff water harvesting

Rainwater harvesting

It is the collection and connection and storage of rainwater for reuse on site rather than allowing it to runoff. The stored water is used for various purposes e.g. gardening and irrigation

Rooftop water harvesting

It is a system of catching rain water where it falls in the rooftop. The roof becomes the catchment and the rainwater is collected and stored in a tank or diverted to artificial recharge system.

The rooftop rainwater harvesting system components

- **Catchments:** This is the surface that receives rainwater directly e.g. roof, paths, terraces
- **Transportation:** Rainwater from the roof top should be carried through down to take water pipes or drains
- **First flush:** This is a device used to flush off the water received in first shower of rain to avoid contaminating fresh water
- **Filters:** These are materials put on a water storage to filter away microorganisms, dead animals etc.

Example of filters; sand gravel filter, charcoal filter, sponge filter.

Method of rooftop rainwater harvesting

i. Collection of water from roof of the building and diverting to a storage tank that should have a filter for filtration
ii. Recharging ground aquifer. It can be recharged by various kinds of structure to ensure percolation of rainwater in the ground, instead of draining away from the surface runoff

Examples of the structure are

- Recharging of bore wells
- Recharging of pits
- Recharging trenches
- Soak away
- Percolation tanks

Surface runoff harvesting

This is where water which flows away can be caught and reused for recharging aquifers

Examples of construction that reduce surface runoff water for harvesting are:

i. Contour farming

This refers to field activities such as ploughing and furrowing that are carried out along contours rather than up and down slopes. They conserve water by reducing surface runoff and encouraging infiltration of water into the crop areas. A number of waters harvesting techniques or methods are based along contours. They include; contour ploughing, contour ridges, store lines, grass strips and terraces. Techniques used depend on the steepness of the slope, soil type, crop grown and availability of labour.

ii. Contour ploughing

Any ploughing on a slope should be carried out along the contours. This is to reduce run off and soil erosion and increase moisture content. It can be practiced on any slope with gradient less than 10%. On steep slopes it should be combined with other measures e.g. terracing, bunds or strip cropping. It is an important factor in determining the direction of ploughing. It is also important to layout contours properly or they may channel the water and increase run off.

Figure 27: Contour ploughing

iii. Bench terraces

Terraces are made by creating ridges and furrows along contours on a slope. The ridges hold back water, soil and runoff. Terraces can be used on steeper slopes than contours. They are firmed by digging a ditch along a contour.

Figure 28: Bench terraces

Other examples of construction that reduce surface runoff water for harvesting include: Grass strips planted along contours. It reduces soil erosion and runoff, store lines and retention ditches

Advantages of contour farming

- Reduces soil erosion
- Improves soil moisture content
- Induces natural process of terracing e.g. store lines
- Planting pits

These are the simplest forms of water harvesting. Small holes are dug at spacing of one meter. During rainstorms, planting pits catch runoff and concentrate it around the growing plant; compost manure is also placed in the pits thus improves soil fertility.

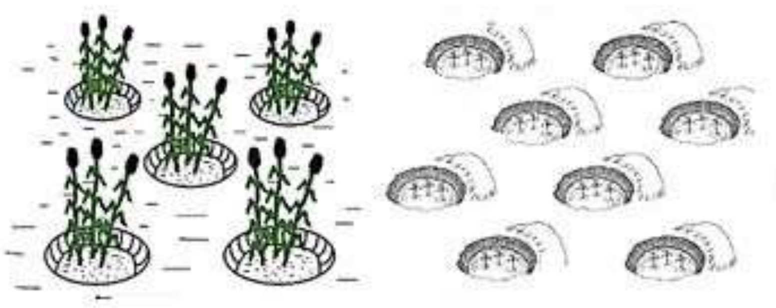

Figure 29:Planting pits

- Semi-circular bunds

These are earth bunds in the shape of a semicircle with the tip of the bunds on the contours. The size of the bunds varies. They are mostly used to harvest water for fruit trees and for seedlings. Large structures are used for rangeland rehabilitation and fodder production. Other planting pits include:

- Mulching
- Cover crops
- Conservation tillage

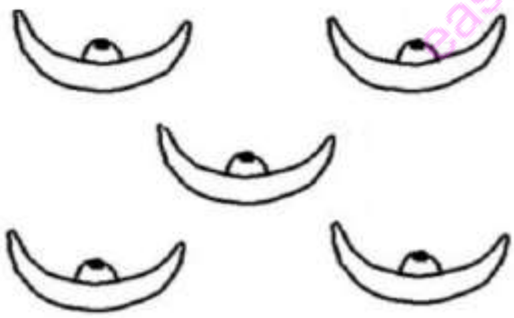

Figure 30: Semi-circular bunds

8.2 Water harvesting structures are constructed as per soil and water conservation manual

Water harvesting structures include all mechanical or structural measures that control the velocity of surface runoff and thus minimize soil erosion and retain water where it is needed. These structures consist of engineering works involving physical structures made of earth stones, masonry or other material for construction of earth works. The water harvesting structures can be made to either conserve or harvest water or to safely discharge it away.

Suitability of the water harvesting structure depends on:

- Climate and the need to retain or discharge runoff
- Farm size
- Soil characteristics
- Availability of an outlet
- Labor availability and cost
- The adequacy of existing agronomic or vegetative conservation measures

Amount of surface runoff determines the type of structure of water harvest to be constructed.

Surface runoff

Surface runoff is the portion of precipitation that makes its way towards the stream, lakes, rivers. Runoff occurs when precipitation rate exceeds infiltration rate and is the most destructive component of rainfall.

In constructing of water harvest structures, these factors are considered

- Peak runoff rate
- Runoff volume
- Temporal distribution of runoff rates and volumes

Factors that affect runoff

- **Catchment factors**

Catchment factors include: topography, vegetation, infiltration rate, soil storage capacity, the size of the catchment, its shape and orientation. The larger the catchment the more the runoff it will generate.

- **Rainfall factors**

Rainfall factors associated with surface runoff and erosion include rainfall amounts, storm duration, intensity and distribution

The most significant component of rainfall is the intensity which is a function of the energy the raindrops impact on the soil

- **Estimation of surface runoff**

It's important to know the quantities of water to be handled if the objective is to impound water e.g. dams peak volumes are used. If the purpose is to convey water e.g. channels, water ways, peak run off rates are used. It is necessary to estimate runoffs or construction of conservation and also conveyance of water to avoid failure due to over topping

Estimate of the rates of surface run off therefore depend on two processes:

i. Estimating the rate of animals
ii. Estimating how much of the rainfall becomes run off

The run off rate is more crucial and is determined using various methods or equations.

i. The runoff coefficient

The simplest method to use a single coefficient which represent the ratio of rainfall loss, if half of the rainfall is lost by infiltration, the other half appears as runoff then the coefficient C is 0.5

ii. **Catchment characteristic or cook's method**

The method consists of summing numbers of which represents the extent to which runoff from the catchment will influence a particular characteristic. The effect of four features is considered in cook's method which is the relief
Soil infiltration
Vegetation cover
Soil surface storage

iii. **Runoff curve numbers**

iv. **The rational formula**

The rational method predicts runoff through this equation Q=0.0028 CIA
Q= the design peak runoff rate in m^3/s
C=runoff coefficient (a function of catchment vegetation, slope, surface culture)
A=area of the watershed in hectares
I=rainfall intensity in mm/hr. (for the design return period.

Principles for the design of water harvesting structures

The construction of structures considers severity and extent of erosion damage or risks of the factors causing erosion. The suitability of land to the identified intervention to be considered. Water harvesting control measures are directed at protecting the soil from raindrop impact and hydraulic forces of runoff.
The process involves three areas of attention

i. Reduction of raindrop impact on the soil
ii. Reduction of overland flow
iii. Increase infiltration rate
iv. Slowing runoff velocities.

Factors considered in construction of a structure

The structures are usually made by hand labour or machinery although some terraces develop naturally from vegetative barriers. They are important on steep slopes where annual crops are grown and in marginal rainfall areas where there is a need to conserve rainfall in situation.
The selection and structure to be constructed depend on the factors below:

- Climate and the need to retain and discharge runoff
- Farm size and system
- Cropping pattern
- Soil characteristic
- The availability of outlet for discharging runoff away from cropland
- Labor availability
- Availability of materials

Types of water harvesting structures

These structures include diversion ditches (cut off drain) retention ditches, terraces and water ways. Supportive cultural measures e.g. grass or vegetation for stabilizing the structures are recommended. The identification of types of harvesting structures should take into account the need to retain water or drain the excess water. Structures which are intended to discharge runoff should not be installed unless there is a place for disposal of water. In higher rainfall areas. It is good to construct structures to discharge runoff. Discharging water into footpaths, road or existing gully will aggravate the problem of erosion. It is important to dispose water in natural or artificial waterways. In dry areas with low rainfall it is advisable to keep rainwater to prevent runoff.

Benefits of construction of structures

- Increase agricultural productivity
- Conservation of potentially productive land
- Reduce nutrients loss from soil
- Environmental conservation by strong more water within the soil profile
- Soil drainage benefit in areas to floods or water logging
- It protects infrastructure e.g. roads from erosion, drainage etc.

Limitations

- Small holder farmers cannot plan for construction of the structures
- Constructing can be expensive to in falls
- There is a lot of labour needed

8.3 Water harvesting structures are maintained as per environmental management plan

Water harvesting structures require regular maintenance and repairs if they get damaged. Grazing in cultivated lands that have constructed structures should not be allowed as the animals can damage the structures. Replanting vegetative materials and lining out construction and channel should be done at least every season. Regular cleaning catchment, gutters, filters, and tanks should be done to reduce the likelihood of contamination. Water from other sources should not be mixed with that in the tank.

Conclusion

This learning outcome covered; roof catchment, surface runoff, how structures are constructed; their limitations and benefits; the different types of methods of how water is harvested in the farm and how the structures are maintained.

Further Reading

1. Delmar D.Fangmeier, P.E. Professor Emeritus of agricultural and bio systems engineering. The University of Arizona
2. www.rainfoundation.org

4.3.9.3 Self-Assessment

Written assessment

1. Which one is not a rainwater harvesting system component?
   a) Catchments
   b) Tanks
   c) Filters
   d) Flush
2. Which one of the following structures is not an example of recharging ground aquifer?
   a) Recharging boreholes
   b) Recharging pits
   c) Soak away
   d) Rain
3. Which one is not a method of water harvesting?
   a) Contour ploughing
   b) Grass strips
   c) Semi-circular bunds
   d) Catchments
4. Which one does not affect run off?
   a) Catchment factor
   b) The run off coefficient
   c) Rainfall factor
   d) Estimation of surface runoff
5. Which one is not considered in structure selection?
   a) Farm size
   b) Soil characteristic
   c) Labor availability
   d) Footpath

Short answer question

1. What is water harvesting.
2. List down 5 benefits of constructing water harvesting structure.
3. List down how maintenance is done in water harvesting structures.
4. Name the methods of farm water harvesting
5. List down types of water harvesting structure.

Oral Assessment

1. What do you understand by water harvesting structures?
2. Mention advantages of contour farming

Case Study Assessment

Have a trip to one of agricultural institution and have a tour around and view the different types of water harvesting structures. The teacher and the industrial supervisor should guide you.

Practical Assessment

1. Having a farm session and construct a bench terraces; cut; off drain
2. In the farm plant grass strips and also make stone lining on a farm of crops in your school

4.3.9.4 Tools, Equipment, Supplies and Materials

- Water tanks
- Levelling boards
- Shovels
- Gutters

4.3.9.5 References

Anil Kumar, A.K Madhakar August (2019)

Duveskog, D, 2003 Soil and Water conservation with focus on water harvesting.

Huffman, R. L. (2009). The Future of the AG PE Exam--Survey results and commentary. *Resource Magazine*, *16*(6), 10-12.

4.3.10 Learning Outcome No 9: Manage waste water disposal

4.3.10.1 Learning Activities

Learning Outcome No 9: Manage waste water disposal	
Learning Activities	**Special Instructions**
9.1 Identify waste water disposal methods as per water management manual 9.2 Identify waste water disposal structures as per wastewater management manual 9.3 Construct waste water management structures as per waste water management manual	Arrange to visit a waste treatment plant. Set a lesson to conduct the practical

4.3.10.2 Information Sheet No4/LO9: Manage waste water disposal

Introduction

This learning outcome covers; waste water treatment, waste water recycling, waste water disposal and waste water pollution management

Definition of terms

Waste water disposal: It is the process of conveying waste water form homes, business and industries to water treatment plant or to a collecting point.

Waste water: It is any water that has been affected by anthropogenic use.

Water treatment: It is the process of remove contaminants from the water to convert it to reusable water.

Water pollution: It is the contamination of water bodies mostly due to human activities.

Content/procedures/methods/illustrations

9.1 Waste water disposal methods are identified as per waste water management manual

Water pollution

Classification of pollution population

According to the medium affected that is water pollution, air pollution and soil pollution.

Sources of water pollution

- Natural and anthropogenic pollution.
  Natural this is pollution due to presence of gas in the atmosphere that dissolve in the water inform of carbon iv oxide. Also, decomposition of organic materials and lastly suspended materials render it not useful.
- Anthropogenic: This is changing of water activities by human being.

Activities that cause water pollution

- Industrial activities
  Some raw materials for the industries contain sediments that make water polluted. The end products such as plastics also cause water pollution.
- Domestic activities
  Waste such food remains, excrement and urban cleaning cause pollution.
- Agricultural activities
  Use of herbicides, fertilizers and manure in farming activities cause water pollution downstream.

Characteristics /properties of contaminated water

- The water has a smell
- Water is greyish brown; this colour indicates pollution.
- It has a bad odour. Clean water-clean water should have no odour.
- Water is turbid showing presence of dish water.
- Water contains solid suspension, dissolved solids and colored solids.
- Presence of organic matter such as gravel, dissolved salts and chlorides in the water.

Waste water disposal methods

i. **Rain water**

This water is in large volumes but has less load. This water is polluted due to human activities such as industrial emission of waste. Atmospheric pollution also pollutes the water. The water is deposited through precipitation.

ii. **Disposal through domestic water disposal**

Discharge of municipal sanitary system, household, commercial and large facilities such as hospital is discharged to the sewage.

iii. **Industrial waste water**

Industrial effluent from industries is released to the rivers and some of the sewer system. This effluent emission is disposed.

Urban water

Water is released from the urban buildings and urban business. The water is conveyed through pipes.

Onsite effluent disposal

This is where water is conveyed to be treated on the site of the pollution. These are water stored in a septic tank and leach drains.

Grey water systems

The gray water is a system where waste from laundries, kitchen, and bathroom is conveyed to the garden and lawns. This help to save water.

Decommissioning of the existing disposal system.

When a new sewage is established, the existing waste water treatment plants should be replaced and contents emptied to the sewage system.

Factors to consider in choosing a disposal system.

- Chemical contamination level
- Detection limits of the system
- Quantity of the water required
- Number of analysis to be performed
- The level of analysis of water
- The source of effluent
- The previous treatment of the waste

9.2 Waste water disposal structures are identified as per waste water management manual

Factors to consider when choosing a waste treatment plant

- Plant location

  Location of drinking water sources, surface water intake and ground water is considered because it should be close. It should be isolated from the residential land and its use environs.
- Prevailing wind directions

  The direction of the wind is considered to avoid disrupting the treatment process.
- Susceptibility of the site to flooding.

  The site should not be prone to floods, i.e. it should be gently sloping
- Provision of future expansion

  The site should allow for expansion. The site should have enough space for expansion
- Suitability of the place to receive treated sewage

  The site should be n capacity to receive waste water.
- Accessibility of the area. Areas off site

  The site selected should be in a position where treated water can be conveyed ease to the area of use.
- Design capacity

  The amount of waste water to be treated is considered in designing the capacity.

Construction of a water treatment Plants

i. Preliminary treated section

ii. Bar screens are established here. the screens are made of series of sieves. This is the first section of the plant.

iii. Pump and blower house

This section is made of pumps where waste water is received. Pumps provides pressure for water flow.

iv. Piping

PVC pipes are used to convey water from one section to the next

v. Tanks

A series of tanks where water is stored are constructed. At the reception water is received at a tank. Another tank is constructed to receive contents after the water has been sieved.

vi. Concrete section

The various compartments are of concrete to hold water while awaiting the next stage

Construction of a septic tank

What is a septic tank?

It is a tank constructed underground for sewage or waste water collection.

Process of construction

A septic tank should have at least two chambers. The first chamber should be around half the first chamber.

Measurement

The first chamber is 1.2m by 1.0m by 1.6m deep

2nd chamber is 0.6m by 1.0m by 1.6m

The tank is designed to be deep, so that it takes less space.

Figure 31: Septic tank

https://www.shutterstock.com/search/septic+tank

9.3 Waste water management structures are constructed as per waste water management manual

Water treatment and recycling

Reasons for water treatment

- To make it safe for drinking and domestic use
- To remove bad taste and smell
- To remove solid sentiments from water
- To prevent disease outbreaks
- To remove chemical contaminants in water.
- To improve flavors in water
- To reduce cost of acquiring water
- Increase the amount of water available for use.

Water treatment stages

Stage 1: Screening and sieving

At this stage any coarse objects such as solid is removed.

Stage 2: Aeration

Dissolving oxygen in water to remove bad smells and taste, here bacteria growth is reduced.

Stage 3: Ph. correction

Chlorine is added to water to correct PH. levels

Stage 4: Coagulation and sedimentation

Aluminum sulphate is added to the water. This causes agglomeration and sedimentation of solid particles. This removes the remaining solid particles.

Stage 5: Chlorination

Chlorine water is added to water to kill microorganisms. This is it keep water free from micro-organisms.

Stage 6. Filtration

This is the last stage of removing solid water particles. The smaller particles are removed using fine sieves.

Stage 7. Storage

Treated water is conveyed in the storage tanks waiting for the use.

Water recycling

This is the process of reusing water from the industries, domestic activities and irrigation to implement a beneficial function.

Types of water to be recycled

- Grey water, water from non-toilet plumbing as basins shower and taps
- Black water, water from toilet.
- **Recycling grey water**
  To be reused in flushing the toilets
- **Black water recycling**
  It can be used to mix concrete for construction.

Water pollution management/ Prevention of water pollution

- Washing a car or other implements should be done away from water resources
- Don't throw trash, chemicals or solvent in the sewer drain
- Septic tank should be checked after every 3years
- Avoid using pesticides and fertilizers that can run off to the water system
- Waterways should be swept to avoid driving dust to water ways
- Paint brushes should not be washed in the sink to avoid driving chemicals to the water.
- Avoid use of pesticides along river bank
- Industrial effluents should not be drained into rivers.
- Legislation should be established to control waste water disposal and uses.

Conclusion

This learning outcome covered; waste water treatment, waste water recycling, waste water disposal and water pollution management.

Further Reading

1. Estimation of domestic waste water characteristics in a developing country by campos,H. and von sperling
2. The world commission on environment and development. Ny WCED.
3. Water and waste water technology by Hamma and Hammer.

4.3.10.3 Self-Assessment

Written assessment

1. The following are classification of pollution according to the medium affected. Which one is not?
   a) Water pollution
   b) Land pollution
   c) Air pollution
   d) Soil pollution
2. Which statement describes best waste water disposal?
   a) The process of conveying waste water from home and business buildings to the treatment plants
   b) The process of carrying water to the farm
   c) The process of removing chemicals from water
   d) None of the above

3. Which of the following is not a waste water method?
    a) Domestic water disposal
    b) Onsite effluent water disposal
    c) Rainwater
    d) All of the above
    e) None of the above
4. Which of the following factors are considered when choosing a water treatment plant?
    a) Plant location
    b) Prevailing wind direction
    c) Provision of future expansion
    d) Design method
5. Choose one method of water treatment?
    a) Recycling
    b) Plant treatment
    c) Water conveyance
    d) Construction of a dam
6. Which best describes water recycling?
    a) Re-use of the water other the first use
    b) Use of water for another reason other than the intended
    c) Re-use of the water after the first time for a beneficial purpose
    d) None of the above
7. Which factors affect water content?
    a) Chemical
    b) Solid particles
    c) Agricultural practices
    d) None of the above
8. What do you understand by water recycling?
9. What do you understand by the term water disposal?
10. State factors considered in selection of a treatment pant
11. What is water treatment

Oral Assessment

1. What is the importance of water recycling?
2. What do you understand by land pollution?
3. Explain the factors to consider in sitting a day house.

Case Study Assessment

Visit a water treatment plant in the country of your school and study the various structures

Practical Assessment

1. Collect contaminated/ polluted water from your school.
2. Construct a simple water treatment plant in your school.
3. Develop a water treatment manual and present it to your tutor

4.3.10.4 Tools, Equipment, Supplies and Materials

- Gutters
- Water tanks
- Jembe
- Panga

4.3.9.5 References

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Ferguso, b (1990) on site. Stormwater.management .Georgia. Columbia.

USEPA. (1980).process Design Manual: onsite wastewater. Treatment and disposal system.. Cinannat.ohio.

4.3.11 Learning Outcome No 10: Manage water supply

4.3.11.1 Learning Activities

Learning Outcome No 10: Manage water supply	
Learning Activities	**Special Instructions**
10.1 Identify sources of water as per water supply and maintenance manual 10.2 Identify waste water supply methods as per water supply and maintenance manual 10.3 Install water supply systems as per water supply and maintenance manual	Demonstrate installation of water supply systems Guide on installation of water supply system

4.3.11.2 Information Sheet No4/L10: Manage water supply

Introduction

This learning outcome covers; water supply equipment, water supply survey, water supply layout, water supply system operation and maintenance.

Definition of terms

Water supply: It is a source, means or process of making water available by public utilities, commercial organization community endeavors or by individuals via a system of pumps and pipes.

Water supply system: It is the infrastructure for the collection, transmission, treatment, storage and distribution of water for homes, commercial establishments, industry, irrigation and public needs.

Content/procedures/methods/illustrations

10.1 Sources of water are identified as per water supply and maintenance manual

Water source: Natural resources of water that is potentially useful.

Types of water sources

- Protected or improved- covered with stones or concrete or materials.
- Unprotected or unimproved.

Characteristics protected water sources

- The water source is fully enclosed or capped and no surface water can run directly into it.
- People do not step into the water while collecting it.
- Latrines, solid waste pits, animal excrete and other sources of pollution are inaccessible.
- No stagnant water within five meters of the water source.
- The water collection buckets or hand pump at the source are kept.

Unprotected sources: These are sources with no barrier or other structure to protect the water from contamination. Examples are like: lakes, rivers and wells.

Ground Water: It is water that is found underground within the rocks. Its presence depends primarily on the type of rock.

Advantages of ground water

- Likely to be free from pathogenic bacteria.
- Usually free from turbidity and colour.
- Can usually be used without further treatment.
- Can often be found in close vicinity to consumers.
- Economical to obtain and distribute.
- The water bearing soil or rock provides a natural storage point.

Disadvantages

- High mineral content e.g. calcium, magnesium. iron.
- Requires pumping for construction.
- May have high level of bicarbonate and chloride.
- Poor in oxygen content.
- Can contain chemical contaminants e.g. arsenic, fluoride and nitrates.
- Difficult to treat in case of pollution.

Factors influencing contamination of ground water

- Polluting source e.g. pit latrine
- Depth of the pit and its vertical distance from the water table.

Well and boreholes

They are described according to their depth or the way they are constructed.

Example

- Shallow wells- Have a depth of less than 30m, although they can be as much as 60m deep in dry areas.
- Deep wells/Boreholes- Sunk with drilling machines designed for constructing water extraction boreholes. The machines penetrate through harder material that cannot be tackled by hand digging and pas through at least one impermeable layer of rocks.

Springs

This is the emerged ground water e.g. at the foot of mountains and hills, in lower slopes of valleys and near the river banks.

Surface waters

Found on the land surface.

Factors that determine quality and quantity of surface water

- Ecology
- Climate
- Surrounding land use

Rainwater: It is available where rainfall is abundant and frequent.
Rainwater harvesting: It involves collection, harvesting of rainwater as it runs off from hard surfaces and storing it in a tank or cistern.
Ways of collecting rain water

1. **Roof catchments:** Rain water is collected from house roofs made of tiles, slate galvanized metal or equivalent. Pipes feed water from the roof and gutters into a collection tank where it can be stored until needed.

Precautions to avoid contamination

- The tank must be completely covered and well-maintained.
- The roof and gutters should be cleaned regularly, especially before the start of the wet season.
- Divert the first rainwater away from the tank so that dust and dirt are washed away.
- Put a mesh screen between the guttering and pipe that leads to the tank.

2. **Ground catchments:** Collect and store water falling on the area or ground.

Factors determining amount collected

- Topography of the area: Flat/sloping.
- Permeability of the top layer of ground.

3. **Sand dams:** It is a concrete wall (1-5m high) built across a seasonal sandy riverbed. During rainy season, a seasonal river forms and carries sand and silt downstream. The water can be abstracted from the sand dam, via a slotted pipe buried in the sand that either passes through the dam wall or connected to a simple hand pump situated on the river bank.

Water source development: Availability of plentiful water supply.

Factors considered

- Volume of water required
- Quality of water
- Season variations
- Distance between sources and users
- Costs
- Environment impact
- Sustainability

10.2 Water supply methods are identified as per water supply and maintenance manual

These are means through which water is conveyed to the destruction of use or storage.
Precautions before supply:

- Treatment- process that ensures purity of water and remove or reduce harmful substances. The methods are purification, disinfection through chlorofication, fluoridation and desalination.
- Methods of water supply are pumping, piping and flow by gravity.

Pumping: Water is conveyed through devices known as pumps by mechanical action.

Types of pumps

- Positive displacement pumps
- Centrifugal pumps
- Axial-flow pumps

Positive displacement pumps

They include the rotary pumps are gear, screw, and rotary. The reciprocating pump are hand, piston and plunger pumps. The linear pumps are gravity, steam and valve less pumps.

Advantages of pumps

- Economical and simple solutions for providing a collective supply of water in rural and sub-urban areas.
- They eliminate the risk of people and children falling into open wells.
- Improve the conditions of hygiene under which water is drawn off e.g. when using buckets.

Disadvantages

- Regular maintenance is required, which is expensive and the spare parts are rarely found.

Factors to consider before purchasing a pump

- Price: cost of the pump.
- Economic environment: Possibility of easily finding space parts and the personnel to repair.
- Social environment: Public acceptance
- Ease and cost of maintenance.

Piping: Water is conveyed through a network of pipes.

Types of pipes used

- **Cast iron pipe:** Widely used for city water distribution systems. Has a long life and is resistant and corrosion.
- **Galvanized iron pipe:** Made of mild steel sheath.
- **Wrought iron pipe:** Prepared by welding wrought iron sheets.
- **Steel pipe:** Made from steel.
- **Copper pipe:** Made from copper. They are durable since they are resistant to rusting.
- **Plastics pipes:** They include rubber and P.V.C pipes.
- **Asbestos cement:** Made from asbestos, silica and cement converted under pressure to a dense homogenous material possessing considerable strength.
- **Concrete pipe:** Made from concrete.

Advantages of PVC pipes

- They are safe, durable and sustainable
- Cost efficient
- Environmentally friendly
- Recyclable

Limitations

- Can burst under high pressure.
- Can become brittle on exposure to the sun
- Can be gnawed by rodents.
- Can be damaged easily during land preparation.

Flow by gravity

Water is let to flow into reservoirs by the force of gravity. The reservoirs are constructed depending on the flow of water.

Installation of water supply systems

Water supply system is the infrastructure for the collection, transmission, treatment and storage of water.

Types of water supply systems

- Public water system
- Private water system

Public water systems

a) **Community water system:** Supplies water to the same population year-round. They serve at least 25people or 15 residences that are primary residence e.g. municipalities mobile home park, sub- divisions.

b) **Non-community water system**: They are composed of transient and non-transient water systems.

- **Transient non-community water system (TNCWS)**

Provide water to 25 or more people for at least 60days or year, but not to the same people and not on a regular basis. E.g. camp grounds and gas stations.

- **Non-transient non-community water systems (NTNCWS)**

Regularly supply water to at least 25 of the people at least six months per year, but not year-round e.g. schools, factories, office building and hospitals. The places normally have their own water systems.

10.3 Water supply systems are installed as per water supply and maintenance manual

Factors to consider before purchasing and installing water purifiers

- Cost of the purifiers
- Daily water intake
- Annual maintenance cost
- Electric or non- electric
- Contaminants found in the available water

Conclusion

This learning outcome covered; water supply equipment, water supply survey, water supply system layout and water supply system operation and maintenance.

Further Reading

1. Impact: A performance Review of kenya's water services sector 2013-2014
2. Joint monitoring programme (JMP) for water supply and sanitation.
3. Ministry of water and irrigation: Annual water services sector review 2009

4.3.11.3 Self-Assessment

Written assessment

1. Which one of the following is not considered as an unprotected source of water?
    a) Rivers
    b) Rainwater
    c) Lakes
    d) Wells
2. Which one of the following is an example of ground source of water?
    a) Lakes
    b) Oceans
    c) Rivers
    d) Springs
3. Which one of the following is not a natural source of water?
    a) Boreholes
    b) Oceans
    c) Lakes
    d) Permanent
4. The following are not safe sources of drinking water. Except one, Which one?
    a) Well
    b) Rivers
    c) Lakes
    d) Taps
5. Which one of the following is an example of water pollutant?
    a) Silt
    b) Soil
    c) Stones
    d) Chemicals

6. Which one of the following is not an example of water supply system?
    a) Water tanks
    b) Pipes
    c) Pumps
    d) Spring
7. What do you understand by the term water source?
8. Give an example of a protected source of water.
9. Name one pollutant that contributes to pollution of water sources.
10. What do you understand by the term water supply system?
11. State an example of ground water source.

Oral Assessment

1. Differentiate between water supply and water supply system.
2. Give any two characteristics of the protected water sources.

Case Study Assessment

Visit a water and sewerage company near you and carry out the following activities.

a) Identify the main source of water found.
b) Identify any form of treatment carried out.
c) Observe the water supply methods practiced.
d) What is the common water system present in the area?

4.3.11.4 Tools, Equipment, Supplies and Materials

- Water tanks
- Gutters
- Levelling boards
- Measuring tapes
- Topography mapping tools

4.3.11.5 References

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4.3.12 Learning Outcome No 11: Prepare soil and water management report

4.3.12.1 Learning Activities

Learning Outcome No 11: Prepare soil and water management report	
Learning Activities	**Special Instructions**
11.1 Collect data on soil and water resources as per user needs 11.2 Analyze data on soil and water resources as per standard data analysis tools 11.3 Record data analysis results	Assign each group a supervisor for the project.

4.3.12.2 Information Sheet No4/L11: Prepare soil and water management report

Introduction

This learning outcome covers; collection of data, data analysis, documentation and report writing

Definition of terms

Data: These are the facts and statistic collected processed and analyzed to generate useful information.

Data collection: This is the process of gathering and measuring data of interest using standardized methods to achieve a particular objective.

Data analysis: The process of standardizing, transforming and modeling data to discover useful information

Content/procedures/methods/illustrations

11.1 Data on soil and Water resources is collected as per user needs

Types of research

i. Explorative research: Conducted when few or previous study exists. The learner should use case study and observation of soil and water resources
ii. Descriptive research: This is used to classify the elements and characteristics of a study subject.
iii. Analytical research: This tries to explain the how and why aspects of a subject
iv. Productive research: This attempt to speculate possible outcome basing on the analysis of available evidence

Research approaches

Quantitative and qualitative research

Qualitative research: It is focused on collecting and analyzing numerical data using scale, range and frequency.

Quantitative research: This is subjective research. It involves examining and reflecting the less tangible aspects of the research, using value, attitudes and perception.

Basic and applied research

Basic approach aims to improve knowledge without any particular applied purpose. Applied research is designed to find outcomes to apply to a particular situation. For instance, improve soil fertility.

Deductive and inductive research

Deductive approach is focused on moving from general to specific ideas. Inductive approach is focused on ideas.

Data collection methods

Survey

This involves selecting a representative sample from a population one wishes to study. the sample is asked questions using face-to-face, interviews or using questionnaire to derive data. It is both descriptive survey, which involves identifying, and counting the frequency from a group

It could be also analytical which tries to get the relationship between various elements. For instance, between high production and level of education.

Experimental studies

This is the study done in a controlled environment to enable causal relationship of a phenomenon to be studied. It allows for manipulation. For instance, studies of water infiltration on soil, done in the laboratory, data is collected and recorded.

Longitudinal studies

Study done over a long period to observe the effect that time has on the situation under observation. Primary data is collected here. For instance, studies of the effects of rainfall on soil composition after three years.

Cross-sectional studies

This is the study of different organizations to look at similarities and differences between subjects. For example, study of the types of the types of soil in different regions of a county.

Case study

This is the study of a particular subject such as soil and water conservation policy and analysis its information.

Action research

This study is intended to bring intervention by a researcher to influence a change in a given situation or subject. For instance, to improve soil and water management practices. The research explores ways of achieving improvement. After the research, he/she introduces new techniques and monitors the results.

Ethnography observation

In this research, the researcher makes a working member of the group or subject to be observed, with the 0bjective of understanding from inside. They are either covert-where the subjects are not aware of the study or overt where the subjects are aware of what is going on.

Participative enquiry

The researcher involves the subjects in the process of research. The whole group of subjects may be involved in the process. The researcher can work with the subject, where he or she is already known.

The process of data collection

Step 1. Establish a general field of interest.

The researcher decides on the research decides on the research problem. The learner should consider the school requirements for the project.

Step 2. Background and predatory reading

The researcher acquits himself/herself, with the work or the research that has been done on the topic area. This is to identify research possibilities and avoid repetition. Limitations and weakness of the previous research studies and identify previous findings

Step 3. Writing research proposal.

At this stage, the ideas are narrowed down and put together. A title is given to the research problem. Methods of data collection are chosen here. For instance, use of questionnaires observation or review

Step 4. Preparing information gathering tools.

After selection of the methods, the data collection tools are gathered and assembled

Step 5. Conducting research

The data is collected using the methods chosen and approaches selected are used.

Types of data collected depending on the source

- Primary data- data collected first hand
- Secondary data-data sourced from a primary source

Depending on the source collected

- Discrete data -data that can take only certain specific values rather than a range of values
- Continuous data-values that can take values between a certain, range for instance ratios

Ethical considerations in research

- Individual’s privacy should be considered
- Individuals should participate in the research voluntarily
- The consent and possible deception of the participants should be avoided
- Confidentiality of data provided should by the individuals should be kept
- Effect of the research on the participants should be made aware
- If the research is funded the information should only be given to the funder

11.2 Data on soil and water resources is analyzed as per standard analysis tools

Data analysis

What is the purpose of data analysis? It answers the research questions and helps determine the trends and relationships among variables?

Types of data analysis

Descriptive analysis. This is description of data from a particular sample, this can be:

i) Frequency distribution - this is the arrangement of numerical value from the highest to the lowest.

ii) Measure of central tendency-this calculation of mean, mode and median

iii) Calculating measures of variability-this is the measure of the degree to which scores in distribution are different or similar to one another

iv) Standard deviation- The most commonly used measure of variability which indicates the average to which the scores deviate from the mean

Inferential statistics: Numerical values that enable the researcher to draw conclusion about a population based on the characteristics of the population

Presentations of findings: Findings are presented in different forms such as;

Narrative or textual form: This is composed of the summary of the findings by considering the objectives of the study. This is where the objectives are checked if they were met. Direct quotations are also used and implications of the study are noted down.

Tabular form: Tables provide clear data and presentations, so that is they used it is easy to analysis data.

Sample table

	Dependent variables	
Independent Variables		

Table 6: Sample table

Interpretation of data

When analysis has been done and the appropriate statistical procedures completed this process of data presentation is done. Area covered in data presentation

i) **Summary of the findings**: The portion summarizes the results of data analysis from the analysis from the analysis from the analysis section. Here, the stated problems of the research are reviewed and linked to the results of data analysis

ii) **Conclusions:** A conclusion is drawn from the findings. it focuses on the answers provided for the hypothesis.

iii) **Recommendations:** This is based on the results of the conclusion, this is aimed at improvements.

11.3 Data analysis results are recorded

The format of report writing

Tile page

This statement describes the research study. It should not be too narrow nor should it be too wide, to allow proper study process

Acknowledgement page

Acknowledgement begins on a separate page. It is a section where the researcher expresses his gratitude for those who contributed and participated in the research process.

Declaration page

This is the page where a researcher pledges that he conducted the study.

Table of contents

It contains the parts of the documents showing all the pages for easy referencing

List of tables

After the tables of contents, the tables in the research paper are indicated in this section

List of figures. This is composed of the diagrams, graphs and chart

The main body: This section is comprised of:

i) **Chapter 1:** Introduction to the

This is what the study is about and what makes the researcher interested in doing the study. It introduces the reader to the subject matter

ii) **Chapter 2:** Review of related literature

iii) **Chapter 3:** Research design and methodology

This is where the method of data collection and the process of collecting data is stated and described

iv) **Chapter 4:** Analysis and interpretation of data

v) **Chapter 5:** Summary, conclusion and recommendations

vi) Bibliography and appendices are listed here

Conclusion

This learning outcome covered; collection of data, data analysis, documentation and report writing.

Further Reading

1. Research metholody by Ebraim
2. Yusuf Zuber-skerrt(1991)action research and development
3. Shufgnessy,J.EB9(1985).research methods in psychology

4.3.12.3 Self-Assessment

Written assessment

1. Choose one statement that best describes the definition of data
    a) This are the internet subscription necessities
    b) Data is the information collected processed and analyzed
    c) Data are the facts and statistics, processes and analyzed
2. Which one of the following if the odd one out?
    a) Explorative
    b) Description
    c) Innovation
3. Quantitative data is aimed at collecting numerical data.
    a) True
    b) False
4. Which one of the following is not a method of data collection?
    a) Survey
    b) Longitudinal
    c) Cross-sectional studies
5. Choose two types of data analysis
    a) Descriptive analysis and descriptive data
    b) Frequency distribution and measure of central tendency
    c) Descriptive analysis and inferential analysis
    d) None of the above
6. What do you understand by the term data analysis?
7. What do you understand by the term two types of data analysis?
8. What are cross-sectional studies?
9. Outline the process of data collection.
10. State four methods of data collection.

Oral Assessment

1. Discuss the process of data collection.
2. What do you understand by the process of data interpretation and recording?

Case Study Assessment

1. In groups of four, find one project that has been published and review it to produce your own version of the project.

Practical Assessment

1. Collect data using at least two methods of on the uses of water in your school
2. Design a data analysis manual foe manual for your data in 1 above
3. Analyze your data in 2 above and write a report

4.3.12.4 Tools, Equipment, Supplies and Materials

- Notebook
- Measuring tape
- Quick set

4.3.9.5 References

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CHAPTER 5: PRODUCE AND FORMULATE LIVESTOCK FEEDS/FORMULATE LIVESTOCK FEEDS.

5.1 Introduction

This unit specifies competencies required to produce and formulate livestock feed. It involves determination of animal nutritional requirements, calculating livestock feed ratios, producing animal feeds and feedstuff, animal feedstuff mixing, packaging animal feeds and storing animal feeds that an animal consumes in a day. This unit is a part of animal nutrition that is very critical to a farmer as it determines the productivity of a particular animal thus determining the profit a farmer gain. The aim of formulation is to have a balanced ration in terms of required nutrients by the animal and have an economical ration without compromising the palatability and balance of nutrients.

The critical aspects of competencies to be covered include; Determining animal nutrition requirements, formulation of livestock feed ration, production of animal feed and feedstuffs, processing of animal feedstuff, packaging and storage of already processed feedstuff. The basic resources required for this particular unit include: Animal feed ingredients, feedstuffs, animal feed meals, animal feed mixers, shovel, protective clothing, hay boxes, legumes etc.

The unit of competency covers six learning outcomes. Each of the learning outcome presents: learning activities that cover performance criteria statements thus, creating trainee's an opportunity for the trainee to demonstrate knowledge and skills in the occupational standards and content in curriculum. Information sheet provides: definition of key terms, content and illustration to guide in training. The competency may be assessed through written tests, demostration, practical assignments, interview/oral questioning and case studies. Self assessment is provided at the end of each learning outcome. Holistic assessment with other units relevant to the industry sector workplace and job role is recommended.

5.2 Performance Standard

Determine animal nutrition requirements, followed by formulation of livestock feed formulation by use of different methods of feed formulation e.g. the Pearson square method as per the requirement of a specific livestock. All these are possible according to different aspects such as Ecological zone, breed of animal and good agricultural practices which bring about a good ration at the end of formulation.

5.3 Learning Outcomes

5.3.1 List of learning outcomes

a) Determine animal nutrition requirements
b) Calculate /compute/formulate livestock feed ration
c) Produce or procure animal feed and feedstuffs
d) Process animal feed stuffs
e) Animal feedstuffs mixing
f) Package animal feeds
g) Store animal feeds

5.3.2 Learning Outcome No1: Determine animal nutrition requirements

5.3.2.1 Learning Activities

Learning Outcome No1: Determine animal nutrition requirements	
Learning Activities	**Special Instructions**
1.1. Categorize animals as per breed, age, production level and physiological status of the animal 1.2. Determine feed requirements as per feeding standard tables	Group Discussion

5.3.2.2 Information Sheet No5/LO1: Determine animal nutrition requirements

Introduction

The learning activity covered is the animal nutrition which is further subdivided into: definition of terms, nutrient requirements, nutritional elements, feed values, animal feed intake, recipes/formula and rations.

Definition of key terms

Feedstuff: A food provided for the cattle or the livestock.

Nutrition requirement: Levels of the particular's nutrients in lowest/ highest amount that is necessary to maintain a person in good health.

Content/procedures/methods/illustration

5.1 Animals are categorized as per breed, age, production level and physiological status of the animal.

The essential nutrients required by the grazing animals are: water, energy, proteins, minerals and vitamins. These nutrients are needed to maintain body weight, growth, reproduction, lactation and health.

Water

Water is essential for all livestock and the producer should plan an adequate supply of clean water when designing any livestock enterprise. Dirty water can lead to inadequate water, consumption which will reduce feed and forage intake and compromise livestock performance. The amount of water required depends on the physiological stage of the animals and the climate. Lactating animals require more water and the amount of water required increases as the atmosphere temperatures increases. Example is at temperatures of 35^0 and above where animals require 8-15 liters of water. Lack of water may lead to death.

Proteins

Amount of protein supplied in the diet is more critical than the quality of the protein. Ruminants have the ability to convert low quality feed of protein sources to high quality proteins through bacterial action. Proteins is required by all grazing animals for tissues growth and repair.

Energy

Insufficient energy probably limits the performance of livestock more than other nutritional deficiencies. Energy requirements vary greatly with the stage of production and adequate amounts of energy are extremely important during late gestation and early lactation. Energy deficiencies can cause; reduced fertility lowered milk production and reduced fertility lowered milk production and reduced wool quantity and quality. Energy is obtained from carbohydrates in plant materials and can be stored in the form of body lipids. Live weight gain can only occur after these animal's energy requirements for the maintenance and location are met.

Vitamins and minerals

Ruminants require all the fat-soluble vitamins (A, D, E and K) but they can synthesize the B vitamins in their rumen. Forage and feed supply contain all essential vitamins in adequate amount except vitamin A which is obtained as carotene from green plants and is often deficient in dormant forage. When formulating a ration, performance criteria must be defined because ration formulation involves constructing a ration that will supply the nutrients needed to support the performance criteria. The performance criteria for animals raised for the food and fiber are targets in ration formulation. Ration is a fixed allowance of nutrients or of a service for a specified period.

Identifying requirements and selection of the product of feeds

Nutrients need of livestock within classes, breeds of production and use vary because of individual differences in the ability to utilize feeds and differing responses to environmental and management conditions. Individual animal variations enforce the need to individually manage the feeding of livestock especially those imposed by rapid growth, heavy states of production or intense work. There are numerous methods used to formulate and evaluate rations, ranging from methods similar to those simple examples to more controls and require higher degrees of accuracy. To be conducted correctly, ration formulation and evaluation require knowledge of feedstuffs, feed manufacturing process, routine feeding management practice and nutritional requirements and psychology of the livestock.

Determining the nutrients of feeds

Methods used to estimate the nutritional value of feeds include: Information from feed tags, nutrients database and nutrients analyses via tests in laboratories. Nutrients requirements can be broken down into four principal components and maintenance, lactation growth and reproduction. For these component requirements energy, proteins, minerals and vitamins are calculated.

Maintenance
Maintenance component include all the nutrients required for the animal health, more digest food, keeping warm, repairing tissues and maintaining body weight. Weigh age, breed, physiological status activity and environmental conditions are primary variables impacting maintenance requirements. The larger the animal, the greater its maintenance requirements especially energy and proteins. Extremely heavy muscled breeds, pregnant and lactating animals increase basal metabolism hence the maintenance requirements are altered accordingly.

Lactation

Heavy lactation has greater nutrients demands than any other production state. Nutrients requirements for lactation are based on the amount of milk at peak lactation and the composition of the milk. Animals that produce more milk with more fats and proteins will have higher nutrient requirements.

Growth
Measured as increase in body weight. Requirements for growth are determined by actual weight average daily gain, weight at maturity and composition of gain. Composition of gain either means that the animals are putting a lot of muscles or more fats. Nutrients requirements per unit body weight are greater for younger animals.

Reproduction
Requirements for reproduction are based on expected birth weight and stage of gestation. Requirements include development of material tissues as well as the foetus. Nutrient deficiencies prior to breeding may result in low fertility or failure to maintain pregnancy.

Factors affecting nutritional requirements

- Breed
- Weight
- Body condition
- Age
- Sex
- Stage of gestation
- Work
- Environment

5.2. Feed requirements are determined as per feeding standard tables
Feed is the food given to animals which are domestic and often refers to fodder in course of care and management of farm animals by humans for profit. Feedstuff is food provided for cattle or livestock.

Feedstuff include in feed tables are:

- Compound feedstuffs
- High moisture industrial product
- Roughage and related places
- Miscellaneous.

Food value of a foodstuff is a measure of its main nutritional components. The worth of any fodder depends mainly on the concentration energy and proteins in dry matter of the feed. Nutrition components of the foodstuff can greatly influence cattle production e.g. minerals, vitamin deficiencies such as calcium and phosphorous. Excess of particular substances in feedstuff can cause lowered production and even death e.g. copper toxify nitrite poisoning form in some grasses. Nutritional components range of foodstuff commonly fed to cattle are:

- Dry matter
- Metabolizable energy
- Crude proteins

Feeding of cattle should be managed adequately by providing the nutritional requirements according to the level of the production desired.

Dry matter

One should have an idea of the dry matter in the content of foodstuff because cattle usually consume a predictable quantity of dry matter per day. If feed is readily available, cattle generally eat a quantity of dry matter each day equivalent from two to three percentage of their body weight.

Energy

There has been a number of different systems used for defining the energy value of feedstuff for livestock. The starch equivalents system and total digestible nutrients systems are two examples. The metabolism energy system has been adopted as the standard system for defining the energy value of ruminants ME value of feedstuff is the amount of energy value that the ruminant is able to use per unit of dry matter of foodstuff eaten.

Two reasons why farmers should know relative values of feedstuff.

- To satisfy the energy demands of various forms of production, the diet of a ruminant must have an average energy value above a particular level.
- When feed is in short supply or when any feeding management is being planned, its useful to cost out each of the foodstuff on its monetary value per unit of ME.

Proteins

The protein requirement of cattle varies according to the weight and type of breed as well as the level of production. This is important to know the protein levels of various feedstuffs so that feeding management can match the protein available in an animal's diet with the animal's needs. The crude proteins value of feedstuff is determined by the quantity of nitrogen it contains.

Control of feed intake in livestock

- **Animals behavior**

The productivity of ruminants is determined by many factors out two of the most important are what and how much they eat.

- **Selection**

Sheep and goats graze more selectively than large ruminants. Cattle are less able to graze selectively than small ruminants because they take larger bites and the what in which they prelend plants is not conducive to selection.

- **Dysphagia**

Dysphagia is the ingestion of materials that can be determined as nutritionally inert or even harmful and which are not normally consumed.

Factors in feed that affect intake

They include: small animals reject feed without tasting it e.g. smell of dung reduces the intake of pasture. Chopping straw into short lengths tend to increase intake of the straw. Fine grinding and pelleting also increases the intake of straw but has low applicability in the developing countries because of high energy costs associated with this form of processing.

Food processing and the costs associated with processing include a wide range of unit operations including: receiving, grinding proportioning, mixing, pelleting, load out, and delivering. Nearly every one of these operations can have either a negative or a positive influence on subsequent animal's performance and can certainly influence final profitability. Grinding, mixing and pelleting are likely to have greatest influence on animal's performance and feed quality. Grinding is a major function of feed manufacturing and is by far the most common method of feed processing and the cheapest and a simple process and result in substantial reduction in particle size. It improves feed digestibility and acceptability increasing the bulk of some ingredients.

Conclusion

This learning outcome covered animal nutrition a whole with more emphasis put on definition of terms, nutrient requirement, nutritional elements, feed values and animal feed intake formula of calculating feed rations with an aim of coming up with a balanced ration in terms of the required nutrients by the livestock.

Further Reading

1. www.fao.org>nutrition-requirements

5.3.2.3 Self-Assessment

Written assessment

1. The 3 are essential nutrients for animals except one. Which one?
   a) Carbohydrates
   b) Proteins
   c) Vitamins
   d) Minerals

2. What are the factors affecting nutritional requirements?
    a) Breed
    b) Weigh
    c) Sex
    d) Health
3. The following are feedstuff included in feed tables except one?
    a) Roughages
    b) Miscellaneous
    c) Proteins
    d) High moisture industrial co-products
4. Which of the factors affect feed intake?
    a) Smell
    b) Palatability
    c) Grinding
5. If you are missing soybeans meat 44% and ground corn 99% CP together to make 2000lb of 10%, the number of soybeans required will be?
    a) 200bls
    b) 300bls
    c) 400bls
    d) 500bls
    e) 600bls
6. What is nutrition requirement?
7. Components of feed stuffs to be listed are?
8. State 6 major nutrients for cattle.
9. What is formulation ration?
10. Mention how grinding helps the animal feeds.

Oral Assessment

1. What are the components of a healthy diet?
2. Why is nutrition important?

Case Study Assessment

1. Discuss the importance of nutrition and digestion for animal's growth
2. Clearly the actual dietary requirements of an organization of an organism will vary according to the age, sex and levels of physical activity discuss.

Practical Assessment

1. Determine dry matter content, organic matter are crude proteins and fractioning of cell wall in forage and concentrates
2. Analyze the physical characteristics of feed by estimating average particles size and a distribution with sieves of different mesh size.
3. Assessing nutritional value of feed through vitro in situ and enzymatic methods.

4.3.9.4 Tools, Equipment, Supplies and Materials

- Feedstuff
- Animal feed mills
- Animal feed mixers
- Shovels

5.3.9.5 References

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5.3.3 Learning Outcome No 2: Formulate livestock feed ratio

5.3.3.1 Learning Activities

Learning Outcome No 1: Formulate livestock feed ration	
Learning Activities	**Special Instructions**
2.1 Animal feeds ingredients are identified as per animal feeding standard tables. 2.2 Livestock feed ingredient rations are formulated using formulas or computer programs as per animal feeding standard tables	Demonstrate field formulation method

5.3.3.2 Information Sheet No4/LO2: Formulate livestock feed ration

Introduction to learning outcome

Learning outcome covered include: feed formulation, animal feed rations, weighing methods, feed formulation formulas/recipes and feed analysis.

Definition of key terms

Feed analysis: This is the process establishing contents of nutrients and other biological essential ingredients in the feed. It can be physical analysis which involves visualization on color, dryness, odour or presence of a foreign materials that interfere with fed quality especially palatability or chemical analysis that involves evaluation and knowing levels of moisture, dry matter (DM), nitrogen, fat, crude protein, cellulose and ash in a feed.

Feed rations: A ration is the daily portion of feed prepared from a combination of various feeds based on various animal feed requirements.

Content/procedures/methods/illustrations

2.1. Animal feeds ingredients are identified as per animal feeding standard tables.

A feed ingredient is a component part/constituent or any combination/mixture added to and comprising the animal feed. Animal feed ingredients might include: grains, milling by-products, added vitamins, minerals, fat/oils and other nutritional and energy sources

Feed ingredients

i) Dry matter

This is part of food stuff or other substance which would remain if all water content is removed. It is a measurement of mass of something when it is completely dry. It constitutes fats, protein, vitamin, minerals and antioxidants.

Calculation of DM

Procedure

i. Weigh empty containers selected to hold the feed and record its weight
ii. Place the feed in the container (step 3)
iii. Weigh and record the container from total weight
iv. Subtract weight of container from total weight (step 3) to determine weight of feed before drying
v. Thoroughly dry the feed
vi. Weigh and record the container and feed weight immediately after drying
vii. Subtract the weight of the container from total weight (step 6) to determine the weight of the feed after drying
viii. Divide the weight of the dry feed (step 4) by weight of the wet feed (step 7)
ix. multiply by 100 to get percentage

Example

Container weight =300 g

Container and sample before drying= 450g

Wet sample weight= 450g - 300g

= 150g

Container and sample weight after drying = 354g

Dry sample weight = 354g-300g

=54g

Dry matter= $\frac{54}{150} \times 100$

= 36%

Note: Routine dry matter determination is essential in keeping the feeding programme on target.

Total Ash

This is the residue remaining after incineration. It is the final burnt product without water and any possible volatile products that escaped during incineration. Total ash has a sub-ingredient of acid insoluble ash which is the part insoluble in diluted hydrochloric acid. Analysis of ash content in feed involves burning away organic content and leaving inorganic minerals, thus helps to know amount of minerals and type; thus, determining physiochemical properties of foods.

Determining Total Ash value

Requirements:

- Porcelain crucible (50ml)
- Furnace (600∓20)
- Weighing machine
- Desiccator

Procedure

i) Weigh accurately 2gm of feed sample prepared in a crucible
ii) Incinerate up to 4 hours until ash turns while
iii) Cool crude having ash and weigh
iv) measure the weight
v) Find the difference

Crude protein

It is the amount of protein present in a specific feed.

Crude protein depends on nitrogen content in a feed without other non-nitrogenous proteins. They are the best as animal sources proteins are easily digested than vegetable protein. Crude protein is determined through laboratory feed analysis.

Calculating crude protein

Procedure

i. Remove water in a feed, e.g. 100g powder-5.3 H_2O = 94.7g of DM and feed had 82g of P.
ii. Convert from "as is" to (DM basis) by taking the percentage protein on a DUB basis and dividing it by new percentage of dry product % protein DMB=as in protein/ (1-% of water).

Thus % protein DMB = 82(1-053)

= 0.866

Crude Fiber

This is the measure of quality of indigestible cellulose partisans, lignin and other components. It is different from dietary fiber because dietam fiber is plant-based food that mostly passes through the digestive system without being digested. It can either be soluble fiber or insoluble fiber.

Determination of crude fiber

- Determined using Weende method
- Crude protein, crude fat and crude ash are determined and the moisture and carbohydrate content can then be calculated by difference i.e.

Carbohydrates = Amount of Total sample – Moisture - (Crude protein+ crude fat)

An advanced method 2 is the use of acid **hydrolysis** especially in developed countries is 25% H_2SO_4 is used in extraction of sugar and starch followed by alkaline hydrolysis with 25% NaOH which removes protein and some hemi-cellulose and lignin.

Minerals

These are solid substances that are present in nature and can be made available of one element or more. They can be macro-elements or micro-elements. Macro-elements are needed by the body in larger quantities since they do major growth roles e.g. Calcium, Magnesium, and Sodium. Some of the useful minerals in live stone include:

- Cobalt
- Copper
- Iodine

- Iron
- Manganese
- Selenium
- Zinc

Vitamins
A vitamin is an organic molecule and an essential micro-content that an organism needs in small quantities for proper biological functioning. Vitamins are essential in boosting immune system and repair damaged cells. Vitamin include:
Fat soluble: A, D, E, K – cannot be lost during making water soluble B-complex and C
The body does not need fat soluble vitamins because they are stored in the liver.

Water
Water plays a very important role in the body. Water softens feed and comes through digestion tract. It is also a component of blood (90% of blood content) water also contain nutrients and maintain the cell living part. Water also carries away waste products.

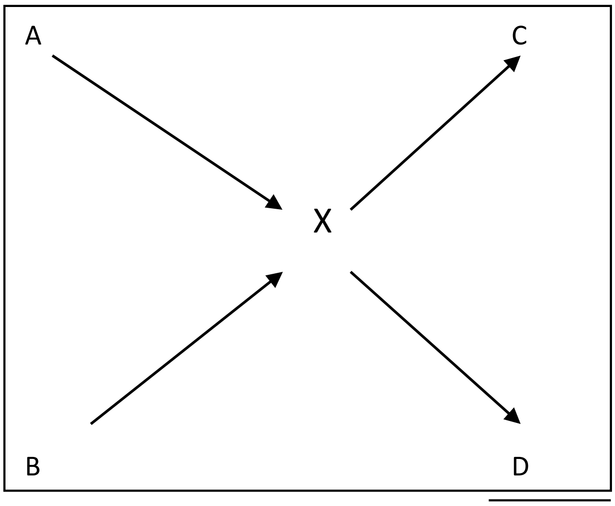
2.2. Livestock feed ingredient rations are formulated using formulas or computer programs as per animal feeding standard tables
Feed formulation: This is the process of quantifying amount of feed ingredient that need to be considered to form a single uniform mixture. Before feed are fed to the animal they are then formulated and weighted and the right quantity given to the animal.
Feed formulation Methods

i) **Use of person square**

This use a simple box procedure method of balancing rations that can be used for many years. It is of great value when the ingredients are mixed.

Other Methods
- Trial and error methods
- Simultaneous equation method
- 2x2 matric method
- Computer method
- WAG method
- Algebraic equation methods
- Substitutions method

Pearson square
- Simple nutrients needs are met with simple feed formula
- Lesser value is subtracted from greater value
- Record diagonally
- One feed must have a value higher than the derived value and one must have a value lower than the designed value.



Total =

A – X =D

B – X=C

Table 7: Pearson square

Substitution Method: Involves substituting ingredient with another in a new ingredient.

Example:

Original Information:

Ingredient	Amount (lbs)	% CP	CP ibs
Smooth become hay	60.0	6.0	3.60
Ground corn	33.0	9.0	2.97
SBM	7.0	46.0	3.22
	100.00		9.79

Table 8:Substitution Method

Assume you want to increase crude protein content to 13% by substituting SBM for corn. Rather than using a trial and error approach establish one for one substitution.

Add lb.- cone = 0.46lb. CP

Remove 1b – con =0.916 CP met change in protein = +0.37lb CP

Since you want to increase from 9.79-13% CP, you will meet 3.21lbs (13.0-7.97) additionally protein in each look mixture.

Thus, if each one for one substitution increase CP by 0.37lb, then 3.21/0.37=8.68lds SBM needed to substitute for 8.65lb.

Table 9:The revised formulation

Ingredient	Amount (lbs.)	% CP	CP lbs.
Smooth become hay	60.00	6.0	3.60
Ground corn	24.32	9.0	2.19
SBM	15.68	46.0	7.21
	100.00		13.00

Computer formulation (Linear programming)

Computerized feed formulation programme are often called least-cost program because they compare nutrients needed by livestock to nutrients supplied in food stuffs.

Example

Requirements = $aX_1 + bX_2 + cX_3 + dX_4$

Where a. b. c. d represent amount of each of the focus ingredient in the diet and X_1, X_2, X_3 and X_4 represent the amount of specific nutrient in each ingredient, simultaneous manipulation can be done by compete than manual methods. The feed formulation software programs used by major feed companies are useful in long-term important formulation programmes. Computer formulation will provide information on inclusion levels of ingredient, nutrients analysis, cost margin and amount of each ingredients for a given batch size.

Algebraic Equations/Simultaneous equations method

Formulate a diet which contains 0.85 % lysine using the following fine ingredient barley, wheat, soybean, and premix and Lucerne meal. These ingredients have been analyses. The Lucerne mean contains 0.69% lysine and is fixed at 5% of the diet. The premix contains no lysine and is fixed at 3.5% of the diet. The wheat contains 0.33% lysine and make up 25% of the total diet. The barley has 0.39 lysine and soybean has 30.5% lysine. At this state the diet is composed of:

Solution

i) With the wheat and Lucerne meal percentage food we can calculate that the mixture already contains 0.12% lysine $(0.25\times 0.33) + (0.05\times 0.69) = 0.12\%$
   The remaining component, barley and soya bean must therefore provide 0.73% lysine is 66.5% the total mix i.e. [100- (25.0+5.0+3.5) = 66.5%]

ii) Let × equal the proportion of barely in the diet and let (66.5 – X) equal to the portion of soya bean in the diet. The amount lysine required will be 0.73% i.e (0.85-0.12= 0.73%)

iii) The amount of protein supplied by barley will be 0.0039X where X is the amount of barleys and 0.039 is the fraction of barley that is lysine (0.39% w/w). The amount of lysine supplied by soya bean meal will be 0.0305(66.5-X) where (66.5-X) is the amount of soya bean on the diet and 0.03.5 is the fractions (g/g) of lysine in the soya bean meal.

Algebraic equation to solve this problem is

$0.0039X + 0.3.5(66.5\text{-}X) = 0.73$

Equation

$0.0039x + 0.0305(60.5) – 0.03.5x = 0.73$

$0.0039x = 2.0283 – 0.0305x = 0.73$

$-0.0266X + 2.0283 = 0.73$

$x = 48.8\%$

The amount of barley in the diet will be 48.8 while soya bean will be 17.7% (66.5-48.8). The Final made up is

Barley = 48.8%
Wheat = 25.0%
Soya bean = 17.7
Lucien = 5%
Premix = 3.5% lb.
Total = 100%

1. **Batch weighing:** This is a method of weighing that utilizes a special shortened and separate conveyor installed specifically for the purpose of controlling balance of feed.
2. **Automated weighing:** This is the use of electric machines in determining the ration that has been formulated in reactive of mixing. This is more accurate as it provides up to gram measurement thus is very precise.

Conclusion

This learning outcome covered feed formulation methods animal feed ratio, weighing methods and feed formulation formula which are important in this unit as this will help in finding a balanced ration for the livestock.

Further Reading

1. www.Youtube .com//Dairymealformulatiobalancedfeedforday cattle.
2. De bias, C. and Mateou, C. C (2010), 12 feed formulations. Nutrition of the rabbat, 222.
3. Tavon, A. G. (1995). Feed formulation and on-farm feed management. FAO fisheries technical paper, 61-74.

5.3.3.3 Self-Assessment

Written assessment

1. Formulation of feed ration is limiting animal referral food intake requirement.
    a) True
    b) False
2. Food analysis is a waste of time and resources since feed are composed of natural nutrients.
    a) True
    b) False
3. The following are food ingredients except
    a) Dry Matter
    b) Total Ash
    c) Mineral
    d) Maize Bur
4. Water is not an ingredient of food in animal nutrition
    a) True
    b) false
5. Pearson square is the only method of feed formulation
    a) True
    b) False
6. Batch weigh is not an effective method in feed measurement
    a) True
    b) False
7. Crude pattern is the total amount of protein in a feed
    a) True
    b) False
8. Give the importance of feed analysis
9. state two feed weighing methods
10. Highlight 3 feed formulation methods
11. Active feed rationing and feed analysis
12. Give three feed ingredients important to livestock

Oral Assessment

1. Whey is feed formulation and analysis important
2. What is the importance of Pearson square in feed formulation methodology?

Case Study Assessment

Students during their holiday to identify animal feed ingredient, formulate ration, using person square and batch weight methods and record their project results in the handbook, they should visit nearby farm feed lots for technical assistance and use of materials and equipment.

5.3.3.4 Tools, Equipment, Supplies and Materials

- Feedstuff
- Animal feed mills
- Animal feed mixers
- Shovels

5.3.3.5 References

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5.3.4 Learning Outcome No 3: Produce or Procure Animal feed and feedstuffs

5.3.4.1 Learning Activities

Learning Outcome No 3: Produce or Procure Animal feed and feedstuffs	
Learning Activities	**Special Instructions**
3.1. Source propagation materials as per agro-ecological zone 3.2. Prepare land is as per planting material requirements 3.3. Establish propagated materials as per good agricultural practices 3.4. Manage fodder crops as per good agricultural practices 3.5. Harvest fodder crops as per maturity index and height	Identify different types of fodder crops in the farm. Illustrate how to prepare vegetative materials in groups

5.3.4.2 Information Sheet No5/LO3: Produce or Procure animal feed and feedstuffs

Introduction

The learning outcome covers land preparation, livestock feed and feedstuffs, types of feedstuffs, sources of livestock feeds, type of pasture species and their nutritive values, Pasture establishment and management, harvesting, range management and conservation of feedstuffs

Definition of key terms

Range management: It is the professional natural science that centres around the study of herbivores that could have resulted in altered ecological states.

Plant propagation: It is the process of growing new plants from a variety of sources (e.g.) seeds cuttings and other plan parts.

Fodder crops: They are crops that are cultivated primarily for animal feed.

Content/procedures/methods/illustrations

3.1. Propagation materials are sourced as per agro-ecological zone

Agro-ecological zoning (AEZ) refers to the division of an area of land into smaller units, which have similar characteristics related to land suitability, potential production and environmental impact. An agro-ecological zone is a land resource mapping unit defined in terms of climate, landforms and soils and a land cover and having a specific range of potential and constraints for land mapping unit. The essential elements in defining an agro-ecological zone are the growing period, temperature regime and soil mapping unit. There are several systems of describing agro-ecological zones in the topic. In Kenya two are used:

- FAO classification for topic generally
- An order Kenya version which is only applicable in Kenya

Classification of Kenya Agro-ecological zone simple

Simple agro-ecological zones were established by Fao in 1981. They are suited to make decisions in international and long-term agricultural policies. In order to give advice to same districts, a move differentiated system showing yield probability and risks as well had to be developed.

Zone groups are temperature baits defined according to the maximum temperature limits within the crop in Kenya. The highest zone is high altitude for rough grazing (e.g.) tropical alp lined vegetation. The threshold value of annual mean temperatures has been established along similar lines but supplemented by limiting factors for crops.

Zone one

Annual average rainfall of over 350mm. The zone is divided into two areas

- Areas with an annual average rainfall of over 600mm where rainfall pastures can be grown successfully
- Areas with an annual average rainfall between 350mm to 600mm but not less that 300mm during two hinds of the monitored years and where it is possible to grow two successful crops every year. The main crops are Wheat, legumes and summer crops such as watermelon.

Zone two

Annual rainfall of 250mm to 300mm in not less than two hinds of the monitored years. It is possible to grow pastures every three years. Besides, the areas of the zone 2473000ha, forms 13.4 percent of the natural area

Zone three

Annual rainfall of 250 to 350mm with not less that 250mm during half of the monitored years. It is possible to grow crops incorporated with pasture crops especially legume pasture. The area of these zones 1306000ha accounts 7.1 percent of the total national area.

Zone four

A marginal zone between the available zones and the desert zone with an annual rainfall between 200 and 250mm and not less than 200mm during half of the monitored years. This area is suitable for permanent grazing. The area of it is zone,1823000ha forms 9-8 percent of the national area. This area is suitable for pasture production.

Zone five

Desert and steppe zone. This area covers the rest of the country and is not suitable for rained crops and pastures. The area of this zone is 10218000ha and accounts for 55.1 percent of the total nation area, there are some area in this zone adjacent to rivers which permits irrigated agriculture and natural rangeland. As rainfall decreases towards the interior it becomes desert.

In the desert areas only irrigated agriculture and nomadic grazing are possible in the steppe and native pasture systems, where the rainfall is below 200mm steppe occupies most of the land areas. It is too dry to crop, although at the wetter margin of the steppe there originally, it is characterized by ephemeral vegetation of very low productivity. Even the rainfall exceeds 250mm, it is native pasture that occupies land which are too steppe and where the disappeared due to overgrazing. Steppe land and native pasture are used primarily for the grazing of small ruminants and only rarely can it be supportive to livestock year-round. They are grazed mainly in winter and springs.

Selecting forage species

Forage grass and legumes performance vary depending on environmental conditions. The adaptation of a species on its potential longevity in the field is determined greatly by genetic, cold-hardiness traits and its tolerance of other site, soil and use conditions.

When selecting fodder crops the following factors may be considered that attract the suitability of fodder species

- Drought tolerance
- Soil pH level
- Fertilizer nutrients requirement
- Soil drainage
- Intensity
- Harvest or grazing

3.2. Land is prepared as per planting material requirements

Land is prepared depending on the method of saving an establishment. For example, either direct sowing of seeds, under-sowing and over-sowing on vegetative propagation.

Steps in seedbed preparation

The steps to properly prepare seedbed will result to more germination. A key to plants growth rests in the concept that there must be good seed to soil contact

The characteristics of a good seedbed are: depth of soil to depict 5 inches (12.7cm), adequate soil moisture and weed free. Each of these characteristics helps the seed to have the best chance to germinate and flourish.

The steps to obtaining a good seedbed include:
The soil to 5 inches (12.7cm) in depth.

i. Using a disk to carve though soil is especially beneficial when the disk is run though the soil twice with the second strip cutting perpendicularly to the first cut.
ii. Is the soil ploughed north south? The second disking would be east to west more thoroughly disturbing the soil.
iii. When ploughing, weed seeds are brought closer to the surface and with the closer contact with the sunlight and soil moisture they will germinate soon thereafter.
iv. After disking or ploughing a procedure will allow the weed seeds to germinate and use herbicides to indicate them.
v. The soil is disked to promote soil seed contact.
vi. Tilth to be acquired depends on the size of the planting materials.

3.3. Propagated materials are established as per good agricultural practices

General establishment and management of the seeds and pasture. There are three methods of pasture establishment

- Direct sowing
- Under-sowing
- Over-sowing

Direct sowing

It is the establishment of pasture grasses without a nursery or career crop. It consists of sowing seeds in a fine firm and weed free seedbed. Pasture should be sown in to land that has been under crop for 2 or more years for example Lucerne which is slow to germinate is often sown together with barley or oats (under-sowing). The barley or oats is then harvested early for silage or direct feeding to give room for the Lucerne to grow when it is ready

How to prepare seedbed

- On previously cropped land, plough the end of the proceeding dry season ploughing shortly before rain.
- On virgin land I ploughing and 2 harrowing may be required to make a good seedbed.

When and how to sow

i. Sow as early in the rainy season as possible. In bimodal rainfall area sowing is preferred in the short rains so that annual weeds are eliminated.
ii. Seeds should be sown close to the surface in order to contact with most soil so as to enhance germination. Seed should be deeply buried since initial vigor is not sufficient to push through a heavy cap of soil
iii. Grass seeds can either be broadcasted or disked in rows 30-40 cm apart
iv. Mix the seeds with sow-dust rough sand or phosphate fertilizer.

v. Sowing of the grass is effectively done with a wheat drill. Hand sowing is recommended for smaller averages where close supervision and attention in detail is possible

vi. Immediately after sowing the seedbed should be compacted to enhance germination of the grass seed by improving contact with the soil. This can be done by use of three branches or even by trapping by foot on small plots. In mechanized farms a roller can be used.

Fertilizer used at plating

Use phosphate fertilizer or farm yard manure at planting to promote strong root development

Over-sowing

(e.g.) non plough able land. The technique improves the quality of the natural pasture by introducing high quality herbage.

Over-sowing is done into way

- Overgraze the natural pasture field then broadcast to improve pasture species
- Overgraze the natural pasture field then harrow or ex-plough using a hard hoe and broadcast the improved species

3.4. Fodder crops are managed as per good agricultural practices

Good management practices are just as important as proper establishment techniques. Pasture establishment involves a considerable investment and returns depending on how effective the pasture can be managed and converted into milk or meat. It involves:

- Weed control
- Graze management
- Fertility management

Weed control

Weeds can reduce the productivity of the sown pastures particularly during the establishment year. Therefore, control weeds control during the first year by either:

- Hand weeding
- By the use of herbicide

In subsequent years, keep fields clean by slashing or hand pulling on moving weeds.

Grazing management

Grasses reach early flowering stage 3-4 months after planting. At this stage the plant is not firmly anchored in the soil and therefore, it is usually advisable to make hay rather than graze the pasture to avoid the risk of the cattle pulling out the young shoots

- If grazing must be done during the establishments, it should be light enough to enable the plants to establish firmly in the soil
- For maximum benefits use the pasture not later than the start of flowering stage. Graze or cut at an interval of 4-6 weeks leaving stubble height of 5cm
- Graze animal when the grass is at early flowering stage by moving animals from paddock to paddock

- One animal will need 1-2 areas of improved pasture per year in areas receiving over 900mm rainfall
- Conserve excess pasture inform of hay for dry season feeding
- If you are Zero-grazing your animal, note that an average sized dairy cow requires 80-100kg of fleshly cut grass per day
- A cow in mid lactation period produces on average 5-7 kg milk

Fertility Management

Many areas in Kenya show symptoms of deficiencies in the grass fields. Some of the common deficiencies are copper and selenium deficiencies but also nitrogen, phosphorous and potassium deficiencies. If your pasture does not look green and healthy during rainy season, it will pay to get a soil sample analyzed to see what is missing. Any deficiency can severely lower the production of pasture and cropland.

Importance of weeding

- Minimized the competition for moisture and nutrients thereby promoting early growth and vigor for the seedlings.
- Reduce the risk of fire
- Facilitates perception of water and soil accumulated heat released during the day.
- In forestry area, bare soil accumulates heat the day reaction in forest prone areas

Shoots when carrying out coppicing the following must be observed:

- The cut must be at angle
- The bank should not be damaged
- Only the best shoot should be left when arising from the new stump, when reaching an appropriate length of 1m
- Young copies should be kept weed free
- It should be done in the early season

Species suitable for judge production and being promoted by SDDP to contract farmers are not good at coppicing and might even die. If they are cut too low, they are most suitable for pollarding and side pronging species. Tree species used by SDDP, which can stand coppicing are; calendar and *L. leucocephale*. They are both low altitude species

Pollarding

It refers to cutting back of the crown at a height of 1.5 to 2m. The main purpose of pollarding is to remove the heaviest branches and leavers to stimulate growth of new palatable fresh leavers to get well formed productive crowns to reduce negative shading effects on the adjacent crops.

When pollarding is carried out maximize the production of fodder. Not all species can withstand pollarding. However, there are Species that can withstand pollarding and are promoted by SDDP.

Side pronging

This is the removal of lower branches from the tree. The steps involved are as follow

i. Seed improved species are mixed with fertilizer, broadcast on the overgrazed area at the rate of 10kg grass seed or 2-3 kg of legume seed unit 1-2 bags of missing rock phosphate per hectare
ii. Graze heavily for one or two days to ensure that seeds come in contact with soil due to cattle trapping
iii. Then remove the livestock from the field to allow new species to establish
iv. During establishment year, graze lightly to avoid grass being uprooted

3.5. Fodder crops are harvested as per maturity index and height
Harvesting of fodder

In the establishment of multipurpose trees for forage production it is critical to identify and use the most suitable species for adaptation for the difference agro ecological zone. Likewise, for high quality option yield of forage from planted fodder trees is proper harvesting techniques should be used so that the leafy portion is higher than the steamy portion in the biomass harvested.

Fodder crops need to be harvested timely and regularly for higher and sustainable yield. It must also be understood that there are different harvesting methods for the different fodder species.

- Coppicing

It is the cutting the stem or back of a tree at height of 10-50 from the ground to stimulate production of new crown. Its importance is;

a) Reduce shade on the agricultural branches
b) Harvest the branches for fodder fuel wood

In inter-cropping system side pronging should be done before or the beginning of the cropping season in order to minimize shade on the crop. Pruning should be done in a declining angle with a sharp stroke in order to allow water to run off and thus minimize the risk for fungal attack. The branches should be cut 2-3 cm from the stem. Pronging should be straight from the bottom and then move upwards in general a cutting height minimum 1.2-1, 5 m is recommended and they should be given a chance to get established properly before cutting.

Subsonic is best cut before it is a year old and should thereafter be cut at a height of approximately 1m. *Leucaena*, *Calandra* and *Tagasaste* should be cut at a height above 1.2m some experiments have however shown that *leucaene* produces most biomass when at height of 3m.

Conclusion

This learning outcome covered land preparation, propagation materials for feedstuffs, management of propagated materials and lastly harvesting of the materials in preparation for processing and storage**.**

Further Reading

1. OudaJO (2001). Feeding and caring of livestock in: Managing dry land resources. A manual for Eastern and southern Africa

4.3.4.3 Self-Assessment

Written assessment

1. Which one of the following is not a method of harvesting?
    a) Pollarding
    b) Copping
    c) Over-sowing
    d) Side pronging
2. The following are methods of a pasture establishment. Which one is not?
    a) Direct sowing
    b) Over-sowing
    c) Pronging
    d) Under-sowing
3. Which one of the following is not a factor to consider during selecting fodder crop?
    a) Soil drainage
    b) Soil pit level
    c) Water content
    d) Drought tolerance
4. Which one of the following is not a fodder crop management practice?
    a) Weed control
    b) Grazing management
    c) Water control
    d) Fertility management
5. Which of the following is not a necessity of weeding?
    a) Minimize competition
    b) Reduce fire risk
    c) increase fertility
    d) Facilitate water preservation
6. What do you understand by the term fodder crop?
7. Distinguish between forage and fodder
8. Name three methods of establishing fodder crops
9. Name two methods of harvesting fodder crops
10. What do you understand by the term pollarding?

Oral Assessment

1. Differentiate between cropping and pollarding
2. Give an example of crop housesit by pollarding

Case Study Assessment

Visit to the nearest pasture land in the surrounding farm. From the visit answer the following questions

i. Name type of pasture planted
ii. Methods used by farmers to harvest crops
iii. Types used for fodder management

Practical Assessment

5.3.4.4 Tools, Equipment, Supplies and Materials

- Feedstuff, rhizoid
- Panga
- splits
- Seeds
- Vines
- Stolon

5.3.4.5 References

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5.3.5 Learning Outcome No 4: Process Animal feedstuff

5.3.5.1 Learning Activities

Learning Outcome No 4: Process animal feedstuff	
Learning Activities	**Special Instructions**
4.1. Procure animal feeds ingredient as per type of feed to be formulated 4.2. Weigh. Ingredient proportions as per feed formulation formula 4.3. Mix ingredients as per feed formulation formula 4.4. Analyze feed as per standardization requirements. 4.5. Package Animal feeds as per market requirements 4.6. Store animal feeds as per occupation safety standards	Arrange for learners to visit a processing industry. Guide students in formulating animal feeds Demonstrate packaging on a video-ICT integration

5.3.5.2 Information Sheet No5/LO4: Process animal feedstuff

Introduction

The learning outcome covered include; types of animal feed processing, hay making, silage making, animal feed supplements and additives, livestock feed mixing equipment animal feed mixing technologies requirement, blending, product standardization requirement (KEBS), branding, animal feed storage structure and storage safety standards.

Definition of key terms

Hay: These are grasses, legumes or any other herbaceous plants that are dried to be stored for use as animal fodder.

Silage: This is grass or any other herbaceous fodder that are first compacted and stored in airtight conditions without 1st being dried and used as animal feed.

Blending: This is the activity of mixing or combining varied things together into one.

Additives: This is a substance which is added to something in small quantities to either serve as a preservative or for improvement purposes.

Feeding processing: This is altering the physical or chemical nature of feed commodities to optimize utilization by animals and to enhance mixing and stability of the diet.

Content/procedures/methods/illustrations

4.1. Animal feeds ingredient are procured as per type of feed to be formulated

Animal feeds should have high nutritional content and digestibility and should cater for all the animals needs through all the life stages. Thus, quality products especially ingredients should be selected for their appropriateness for the production system and even the bioavailability.

Feed ingredients are broadly classified into;

- Cereal grains
- Protein meals
- Fats and oil
- Minerals
- Feed additives
- Other raw materials e.g. tubers

Factors considered in selecting feed ingredients

- The absence of anti-nutritional of toxic factors
- Their palatability or voluntary feed intake
- The cost of the ingredients
- The nutrients the ingredients can store i.e. key nutrients to be supplied by feed ingredients are amino acids contained in proteins, vitamins, minerals and energy obtained from starches, lipids and proteins.

Process of procuring animal feed ingredients

This is done as per the types of feed to be formulated and usually quality of ingredients will vary.

Procedures involved in the process include;

i. First the buyer to set standards for ingredients to be purchased and list of reputable ingredient seller.
ii. Sampling the purchased ingredients periodically to ensure the ingredients are meeting specification.
iii. All incoming ingredients should be inspected and tags/labels feed for medication or trace minerals and other additives.
iv. Check the feed ingredients for any form of contamination i.e. Cu toxins should not be found in moldy feedstuff.
v. There should be a warranty included in purchase order showing suitability of an ingredient feed for use.
vi. All suppliers should have permit documents showing the type of product of the feed mill they belong to.

Transportation of procured feed ingredients

Suppliers or transportation personnel should be responsible and ensure that;

- All equipment should be cleaned before loading the feed

- No other materials should be in the truck, containers or other which could be hazardous.
- The conveyance process should be clean and free of materials that could affect animals or human health.

Types of animal feed processing

The major components of any diet, roughage and grain are the feeds that are to be processed.

Requirements for feed processing

- Processing methods should be based on mechanical, biological smoking, extraction precipitation and siltation.
- Water, ethanol, plants and animal oils, vinegar, carbon dioxide, nitrogen or carboxylic acids may be used for extraction.
- Filtration substances shall not be made of asbestos nor be permeated by substance which may negatively affect feed product.
- Irradiation is not allowed.

Feed processing facilities

This is to be managed throughout to avoid mixing without organic products or ingredients and maintain organic integrity.

Organic feed production lines must be separated from non-organic feed production line. Processed products are classified variedly; 100% organic, organic (not less than 95%, made with organic (at least 70%) salters/ less than 70% ingredients of certified origins which may not be called organic, but indication may appear on ingredients list.

4.2. Weighing ingredient proportions

This is done as per the type of feed formulation and the feed ingredients of plant and animal origin used in formulation of animal feeds with maximum inclusion of each feedstuff.

Expressing the Nutrients and Energy content

This is before weighing whereby it is expressed in forms of;

- **Dry matter (DM) basis**

This is the amount contained only in the Dry Matter portion of the feed ingredient without water.

Feeds contain varying amounts of Dry Matter, so composition and nutrient requirements are expressed on a Dry Matter basis for accuracy.

- **As fed basis**

This is amount entailed in the feed ingredient/diet as it would be fed to the animal including water.

- **Air-dry basis**

Usually assumed to be approximately 90% Dry Matter that most feeds will equilibrate to about 90% Dry Matter after prolonged anerobic storage. Air dry basis and as-fed basis may be the same for many common feeds.

- **Percentage dry matter**

Determined by drying a sample to remove all the moisture and then the weight of the remaining is expressed as a percentage of the original weight.

Example; 1.0g of corn is dried and 0.90g of corned remained after drying

Then % dry matter $= \frac{0.90}{1.00} \times 100 = 90\%$ Dry Matter

Conversion of as fed basis to Dry Matter basis can be converted by the formulae;

$$\frac{\text{Nutrients \% as fed basis}}{\text{\% Dry Matter in the expressed as a decimal fraction}} = \text{Nutrient \% on Dry Matter basis}$$

Or

$$\frac{\text{\% Nutrient (as fed basis)}}{\text{\% feed Dry Matter}} = \frac{\text{\% Nutrient (Dry Matter basis)}}{\text{100\% Dry Matter}}$$

Example;

Alfalfa silage analyzed to contain 7% cp an As- fed basis contained 40% Dry Matter. What would be the cp content on Dry Matter basis?

Method 1

$\frac{7}{0.40} = 17.5\%$cp on Dry Matter

Method 2

$\frac{7}{40} = \frac{x}{100} = 40x = 700 = 17.5\%$cp on Dry Matter

$x = \frac{700}{40}$

Dry Matter basis converted to as fed basis

Can be converted by;

Nutrient %on Dry Matter basis × %Dry Matter in the seed expressed as decimal fraction

Or

$$\frac{\text{Nutrient (as fed basis)}}{\text{\% feed Dry Matter}} = \frac{\text{\% Nutrient (Dry Matter basis)}}{\text{100\% Dry Matter}} = \frac{\text{\% Nutrient (Dry Matter basis)}}{\text{100\%Dry Matter}}$$

*Calculate an example with trainer

Conversion to air dry basis

a) Dry Matter basis to air dry basis 90% Dry Matter

Nutrient % on Dry Matter basis ×0.90=Nutrient % on air dry base

b) As fed basis to air dry basis 90% Dry Matter

90 × Nutrient % on as fed basis =Nutrient % of air-dry basis

Amount in Dry Matter as in fed

A. Amount in Dry Matter= Amount in as fed × Dry Matter content (decimal)

B. Amount in Dry Matter= x (amount in as fed) ×Dry Matter content (decimal)

So, amount as in fed =x = $\frac{\text{Amount in Dry Matter}}{\text{Dry Matter content (decimal)}}$

Rules of thumb for converting

1. When converting from “as fed” to Dry Matter
   - The nutrient content will increase
   - The weight will decrease
2. When converting from Dry Matter to as fed
   - The nutrient content will decrease
   - The weight will increase

4.3. Mixing ingredients as per feed formulation formula

After weighing the ingredients, the next step is mixing which is an important process in the feed production process whereby with efficient mixing leads to solid feed production.

On mixing, the assessment of ingredients (formula)

- **Mixing technology**

Basically, mixing means to transport the individual particles to an exact position in relation to other particles and thereby avoid segregation.

It is important to mix the ingredients properly to achieve a good feed quality.

Optimum mixing of the feed ingredients will ensure uniform distribution of nutrients, vitamins and minerals which will result in a homogenous nutrient content in each feed pellet.

Characteristics of a good mixer

- Speed and quality; Customers prioritize fast and efficient mixer
- Mixer should be easy to clean and maintain
- Feed millers, a list of principles is to be followed i.e. type of feed formulation.

Sample diet formulation techniques

1. Formulating a diet with 2 ingredients

Can also be used for 2 mixtures rather than 2 ingredients

Common method i.e. Algebraic diet formulation using an equation

Pearson square method-a procedure

1. Using an equation with one unknown x

Example; Formulate 9.14% crude protein cp diet using corn (8.8%cp) and a protein supplement (38%cp) and also check results for accuracy

18% supplement =%

corn=100x

0.088 (100x) (1bcp from corn) + 0.38x (1bcp from supplement) =0.14 (1b cp in 1001b of diet)

8.8-0.088x + 0.38x=0.141

0.38x -0.088x=14-88

0.29x=5.2

x=17.8 (1b supplement)

100-x=82.19

=1B corn

=0.088 (82.19) + 0.38(17.81) = 14.00 accurate

Using Pearson square method

Methods;

- The desired solution is placed in Centre (1x)
- Feed sources A1 and B1 are then added
- To solve the difference between X and A goes in the D position and the difference between B and X goes into the C position without regard to sign.
- Then answer is expressed as

Corn 8.8%cp 24.0parts cm

14%

Supplement 38%cp <u>5.2 parts</u> supplement

29.2 total parts

<u>24.0 parts</u>
29.2 total parts × 100 =82.19%corn

<u>5.2 parts</u> ×100 =17.8% supplement
29.2 parts total

Where; 8291b corn ×8.8%cp =7.231b cp
1781 lb. supplement ×38.0%cp=6.77cp
100lb in diet =14.00lb cp

Other methods include;

- Inducing a fixed ingredient
- Algebraic equation with two unknowns (x and q)

Then formulating a complete diet supplement and base mix which usually needs balance for important nutrients CA and CP.
Approaches to formulate a diet with only 2 ingredients can be used here.

Hay and silage making

Hay making is the process of forming seen and perishable forages into a product that can be safely stored and easily transported without danger of spoilage while keeping nutrient use to a minimum.

Suitable crops for making hay

These are crops with thin stems and more leaves. They are better suited as they dry faster than those with thick, pity and small leaves. Those common in Kenya are: oats, disodium, Lucerne, maize, sorghum, Napier grass, Rhode grass (according to KARI, Kenya).

Methods of hay making

i. Cutting the forage before it is fully matured to maximize its nutrient value and cut with as much leaf and little stem.
ii. Do not leave out forage in a moist environment, as this will enhance growth of mould.
iii. The cut forage is dried on sun out in as thin layer as possible, raked a few times and turned regularly to speed drying.
iv. They can also be chopped to fasten drying (drying takes 2-3 days)
v. After drying they should be stored in form of bales

Silage making

Silage is the material produced by controlled fermentation under anaerobic conditions of chopped crop residues or forages with high moisture content.

Ideal characteristics of materials used in silage making

Moisture content of 60-70%
PH below 4.2 for net crops and below 4.8 for wilted silage. Species of grasses used: Napier grass, sorghum, maize and sugarcane tops.

Advantages of silage

Helps ease feed shortages during dry season
Adequate seed is available all year found hence the animals will remain in good health
Silage is made using better wilted silage materials and increases animal productivity.

Methods of silage making

i. The crops should be ready to harvest i.e. the seed of forage sorghum/maize should be soft not milky when you squeeze and one that opens. Napier needs to be about 9 meter high.
ii. Legumes should have pods which are not dry
iii. If it has been raining and the forage is wet or if the forage is seen immature, then best to harvest and leave it in the sun for a few hours to wilt (too much water in the forage can spoil).
iv. The chopping and bagging area of silage pit must be clean and ready for the forage
v. Ensure proper compaction whether pit or bag silage
vi. Seal the silage material and make sure the seal is airtight. (silage is formed through anaerobic fermentation by microorganisms)
vii. Carefully and step by step open a small portion of the silage when needs arises for feeding and seal the remaining silage immediately after removal.

In Kenya the common methods of silage making are;

- French/pit silos; Built underground or semi underground
- Plastic bag silos

4.4. Analyze feed as per standardization requirements

This is a comprehensive activity involving testing of the feeds to ensure they meet the standards and to keep animals healthy while ensuring that suppliers/manufacturers and users are compliant.

Standardization requirements in Kenya is done by KEBS who inspect and validate.

Requirements

People involved in supply livestock feed need to know that the right nutrients are included in the right quantities.

Also, vital that seeds don't exceed maximum allowed number of mycotoxins, veterinary drugs, pesticides and other chemical contaminants.

Then, the process involves testing by accredited testing laboratories involving;

- Comprehensive animal feed inspection
- Analysis
- Testing service to ensure the product doesn't endanger health of animals or humans.

Importance of analyze and testing animal feeds

- Knowledge in ingredients through testing is vital as it makes farmers have an idea of the nutrient requirement.
- Lab analysis is an influential aspect of quality control
- To check for adulterated seed ingredients and contaminants that might seriously affect the feed quality and animal productivity.
- Testing and analysis enhance accurate feed analysis and promote feed quality.

Branding

Animal seeds are becoming more relevant brands where the animal feed industry has a role in feeding the world. So, manufacturing industries dealing with animal feeds need to maintain quality brands for profit i.e. Cooper K. Brand Ltd whereby a good brand is a great marketing strategy.

Advantage of having a strong brand in seed industry

- A strong brand creates a personality for the product
- Helps differentiate a product from competitors
- Branding can help small businesses increase and retain market share and launch new products.
- Also, important in maintaining profitable pricing levels.

4.5. Packaging Animal feeds

This is done as per market requirements including;

- Packaging methods and materials must protect the nitrogen of organic feed and have no adverse effects on the environment.
- Biodegradable, recycling, reusable systems and eco-friendly packaging shall be used

- Materials used for packaging shall not contaminate animal feed
- Packaging materials, containers and storage containing or treated with synthetic chemicals or prohibited substances must not be used
- Recycled packaging materials or containers that had come in contact with substances that may compromise the organic integrity of organic feed must not be used
- The packages shall be closed in such a manner that substitution of the content cannot be achieved without manipulation or damaging the seed.

Advantages of packaging feeds

- Protects the product
- Help keep the product from going bad
- Decreases costs
- The packages help inform on the product i.e. trade name and quality e.g. 100kg
- Packaging provides hygiene as it is a preventive measure

Labeling

After all the organic processed animal feed, they shall be labelled as per requirements.

4.6. Storing animal feeds as per OSH

Animal feeds should be stored in proper well-designed storage structures. Factors which affect quality and weight feedstuff during storage include;

- Losses due to human theft, fire and consumption of scavenging animals i.e. rats.
- Damage due to rain, condensation and to high temperatures
- Damage by insects
- Damage by fungi
- Changes in quality of feeds due to enigmatic actions and the development of oxidative rancidity.

General recommendations for storage

1. Provide a building for storage which is secure and can be adequately locked
    - Ensure that its roof will protect from rain and surface water cannot enter the store
    - Provide it with ventilation points (windows)
    - Orient the building so that one of the long sides faces the prevailing wind
    - Ensure all the entry points are moved to prevent entry of birds, rats etc.
2. Do not accept deliveries of raw materials which are visibly damaged or moldy or inserted with insects.
3. Do not overstock the quantity
4. Always keep the store clean; floors and walls should be regularly swept
5. Arrange your store so that new deliveries are not put in front of old stock
6. Make small shed to control heat generator

7. Ensure that ingredients are clearly and indelible labelled so that in drawing correct ingredients is drawn.
8.Do not walk on the stock of compounded feed unnecessarily; this will break pellets on surface.
9.Do not allow stocks to reef against the outer walls of the store; leave a space between the stocks and wall.
10.Do not allow staff to sleep or eat food in the store and preferably not to smoke

Conclusion

This learning outcome covered process of animal feedstuff which included various activities such as Types of animal feed processing hay making, silage making, animal feed supplements and additives, livestock feed mixing equipment animal feed mixing technology requirement among others.

Further Reading

1. Wu, G (2017) principle of Animal nutrition CRS Press
2. Animal institution handbook let formulation and common feed ingredients D. Rustin sullistian page 573, section 18.

4.3.5.3 Self-Assessment

Written assessment

1. Grasses or other herbaceous plants cut and dried to be stored for use as animal fodder
   a) Silage
   b) Hay
   c) Additives
   d) Plants
2. Silage and hay can be prepared and stored for future use
   a) True
   b) False
3. Which of the following is not a seed ingredient
   a) Cereal grains
   b) Protein meals
   c) Hay
   d) Feed additives

4. The following are factors considered in selecting feed ingredient. Except one?
    a) Palatability
    b) Cost
    c) Nutrients
    d) Bio availability
5. Ingredients and nutrients can be expressed in dry matter basis and fed basis method only
    a) True
    b) False
6. Which of the following is a rule of thumb conversion
    a) When concerting from as fed to Dry Matter the weight will decrease
    b) When converting from Dry Matter to as fed the weight will decreases
7. Which one is not characteristics of a good mixer
    a) Size
    b) Speed
    c) Easy to clean
    d) Quality
8. List factors considered in selecting feed ingredients.
9. Give procedures involved in procuring animal feed
10.Highlight the role of thumb for conversion
11.Give the importance of analysis of seed
12.State 5 requirements for storage of seeds

Oral Assessment
1. What are the common ingredients as per seeds?
2. Which requirements are required when packaging animal seeds?

Case Study Assessment
Trainees to visit an industry dealing with processing animal fields and familiarize themselves with all the activities undertaken and then they write a report.

5.3.5.4 Tools, Equipment, Supplies and Materials
- Feed mixers
- Shovel
- Silage bags
- Hay bailers
- Masking tapes
- Animal feed store

5.3.4.5 References

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CHAPTER 6: FARM PRODUCTS PROCESSING/PROCESS FARM PRODUCTS

6.1 Introduction

This unit specifies competencies required to process farm products (value addition). It involves identification of products for value addition and determine technology or machines/equipment to use to process flour to flour products, vegetables into juice and vegetable products, fruit into juice, herbal products and animal products which include milk, pork, beef, chicken, fish, rabbit, and bee products and package processed products. The significance of the unit constitutes an important role for increasing Gross Domestic Product through provision of additional goods and new processed products as well as creating a source of export and foreign exchange. It also provides employment and increased income for farmers.

The critical aspects of competency to be covered include; ability to identify products for value addition, determine technology/machines and equipment to use, processing products to flour and flour products, processing vegetables into juice and vegetable product, processing fruit into juice, wine and products processing herbal products and processing animal products.The basic resources to be used include; mills, cereals, fruits,herbs juicers, blenders, sieves, hides and skin,dust coats, meat,tannery chemicals and milk among others.

The unit of competency covers seven learning outcomes. Each of the learning outcome presents; learning activities that covers performance criteria statements, thus creating trainees an opportunity to demonstrate knowledge and skills in the occupational standards and content in curriculum. Information sheet provides; definition of key terms, content and illustration to guide in training. The competency may be assessed through written tests, demostrations, practical assignments, interview/oral questioning and case study. Self assessment is provided at the end of each learning outcome. Holistic assessment with other units relevant to the industry sector workplace and job role is recommended.

6.2 Performance Standard

The competency of farm products processing includes; Select products for value addition and determine machines and equipment to use in value addition as per perishability and consumer preference. Process vegetables into juice and vegetable products, fruit into juice products as per technology of value addition. Process products to flour, herbal products and animal products as per technology of value addition used.

6.3 Learning Outcomes

6.3.1 List of learning outcomes

a) Identify products for value addition

b) Determine technology/machines and equipment to use

c) Process products and flour products

d) Process vegetables into juice and vegetable products

e) process fruit into juice, wine and products

f) Process herbal products

g) Process animal products

6.3.2 Learning Outcome No 1: Identify products for value addition.

6.3.2.1 Learning Activities

Learning Outcome No 1: Identify products for value addition	
Learning Activities	Special Instructions
1.1 Choose products for value additions as per perishability and customer preference 1.2 Source products for value addition as per product value requirement.	Group Discussions

6.3.2.2 Information Sheet No6/LO1: Identify products for value addition

Introduction

This learning outcome covers: types of value addition products, perishability, harvest timing, preservation method, packaging methods, transportation methods, customer preference and nutritional/medicinal value.

Definition of key term

Customer preference: These are expectations, motivations, dislikes and inclinations that drive customer purchasing decisions.

Perishability: It is used in marketing to describe the way in which service capacity cannot be stored for sale in the future.

Nutritional value: Refers to contents of food and the impact of constituents on body. It relates to carbohydrates, fats, proteins, minerals, additives, vitamins, sugar intake, fat and cholesterol content.

Content/procedures/methods/illustrations

1.1Products for value additions are chosen as per perishability and customer preference.

Value added products is defined as change in the physical state or form of the product such as milling wheat into flour or making strawberries into jam. Or the physical segregation of an agricultural commodity or product in a manner that results in enhancement of the value of that commodity or products. The value of farm products can be increased in endless ways by cleaning and cooling, packaging, processing distribution, cooking, combining, churning, culturing, grinding, hulling, extraction, drying, smoking, handcrafting, spinning, weaving, labeling or packaging commodities versus products.

The produce and the sell mentality of the commodity business is being replaced by the strategy of first determining what attributes consumers want in their food products and then creating or manufacturing products with those attributes. Market forces have led to greater opportunities for product differentiation and added value to raw commodities because of:

a. Increased demands regarding health, nutrition and convenience.
b. Efforts by food processors to improve their productivity.
c. Technical advances that enable producers to produce what consumers and processors desire.

There is no longer content to sell raw commodities hence some producers are striving for a larger share of the food dollar. These projects range from;

a. Adding value to hogs, cattle, bison fish and eggs.
b. Producing specialty cheese and even alfalfa-based biomass for a local power plant.
c. Marketing crops like organically grown grains, potatoes, carrots, beans, and corn for sweeteners and fuels.

Producers have a challenge to be responsible to customers' demands by producing what is desired. Attentiveness to consumer demands in quality, variety and packaging are important because demographic trends slow growth in the convenience-oriented, health conscious and environmentally concerned sectors where price is not an important quality. Value added research is important, producers examine competitive advantages obtainable with processed products compared to raw commodities.

Approaches to adding value

Adding value to agricultural products can be accomplished in a number of different ways, but generally fall into one of the two main types, innovation or coordination. Generally, the problem is to evaluate what, where, how and who can efficiently perform the market functions.

Innovation

Innovation focuses on improving existing processes, products and services or creating new ones. Often successful value-added ideas focus on very narrow, highly technical geographically large market where competition is spare.

Industrial innovation: Specific type of innovation which is processing of traditional crops into nonfood end uses. These values adding innovative activities use the research and emphasis that has been placed on finding industrial nonfood uses for common agricultural products for example producing ethanol from corn.

Coordination

Coordination focuses on arrangements among those that produce and market farm products. Fundamental changes through coordination are altering traditional marketing relationships that link consumers, food retailers and whole sellers, food processors and producers. Few individuals possess all the business management for processing, marketing and business management as well as staying efficient with their production enterprises.

Vertical integration

Complete vertical integration is to align and control all of the segments of production and marketing system under single ownership. The factors aligned and controlled are: price, quantity, quality and transactional terms of exchange. producers who invest in value added products past the farm gate cause the market to become more vertically integrated.

Importance of minimizing cost in value-addition

Before producers examine value added processing and marketing, cost minimization in production must be achieved. Only low cost and efficient producers will be able to survive and compete in production agriculture.

Consumer not only want food products to be of high but also to meet health, safety and environmental attributes. Income increases, food consumption also changes and consumer become more demanding in terms of quality and safety of the products. The range of choices of food product for the modern consumers are literally unlimited hence very often than not their expectation regarding the value or quality has raised a great deal. Events that occur when the food is in the distribution system can adversely impact quality.

These could be the result of random shocks such as power outages or negligence on the part of the employees who improperly store, refrigerate or handle food products in distribution. Perishable goods marketing, according to the needs demands of the customers have become the colossal task of the marketers because if its inherent features. Approximately 15% of perishable goods spoil before they can be sold. Retailers could reduce food wastage and keep food prices by using the freshness indicator help and monitor inventories.

Consumers attitude towards perishable food

The consumers response to perishable food is the primary driver for establishing and delivering acceptable quality Agri-products to the market. One useful measure to establish whether the appropriate quality has been adopted and what criteria are playing the crucial roles. The actual value that they are getting, what they expect and the relative importance of what they receive can be considered as basic information required.

Not all factors are equally important for all kinds of perishable food. Some are highly important as a criterion, whereas some others are to be expected at the best level of availability. Example: Factors that are vitally important while consumers are taking decision of buying leafy vegetables, fruity vegetables, fish and meat.

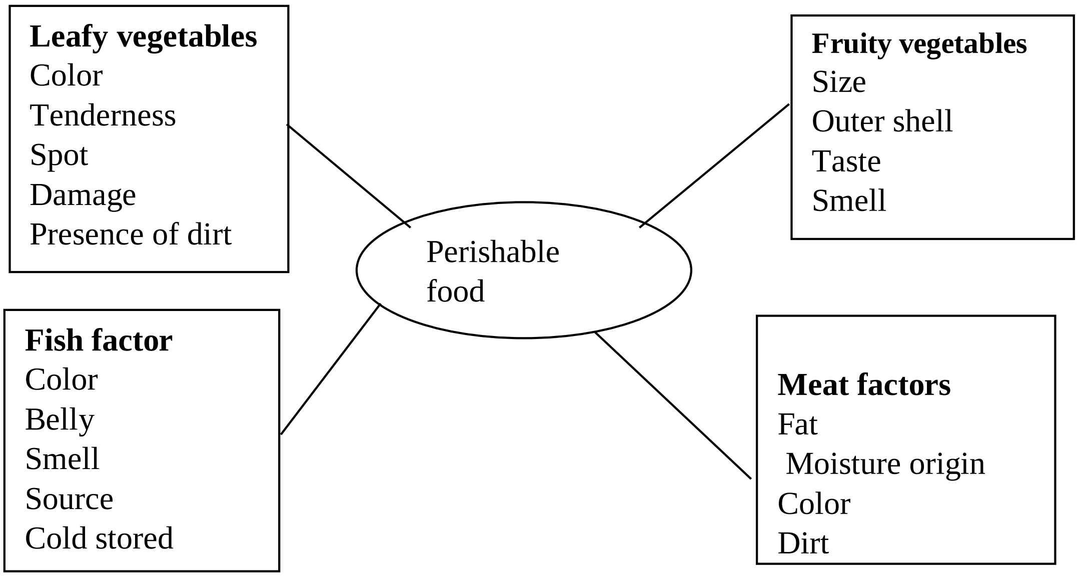

Figure 32: vitally important factors

Benefits of value addition on perishable products.

- Increased shelf life. The longer the product can stay without getting spoilt, the more the guarantee one has of a product selling at their preferred price and time. Milk for instance, hardly last over 24hrs but with boiling it can last more days, while with further processing into ghee, the same milk can last for months.
- Increased bargaining power of the value-added products in the market.
- Value addition allows the farmer to focus on the consumer while producing and through meeting the expectations he can create a loyal market around the product.
- Increased revenue. Any addition adds a percentage of increased financial value to the produce and has the effect of improving the incomes of the local farmers.

1.2 Products for value addition are sourced as per product value requirement.

Agriculturally producers have explored ways to add value to crops and livestock including creating business to capture higher profit margins by further processing or creating specialty market for their products. Value added agriculture focuses on the production or manufacturing process, marketing of services that increase the value of primary agricultural commodities perhaps by increasing appeal to consumer and consumer willingness to pay a premium over similar but unidentified products. Value addition is a worthwhile investment because it generates higher returns, allow penetration of a new potentially high value market, extend the production season or perhaps create brand identity or develop brand loyalty.

What drives value addition?

Agribusiness particularly the food sector is rapidly consolidating and increasingly responding to consumers' tastes and preferences. Consumers have higher income than before therefore focusing on more convenient, quality variety, services, health and social consciousness. They are also faced with increasing value of their time.

Factors that creates added value

Value is usually created by focusing on the benefits associated with the agribusiness products or services that arise from;

- Quality: Does the product or service meet or exceed customers' expectations.
- Functionality: Does the product or service provide the function needed of it.
- Form: It is the product in useful form.
- Place: It is the product in the right place.
- Time: It is the product in the right place at the right time.
- Ease of possession: It is the product easy for the customer to obtain.

Creating a value-added product.

Any agricultural enterprise can be thought of as a value to the product. To do this one must control the activities of each step in the value chain: Procurement of inputs, converting inputs into products, marketing and sales supply chain logistics and customer service activities.

A new value-added business should focus on the product uniqueness which ultimately attracts customer.

Commodity-oriented strategy A producer focuses on costs of production with an aim of being a low-cost producer.

Value added strategy involves a demand side focus on determining who the customers are and what they want. After assessing available resources and source of uniqueness provide and cost a service or product that curbs production costs while meeting needs of the potential market.

Steps to success in value-added business

The key factors in a detailed business plan are operations plan -flow of the business, quality control.

i. Sales plan: Including challenging but realistic goals.
ii. Personal plan: Needs skills and training.
iii. Investment and financial plan. Cash flow planning.

Examples of value-added agricultural product

In the beef industry a rancher can add value by having a cow-calf operation or retaining ownership of his cattle through a feed yard. Another option is producing speciality products such as sausage and tamels.

Example: Wheat grain can be added value in many ways. One of the ways is for farmers to produce wheat grain for use in feed or food products.
Wheat straw a waste product can be harvested, processed then turned onto building materials.

Principles that apply to adding value to farm products.

- Start small and growing naturally.
- Make decisions based on good records.
- Create a high-quality product.
- Follow demand driven production.
- Get the whole partners involved.
- Keep informed.
- Plan for the future.
- Evaluate continuously.
- Persevere.
- Capitalize adequately
- Focus.

To capitalize on value added opportunities farmers can adopt one or more of the following approaches.

- Performing activity that is traditionally done in another stage down the agricultural supply chain, which changes the form, space and time characteristics of the raw agricultural commodities.
- Vertically integrating several stages in the supply chain or horizontally coordinating with other farmers, or bypassing stages in the supply chain in order to create closer or direct connection between farmers and consumers.
- Performing an activity or adopting a production practice at the growing stage that changes the identity or quality characteristics of raw products to characteristics consumer value higher in the market place. These practices establish and preserve customer preferred characteristics along the supply chain using labels and other segregation technique. For example, organic product identity is obtained through organic practices at the growing stage, can be certified and can carry a price premium over non organic products of the same type regardless of the products distribution channel.

Storage of farm produce

The principle underlying food preservation are:

- Destruction of microorganism.
- Prevention of their entry into food.
- Arrest or preservation of purely chemical reaction.
- Arrest the action of food enzymes.

Reasons for preserving food

- To prevent spoilage
- To be able to take care of emerging situations
- To prolong its shelf life
- To avoid wastage, especially when they are most expensive
- To introduce a variety in the family menu

Causes of food spoilage

Food spoilage is undesirable changes taking place in the place in the food which eventually leads to its spoilage. Food spoilage is caused by:

- Actions of insects
- Physical changes
- Action of microorganism
- Purely chemical reaction in the food
- Action of microorganism e.g. bacteria, yeast and molds
- Physical changes in the food

Preparation of food preservation

Some of the preparation that should be embarked upon before preserving our foods are:

i. Clean the food thoroughly
ii. Cut the food into desired sizes
iii. Ensure that the food is of good quality
iv. Package food correctly and label if need be

Various methods of preserving food

People have various methods of preserving food, this include
Drying, frying, bagging, fermentation, smoking, salting, heating, blanching, canning or bottling, refrigeration and freezing and irradiation.

Blanching: Is a method of preserving food. It inactivates enzymes and minimizes changes leading to deterioration in the sensory and nutritional qualities.

Canning and bottling: This process requires canning equipment and the ability to use a heat source. Foods preserved by this method are sealed in a closed container, such as a can, glass or bottle. Such tools are stored for up to a year. The cost of canning or bottling can be expensive after purchasing the equipment and of heating fuel and is a fiddly process requiring sterilization and knowledge of the temperature involved.

Irradiation: Physical method of preserving food has the potential both of disinfecting dried food to storage losses and disinfecting fruits and vegetables to meet quarantine requirements.

Conclusion

This learning outcome has covered types of value addition products, perishability, customer preference and nutritional value.

Further Reading

1. Kilkeny, M, and G.E Schluter ,2001." Value added Agriculture policies across the 50 states "" Rural America" 16(1) 12:18
2. Journal on choices, what do we mean by value added agriculture.

6.3.2.3 Self-Assessment

Written assessment

1. The following shows the principle that apply to adding value to farm products except?
    a) Evaluate continuously.
    b) Follow demand-driven production.
    c) Low cost production.
    d) Keep informed.
2. Market forces have led to greater opportunities for product differentiation and added value to raw commodities because of the following except?
    a) Increased consumer demands regarding health nutrition and convenience.
    b) Technological advances that enables producers produce what consumers expect.
    c) Effort by producers to improve their productivity.
    d) Marketing agricultural products such as organically grown crops.
3. Two of the following are approaches of adding value. Except?
    a) Innovation.
    b) Revenue.
    c) Coordination.
4. To capitalize on value added opportunities, farmers can adopt two of the following except?
    a) Performing activity that is traditionally done.
    b) Innovation.
    c) Vertically integrating several resources.
5. What do you understand by the term perishability?
6. Differentiate between consumer preference and value addition.
7. What is vertical integration in relation to value addition?
8. Give the importance of minimizing costs in value addition.

Oral Assessment

1. Explain the approaches to value addition.
2. Explain how a value-added product is created.

Case Study Assessment

A certain horticultural company has been producing vegetables, and flower for the local market. The company wishes to expand its premises and export the commodities to a foreign country. What advice are you going to give the company on consumer preference, perishability, cost of production and transport in order for the company to avoid incurring losses and instead reap maximum returns.

Practical Assessment

1. Collect several varieties of vegetables or flower and using the learnt knowledge and available facilities, increase the shelf life of the cut flower and vegetables for a period of one week.
2. Using the available perishable products such as milk, flowers or vegetables, survey the customer choice of preference and market the products in your local area and make a brief report on the carried-out activity.

6.3.2.4 Tools, Equipment, Supplies and Materials

- Fruits and vegetables,
- Milk
- Cereals

6.3.2.5 References

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6.3.3 Learning Outcome No 2: Determine technology/machines and equipment

6.3.3.1 Learning Activities

Learning Outcome No 2: Determine technology/ machines and equipment to use	
Learning Activities	Special Instructions
2.1 Identify products to be processed as per client requirement 2.2 Determine technology used as per product type. 2.3 Determine the machines or equipment to be used as per technology of value addition.	Group instructions on various technologies and machines used in value addition.

6.3.3.2 Information Sheet No6/LO2: Determine technology/machines and equipment

Introduction

The learning outcome to be covered include; Choice of equipment and machinery Type of technology equipment and machinery maintenance.

Definition of key terms

Equipment: It is a type of fixed asset used by a company in its business operations and reported on the long-term assets section of the balance sheet.

Machinery: Mechanical device or the parts that keep something working.

Technology: Refers to methods systems and devices which are the result of scientific knowledge being used for practical purposes.

Content/procedures/methods/illustrations

2.1 Products to be processed are identified as per client requirement.

Agricultural product processing and storage plays an important role in the food and feed preparation for the continual survival of man. Through development of modern storage facilities, food crop preservation becomes easy and simple to follow.

Agricultural product: processed agricultural produce which has been turned into finished goods either for human/animal consumption or for industrial use.

Processing: In agriculture, it involves biological, physical, mechanical and biochemical manipulation of agricultural produce in order to preserve it for further use. It involves the series of operations taken to change agricultural products into consumer-finished products.

Agricultural processing involves both scientific and traditional manipulation of agricultural produce so as to make more useful and be able to store them for future uses.

Reasons for processing food crops

- Processing helps make food available even during the off season.
- When food is processed it tastes and looks very attractive.
- Processing helps in the durability of food crop products. When food crop is being processed like in dehydration of food of a food crop, micro-organisms become absent thereby preventing spoilage.
- It adds value to the agricultural produce.
- It creates room for commercial agriculture, thereby promoting agricultural activities.
- By processing of food regularly, more food will be in our food reserve which will aid in adaptation and mitigation of climate change.
- Processing provides raw materials for further studies and industrial uses.
- Through processing, some materials are produced (by-products) which can be used for formulation of animal feed.
- Science of processing can aid in drugs and mechanical purposes.
- Agriculture produce processing gives income to a farmer and improves his living standard.
- Exportation is high when food is processed thereby improving her foreign exchange earnings.
- Processing provides employment for individual and the masses.
- Through agricultural processing of crops like sugarcane, bio-fuel and power is produced which is used for generation of farm or industrial power.

Processing Techniques

There are different techniques involved in processing of agricultural produce. The different machines used in processing are hammer mill, roller mill and bore mill.

a) **The hammer mill**

This machine is used in processing agricultural produce that is dry. The hammer mill is made up of a hammer with a roller with pulleys. The blocks contain hammers. As the hammer rotates, the block rotates as well then, the product will be mill by pressure of the hammer. It is used to mill crops whose moisture content is reduced e.g. rice

b) **The bore mill**

It has two plates, rough and smooth plates, enclosed in a structure. The auger pushes the produce into the collection point. It is used to process agricultural produce that are wet oily and dry.

c) **Roller mill**

Consist of two rollers that are cylindrical in shape, connected to pulley or sheath in between the rollers. There are spaces between the two cylinders so that when rollers rotate, they will rotate in two directions and merge the produce into small particles.

Categories of agricultural products to be processed

Agricultural products are derived from cultivated plants or animals to sustain or enhance human life. Food is the most widely used agricultural product. Agricultural products fall into one of the four groups: Foods, fuels, fibres and raw materials

- **Food**

  Grains and cereals crops are grown on more than half of the world's farmed acreage. Food products encompass more than just cereals like wheat and corn, meat and dairy products like milk, honey and farmed fish.

- **Fuel**

  Ethanol produced from corn, sugarcane or sorghum is the agricultural fuel product in the widest use. However agricultural byproducts like straw sugarcane are also burned to produce power.

- **Fiber**

  Fiber crops include cotton, wool and silk. Agricultural producers also hemp to make rope and flax for linen.

- **Raw materials**

  Those agricultural products used to make other agricultural products e.g. livestock feed considered an agricultural product. It is used to provide nourishment to the animals that produce dairy products.

2.2 Technology used is determined as per product outcome.

Integrated processing technologies for food and agricultural by-products. Some by-products have found use as animal feed or are combusted for energy; new technologies which integrate conversion of production and processing by products into higher value food or non-food products, nutraceuticals, chemicals and energy resources will be a critical part of the transition to a more sustainable food system. Below are technologies related to agricultural and natural manufacturing under four key areas of accelerating change: sensors, engineering, food and automation.

i. **Sensors**

Sensors help agriculture by enabling real-time traceability and diagnosis of crop, livestock and farm machine states.

a) **Air and oil sensors:** Involve fundamental additions to the automated farm. These sensors would enable real-time understanding of current farm, forest or body of water conditions.
b) **Equipment telematics:** Allows mechanical devices such as tractors to warn mechanics that failure is likely to occur soon. Intra-tractor communication can be used as a rudimentary 'farm swarm' platform.
c) **Livestock biometrics:** Collars with apps and biometrics and can automatically identify and relay vital information about the livestock in real-time.
d) **Crop sensors:** Instead of prescribing field fertilization before application high application equipment of correct amounts needed. Optical sensors/drones are able to identify crop health across the field.

e) Infrastructural health sensors: Used for monitoring vibrations and material conditions in buildings, bridges, factories, farms and other infrastructure. Coupled with an intelligent network such sensors could feed crucial information back to maintenance crews or robots.

ii. Food

Food may benefit directly from genetic tailoring and potentially from producing meat directly in a lab. Genetically designed food is a creation entirely new strains of food, animals and plants in order to better address biological and physiological needs. In-vitro meat, also known as, cultured meat or tube steak, is a flesh product that has never been part of a complete living animal. There is no meat which has been produced for public consumption.

iii. Engineering

Engineering involves technologies that extend the reach of agriculture to new means, new places and new areas of the economy. Of a particular interest will be synthetic biology, which allows efficiently reprogramming unicellular life to make fuels, by products accessible from organic chemistry and smart devices.

iv. Automation

Automation will help agriculture via large scale robotic and micro robots to check and maintain crops at the plant level.

Variable rate swath control: Building on existing geolocation technologies, future swath control could save on seed, minerals, fertilizer and herbicides by reducing overlapping inputs.

Rapid iteration selective breeding: The next generation of selective breeding where the end result is analyzed quantitatively and improvements suggested algorithmically.

Agricultural robots (agbots): They are used to automate agricultural processes such as harvesting, fruit picking, ploughing, soil maintenance, weeding, planting, irrigation

Precision Agriculture: Farming management based on observing intra-field variations with satellite imagery and advanced sensors farmers can optimize returns on inputs while preserving resources at larger scales.

Factors affecting adoption of technologies

Diffusion is the process of by which a new idea, practice or technology spreads in a given population. The characteristics of technologies, such as relative advantage, complexity, divisibility, observability and compatibility affect their diffusion. Farmers will be encouraged to adopt new technologies for sustainable farming systems if the dissemination of information is efficient. It is important to facilitate the dissemination of improved farming system technology to farm households through farmer participation methods and to strengthen existing resource planning capability and improve research extension policy. Several ‘barriers’ have hindered the assimilation of new technology through:

- Perceived fundamental inability to demonstrate a linkage between profitable technology adoption and sustainable production at farm level.

- Failure to recognize and address the psychological component of technology adoption as part of the educational process, because generating knowledge is not always synonymous with diffusing and adopting knowledge.
- Instruction and demonstration of new technology within the controlled setting of a university research farm may not encourage farmers to adopt the technology for their own farms which have distinct and different resources.
- Limited movement away from a discipline-based or anti-dimensional approach to a broader system may have reduced ability to evaluate the economic and environmental components of technology uptake.

Development in the processing and retail sectors

Food processing occurs in three ways:

a) The classical way: Farm products are combined with processing.
b) Organic way: Significant market share in some cases
c) Functional convenience way: Farmer acts as a supplier of ingredients. The food industry is the effective creator of food.

Strategy recommendations for processing types

a) Classical way: Classical vertical cooperation including communications.
b) Organic way: Generally, entails an increase cooperation (labelling conditions and communication).
c) Functional convenience way: The only strategy for farmers is production of commodities.

2.3 The machines or equipment used are determined as per technology of value addition used.

Types of equipment used for material handling in food and processing industries include: conveyor systems and fluid transport devices e.g. pumps, hoses, tubes and piping. Additional equipment includes: timers, thermometers, scales, weighing systems, pressure gauges and precision controls.

Food processing machines and equipment refers to component processing machines and systems used to handle, prepare, cook, store and package food and food products.

Although this equipment is primarily aimed toward the transformation i.e. increasing the palatability, consumability and digestibility or preservation i.e. (extending the shelf life of food), some pieces of equipment are also employed to perform preliminary or auxiliary functions such as handling, preparation and packaging. Employed for food and product, applications ranging from bakery goods to beverages and dairy to produce, a wide range of food processing equipment is available to execute the various unit operations necessary during a complete production cycle such as washing, mixing, baking, freezing and sealing.

Depending on the demands of the operation, this equipment can be designed and constructed to handle solid and semi-solid or liquid food products by batch or continuously. Some other design considerations include: the food grade materials used for construction, hygienic and governmental standards, sizing, cost and integration of automation or analytical components.

Types of food processing equipment

Wide range of processing equipment can be classified and categorized in several different ways for example end product form, mode of operation, application, etc. Some of the most common functions by which food processing equipment are grouped include: Preparation, mechanical processing, heat processing, preservation and packaging.

i. Preparation equipment

The initial preparatory operations focus on preparing the raw food material for subsequent processes – typically mechanical or chemical processing by separating the desirable material from the substandard or undesirable material. It ensures production of uniform and high-quality food and food products, as well as remove foreign matter and contaminants which may degrade or damage the food material or equipment. Some of the unit operations and equipment which manufacturers employ during raw material preparation include: cleaning, grading, peeling and sorting.

Table 10: Preparation Equipment

Unit Operation	Equipment applied
Cleaning	Wet processes • Soak/floatation tanks • Spray washers • Washing systems • Sterilizers • Ultrasonic cleaners
Grading	Tungsten lights(candling) Image processors Laboratory equipment
Peeling/Skinning	Pressure vessels (flash steam peeling) Stationary/rotating blades Carborundum abrasive rollers/bowls Conveyors and furnaces
Sorting	See dry processes • Sorting machinery • Disc separators • Sieves/screens (size sorting) • Machine vision sorting systems • Sorting conveyors

ii. Mechanical processing equipment

Mechanical processing operation are employed without the application of heat or chemicals to reduce, enlarge, homogenize or otherwise change the physical form of solid, semi-solid and liquid food matter. By altering the size and form of the food matter, manufacturers can facilitate and increase the efficiency and effectiveness of subsequent processes, improve the overall quality and edibility and allow for a greater range of food products to be produced.

Table 11:Mechanical food processing equipment

Unit operation	Equipment employed
Size reduction	Grinding/crushing • Impact mills • Pressure mills • Attrition mills • Jaw crushers • Roll crushers • Stainers/Pulpers
Size enlargement	Agglomeration • Rotating pans • High speed agitators • Tableting equipment • Pelletizing equipment Forming • Bread molders • Pie & biscuit formers • Confectionary molders • Enrobing machines
Homogenization	Homogenizers • Emulsifiers • Colloid mills • High shear mixers Fluid mixers • Agitated tanks • Paddle mixers • Anchor mixers • Turbine mixers
Mixing	Dough/paste mixers • Horizontal dough mixers • Sigma blade mixers • Cutter mixers Solid mixers • Diffusive (passive) mixers • Convective mixers • Drum blenders

iii. Heat processing equipment

Depending on whether the application and the specific unit operation is aimed towards heating or cooling the food material, heat transfer equipment can be used to direct heat towards or away from material respectively. The unit operations employed during the heat processing stage include: baking, blanching, roasting and frying.

Heat processing equipment by unit operation

Unit Operation	Equipment employed
Baking	Baking ovens • Direct heating ovens • Indirect heating ovens • Batch ovens • Continuous & semi-continuous ovens
Blanching	Blanchers • Steam blanchers • Hot water blanchers
Dehydration	Dryers • Convective dryers • Contact(conductive) dryers • Vacuum dryers • Freeze dryers

Table 12:Heat processing equipment

iv. Preservation

The preservation stage of the food processing production cycle ultimately aims to prevent or inhibit spoilage and increase shelf life of food products. Preservation methods include refrigeration and irradiation.

Food Preservation equipment by method

Preservation method	Equipment used
Chemical	Natural • Salt • Smokers • Acids such as vinegar Non-natural • Sorbic acid • Sulphur dioxide • Benzoic acid
Irradiation	Irradiation equipment such as isotopes and electron accelerators
Refrigeration	Chilling (-1^0C - 8^0C) • Chillers • Mechanical refrigerators • Cryogenic systems Freezers (below freezing point) • Mechanical refrigerators • Cryogenic systems

Table 13:Food Preservation equipment

Machinery and equipment maintenance

Machinery maintenance means mechanical assets in a facility are kept in working order. It involves regular servicing of equipment, routine checks, repair work and replacement of worn or non-functional parts.

Conclusion

This learning outcome has covered choice of equipment and machinery to use, technologies used as per the product and maintenance of equipment and machinery.

Further Reading

1. US Department of Agriculture, Food Safety and Inspection service 2015
2. Basics for Handling Food Safely webpage
3. Cold storage chart www.fsis.usda.gov

6.3.3.3 Self-Assessment

Written assessment

1. Food Processing equipment include the following except?
    a) Preparation
    b) Storage
    c) Mechanical processing
2. Processing Occurs in two of the following ways except?
    a) The classical way
    b) Organic way
    c) Operational convenience
3. The following technologies are used in agricultural and natural manufacturing. Except?
    a) Biometrics
    b) Automation
    c) Precision
4. The following categories of agricultural products to be processed except?
    a) Food
    b) Machinery
    c) Fuels
5. Agricultural robots automate the following agricultural activities. Except?
    a) Irrigation
    b) Harvesting
    c) Temperature regulation
6. Differentiate between machinery and technology.
7. What do you understand by the term agricultural product?
8. Give the functions of the following processing technologies:
    a) Hammer mill
    b) Bore mill
9. Give two reasons for processing food crops.
10. Give the function of equipment telematics.

Oral Assessment

1. Explain the various processing techniques.
2. Explain the reasons for processing food crops.

Case Study Assessment

A certain farm carrying out irrigation on production horticultural crops would like to adopt new technologies to manage crop diseases on time and manage soil nutrients with an aim of increasing their production. Which technologies would you advise them to use and why?

Practical Assessment

Using precision agriculture identify and observe changes in an agricultural farm. Give a brief report on the same.

6.3.3.4 Tools, Equipment, Supplies and Materials

- Tannery chemicals
- Tannery equipment
- Blenders
- Juicers
- Mixers
- Sieves

6.3.3.5 References

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6.3.4 Learning Outcome No 3: Process products to flour and flour products

6.3.4.1 Learning Activities

Learning Outcome No 3: process products to flour and flour products	
Learning Activities	Special Instructions
3.1 Mill products into flour in accordance to miller's association guidelines and KEBS specification. 3.2 Prepare flour products as per recipe manual	Field excursion Illustration of various flour products

6.3.4.2 Information Sheet No6/LO3: Process products to flour and flour products

Introduction

The learning outcomes to be covered include: types of milling technologies, flour products, packaging of flour and flour products and occupational safety standards.

Definition of key terms

Milling technologies: Refers to various ways of machining using rotary cutters to remove material by advancing a cutter into a workpiece.

Flour products: These refers to products such as pan bread made from flour.

Content/procedures/methods/illustrations

3.1 Products are milled into flour in accordance to miller's association guidelines

Flour is a finely ground powder prepared from grain or other starchy plant foods and used in baking. Flour can be made from a wide variety of plants. The vast majority is made from wheat. Dough made from wheat is particularly suited for baking bread because it contains a large amount of gluten, a substance composed of strong elastic proteins.

Raw materials

Although most flour is made from wheat, it can also be made from other starchy plant foods. These include: barley, buckwheat, corn, lima beans, oats, peanuts, potatoes, soybeans, rice and rye. Many varieties of wheat exist for use in making flour. Wheat is either hard or soft. Flour intended to be used to bake bread is made from hard wheat.

The manufacturing process (wheat)

Grading the wheat

Wheat is received at the flour mill and inspected. Samples of wheat are taken for physical and chemical analysis. Wheat is graded based on several factors. The most important is protein content. The wheat is stored in silos with wheat of the same grade until needed for milling.

Purifying wheat

Before wheat can be ground into flour, it must be free of foreign matter. This requires several different cleaning processes. At each step of purification, wheat is inspected and purified again if necessary. Device used to purify wheat is known as separator. This machine passes the wheat over a series of metal screens. The wheat and other small particles pass through the screen while large objects such as sticks and rocks are removed.

Wheat next passes through an aspirator. This device works like a vacuum cleaner. It sucks up foreign matter which is lighter than the wheat and removes it. Other foreign objects are removed in various ways. One device, known as disk separator, moves the wheat over a series of disks with indentations that collect objects and the size of grain of wheat.

Spiral seed separator makes use of the fact that wheat grains are oval while most other plant seeds are round. Wheat moves down a rapidly spinning cylinder. The oval wheat grains tend to move towards the center of the cylinder while the round seeds tend to move to the sides of the cylinder where they are removed. Other methods used to purify wheat include magnets to remove small pieces of metal, scourers to scrape off dirt hair and electronic color sorting machines to remove material which is not the same color as wheat.

Preparing the wheat for grinding

Purified wheat is washed in warm water and placed in a centrifuge to be spun dry. Any foreign matter is washed away. Moisture content of the wheat must be controlled to allow the water layer of bran to be removed efficiently during grinding in a process known as **conditioning or tempering**. Cold conditioning involves soaking the wheat in cold water for one to three days. Warm conditioning involves soaking the wheat in water at a temperature of 46℃ for 60-90 minutes. Hot conditioning involves soaking the wheat in water at a temperature of 60℃ for a short period of time. The method is difficult to control and is rarely used.

Grinding the wheat

Wheat of different grades and moistures are blended together to obtain a batch of wheat with the characteristics necessary to make the kind of flour being manufactured. Wheat is passed through a device with rapidly spinning disks which hurl the grains of wheat against small metal pins. Those grains which crack are considered to be unsuitable for grinding and are removed.

Wheat moves between two large metal rollers known as breaker rolls. They are of two different sizes and move at different speeds. Product of breaker rolls passes through metal sieves to separate it into three categories. Larger pieces, finest material and pieces of interior which are still attached to bran. Middling's purifier moves the middling's over a vibrating screen, air is blown through the screen to remove the lighter pieces of bran which are mixed with the middling.

Processing the flour

Small amounts of bleaching agents and oxidizing agents are usually added to flour after milling. Vitamins and minerals are added as required by law to produce enriched flour. Leavening agents and salt are added to produce self-rising flour. The flour is packed in clothe bags of different quantity.

Corn/maize flour milling

Maize or corn is one of the most widely planted grains in the world. Maize can be processed into flour, grits or even starch.

Corn flour mill process

Impurities discharging process

Maize kernels are fed from material inlet and the flow rate is controlled by a baffle. When maize kernels are transported by the bucket elevator into **de-stoner**, they first go through fine sieve, the sand and other impurities smaller than maize will be screened out and discharged from the tap hole. After sieving corn kernels, enter course screen to screen out impurities that are bigger than corn e.g. corn cob particles.

Above the sieve is a fan which suck light impurities still mixed in maize kernels; such impurities will be eliminated by the function of centrifugal sedimentation.

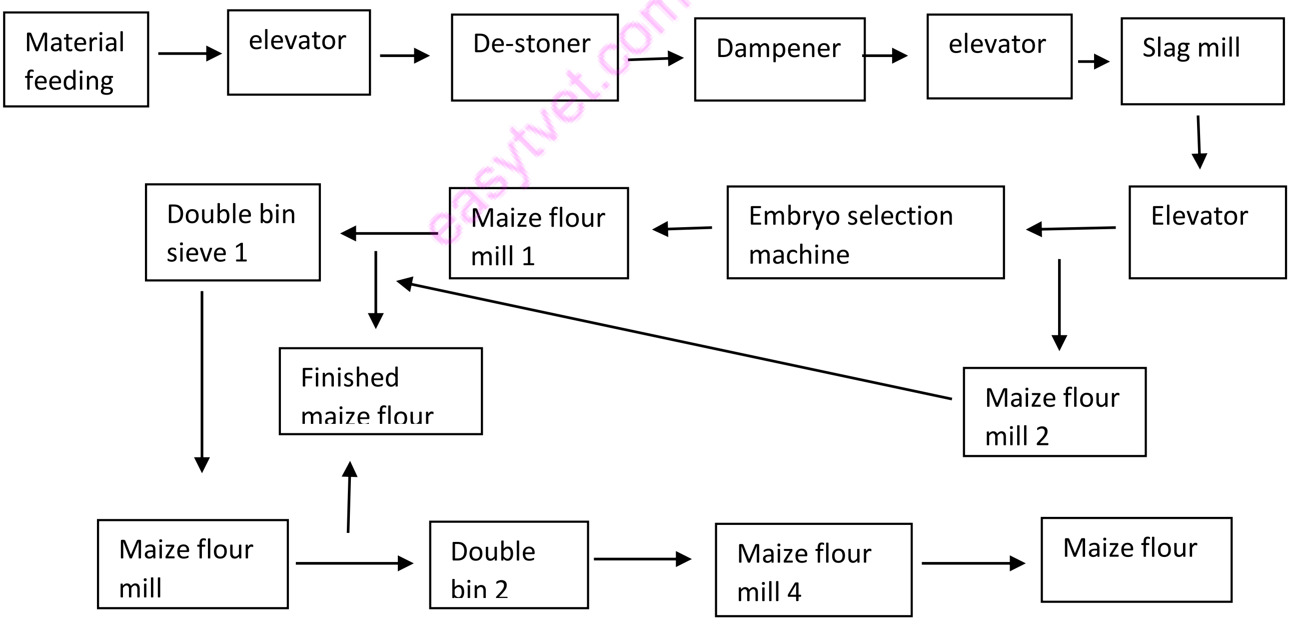

Figure 33: Impurities discharging process

Preliminary breaking and embryo

On the outlet of storage barrel, there is a baffle to adjust discharging flow. When maize kernels get out, they enter slag mill for preliminary breaking, so that some maize skin is separated from embryo. Broken maize is delivered by the elevator into embryo selection machine. Inside it, maize skin and embryo are separated and expelled from different outlets.

Finished products classification

Maize flour meets different classification standards depending on maize flour content and particle size. Maize flour is classified into four grades;

- Grade 1
- Grade 2

They are mainly maize skin and small portions of maize flour. They are used for animal feed, while grade 3 and grade 4 are fine maize flour for edible purpose.

3.2 Flour products are prepared as per recipe manual

Flour is finely ground cereal grains or other starchy portions of plants used in various food products and as a basic ingredient of baked goods. Flour made from wheat grains is the most satisfactory type of baked products that require spongy structure. Several flour products can be prepared. For example; from wheat flour the following products are obtained.

Wheat flour products

Pan breads

Most pan breads produced are white pan bread. Whole wheat and multigrain breads are a significant but smaller percentage of pan breads produced in large commercial bakeries. Pan breads produced in retail, supermarkets and in store bakeries are similar with regard to flour quality requirements but typically use a straight dough process and make up a much smaller percentage of total pan bread production. Several processes are used for producing pan breads through sponge and dough and liquid ferment systems are by far the most commonly used. The processes produce superior bread compared with straight dough and continuous mixing processes.

Flat breads

Tortillas are simply flour, water shortening and salt formulas. Chemical leavening or baking powders are sometimes added to improve the extensibility of the dough to facilitate high speed production and mould inhibitors have been added to increase mould free shelf life.

They also include chapatis which are made in a manual process which require flour that forms dough easily and that is reasonably easy to sheet and hand stretch.

Buns

Buns are basically bread dough with more sugar and shortening than typical pan breads. The process of dough mixing and fermentation are the same as for pan bread with sponge and dough and liquid ferment process. However, there is a preference for liquid ferments in buns. The superior flavor of sponge and dough is less valued because bun is consumed with meat and other condiments contributing flavor to sandwich.

Deep fried pastries

There are two types of deep-fried pastries;

- Yeast raised doughnuts
- Cake doughnuts

Since cake doughnuts have a longer inherent shelf life, they are mostly produced in commercial bakeries. Due to consumer preference yeast raised, doughnuts are produced in retail bakeries, supermarkets and doughnut shops.

Cake doughnuts

Cake doughnuts are similar to cakes in that they are rich, sweet batters produced with chemical leavening. However, their formulas are rather different from baked cakes due to deep fat frying of the batter. Flour quality influences the performance of the batter at several critical points during frying. Proper control of flour quality is important to end product quality. Flour used to make doughnuts are a blend of soft wheat flour and hard wheat flour.

Cookies, crackers, biscuits and wafers

Cookies are made with dough containing higher sugar and shortening levels and often low in water content. They range from dry crunchy cookies to chewy intermediate moisture varieties, most typically produced in retail bakeries or at home. Both are mass produced in retail bakeries or at home

Crackers

They are generally unsweetened to slightly sweet but often salty and made with fermented or enzyme modified dough. Common added flavors are cheese, sour cream, spice and various savory flavors.

Wafers

They are flat and hollow, rolled and soft wafers. The batters for flat and hollow wafers are liquids containing basically flour, water, enzymes, fat and sodium bicarbonate. To enhance quality and produce variations, it is possible to add egg powder, cocoa and powder.

Products of maize flour

Maize flour is used to make pancake mixes, infant foods, breakfast cereals and breadings and as a binder and carrier in meat products. Maize flour is also used in small holder houses to make maize meal such as porridge and ugali.

Importance of flour milling

- Many grains produced, consumed in a variety of different forms such as bread loaves, pancakes and muffins are made available through milling.
- It adds value to flour hence fetching higher market prices.
- Increase of product shelf life.

Conclusion

This learning outcome has covered types of milling technologies, flour and flour products and packaging of flour. Roller milling of maize produces maize flour with different organoleptic characteristics from flour milled in hammer mills.

Further Reading

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2. Prasher, C.L. 1987. Crushing and grinding process handbook John Wiley, London.

6.3.4.3 Self-Assessment

Written assessment

Multiple choice questions

1. The following are raw materials for making flour, which one is not?
    a) Lima beans
    b) Carrots
    c) Potatoes
    d) Barley
2. Which one of the following devices makes up part of purification of wheat?
    a) De-stoner
    b) Fan
    c) Disk separator
3. Which one of the following does not show the process of preparation of wheat for grinding?
    a) Purified wheat washed in warm water
    b) Sieving wheat kernels to enter coarse screen
    c) Controlling moisture content of wheat
4. Which one is not an example of deep-fried pastries?
    a) Cake doughnuts
    b) Yeast doughnuts
    c) Wafers
5. Which one is not an example of product from maize flour?
    a) Breakfast cereals
    b) Pancakes
    c) Mixes
    d) Flat breads

6. Categories of product from beaker mills include the following except?
    a) Pure pieces
    b) Finer pieces
    c) Interior pieces still attached to barn
7. Wheat flour product include —— and ——
8. Name two processes used in making plan breads
9. Differentiate between flour products and milling technologies
10. Give two agents added to flour after milling
11. What do you understand by the term flour and product processing?

Oral Assessment

1. Explain preparation of wheat for grinding
2. Explain the corn flour milling process

Case Study Assessment

Visit a flour milling industry to ascertain the various flour milling processes and write a brief report.

Practical Assessment

Visit a milling industry and grade the various quality of maize/wheat.

1. Participate in the milling process
2. Package the flour in various grades and quantity packages.

6.3.4.4 Tools, Equipment, Supplies and Materials

- Mills
- Cereals
- Hides and skims
- Textbooks and manuals

6.3.4.5 References

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6.3.5 Learning Outcome No 4: Process vegetables into juice and vegetable products

6.3.5.1 Learning Activities

Learning Outcome No 4: Process vegetables into juice and vegetable products.	
Learning Activities	Special Instructions
4.1 Identify vegetables to process into juice as per horticulture technical manual 4.2 Process vegetables into juice and products as per juice making recipes manual 4.3 Dry and ground vegetables into powder as per value addition manual	Demonstration on vegetable processing. Field Excursion.

6.3.5.2 Information Sheet No6/LO4: Process vegetables into juice and vegetable products

Introduction

The learning outcomes to be covered include: types of vegetables for value addition types of technologies used in vegetable processing, packaging of processed vegetable products, occupation safety standards and Standardization requirements.

Definition of key terms

Vegetables: A plant that is eaten raw or cooked such as cabbage, carrot or peas.

Products: Refers to something that is made to be sold, usually something that is produced by an industrial process or less commonly something that is grown or obtained through farming safety standards.

Safety standards: Refers to standards designed to ensure the safety of products activities of products, activities or products. These standards are prescribed by a regulatory body and be adhered by all stakeholders.

Content/Procedures/Methods/Illustrations

4.1 Vegetables to process into juice are identified as per horticulture technical

Vegetables consist of a large group of plants consumed as food. They are perishable when fresh but able to be preserved by a number of processing methods, they are excellent sources of certain minerals and vitamins are often main source of dietary fiber.

Structure and composition of vegetables

Vegetables can be classified by edible parts into:

Root (potatoes and carrots)

Stem (asparagus and celery)

Leaf (lettuce and spinach)

Immature flower bud (broccoli and Brussels sprouts)

Fruit (tomatoes and cucumbers)

Factors to consider in selection of vegetables for processing

Aging and spoilage

Depending on the class of vegetables there are differences in the structure, size shape and rigidly of the individual cells. The fresh market shelf life and processing requirements are also different. vegetables cells have rigid cell walls and are glued together by various polysaccharides saccharine such as cellulose, hemicelluloses and pectin.

Aging

Most noticeable structural change in senescent vegetables is softening or loss of texture. Softening is caused by natural enzymatic reactions that degrade the plant cell walls. Enzymes break open the cells leading to chemical oxidations and the vegetables develop off flavors and loss of nutritional value.

Spoilage

Occurs when broken cells are subjected to microbial attacks. Respiration leads to loss of quality, so that eventually the products are unsuitable for human consumption.

Nutritional value

Quality factors of vegetables are

- Colour
- Flavor
- Texture
- Nutritive values

Fresh vegetables are purchased on the basis of color and texture but repeated purchase is made on the basis of flavor and nutritional content.

Good quality

The vegetables for processing should not be rotten and should appear good. If the vegetables are rotten, they are not fit for processing.

Freshness of the vegetables

The vegetables to be processed should be fresh. The vegetables may not be the ones directly bought from the market but they should not lose their structure and appear stale. Stale vegetables are rougher and reduce the quality of the end product.

Quantity available
Before processing the vegetables, the quantity should meet the economies of scale. The cost of production should be reasonable compared to output to avoid incurring losses.

The price of the vegetables
Price is an important consideration before processing the actual market price of a particular vegetable should be known to avoid spending too much on purchasing. The price and the output prices of processed vegetables should meet the economies of scale. The other factors which determine whether the vegetable is worthwhile processing include: the demand of a particular vegetable

The quality of the raw material i.e. whether it can withstand processing.

Regular supplies of the raw materials
Processing requires frequent handling, high temperature and pressure. For example, many of the ordinary table varieties of tomatoes are not suitable for making paste or other processed products. Even when a variety can be processed, it is not suitable unless large and regular supplies are made available. An important processing centre or a factory cannot be planned just to rely on seasonal gluts it will not run economically unless regular supplies are guaranteed.

Location of the processing unit
The main objective of choosing the location is to minimize the average production cost, including transport and handling. It is an advantage, all other things being equal to locate a processing unit near the fresh raw material supply. It is a necessity for proper handling of the perishable raw materials. It allows the processing unit to allow the product to reach its best stage of maturation and lessens injury from handling it and determination from changes during long transportation after harvesting.

4.2 Vegetables are process into juice and products as per juice making recipes manual
Significant quantities of juice are produced from vegetable sources such as carrot celery, beetroot and cabbage. In general, the fresh vegetables are first washed and sorted before being coarsely milled and pressed to extract the juice, most vegetables have low acidity and therefore require a full sterilization process or freezing to be rendered safe.

Various ways in which vegetables are processed

Vegetable- pickling
In a typical pickling process, raw vegetables are delivered and subjected to washing and screening operations to remove extraneous matter such as stones, depending upon the vegetables, the raw material might be steam cooked and then cooled. The product is then peeled (typically using steam) and re-inspected before being cut to the required dimensions for example sliced/diced and transported to filling line. The chopped vegetables are filled in a containers and acidifying liquor mixed with spices and transferred to the filling line to be used in the pickling sauce.

Heat treated and frozen
After washing vegetables are peeled and trimmed. After peeling the vegetables may be left whole or cut in a number of ways such as sliced or dices. Some vegetables are

washed after slicing to remove surface starch. Most vegetables require blanching; steam or water blanching are the most common methods. After cooling the product is re-inspected and screened before being quick frozen or filled into cans or glass jars usually with a hot brine (sugar, salt acid) and then heat processed vegetable undergo a full sterilization process as the pH is high to inhibit microbial action.

Processing of vegetables flow chart

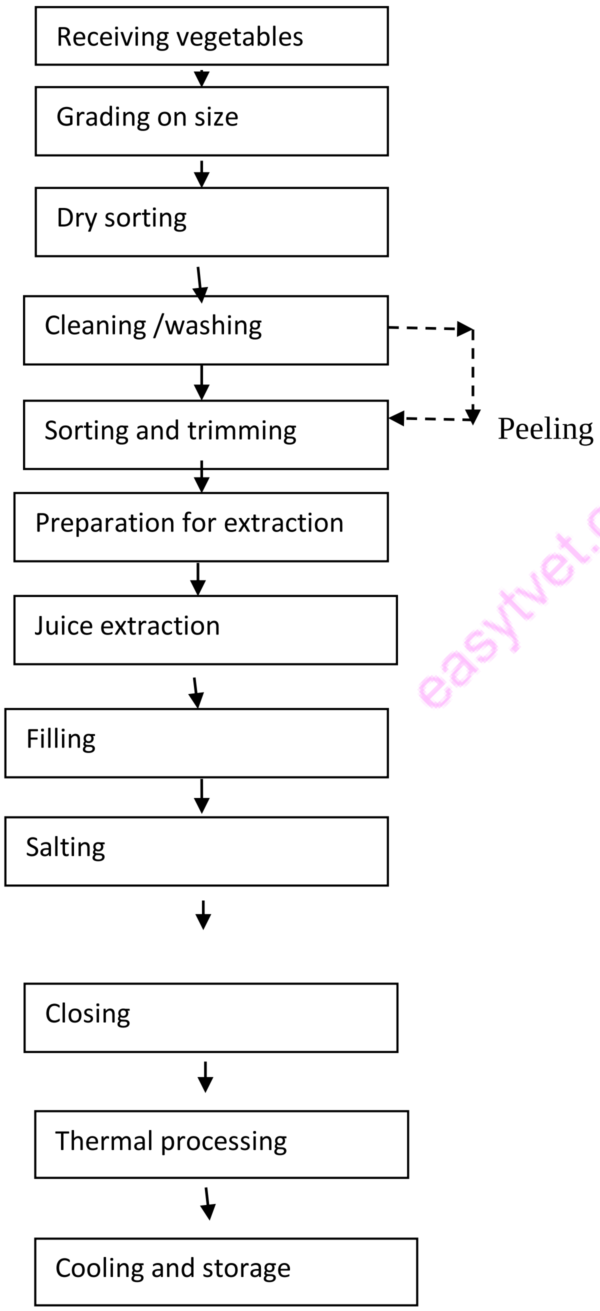

Figure 34:Processing of vegetables flow chart

4.3 Vegetables are dried and grounded into powder as per value addition manual

Drying of vegetables is a widely used food preservation process in which water removal minimize many reactions impacting the bio product quality. Dried vegetables and their application in powder form have gained interest in the food industry. Drying and grinding conditions during powder processing greatly influence the quality attributes of biological materials. It implies not only nutritional changes but also physical, textual sensorial and functional changes. Vegetables are dried until they are brittle.

Preparing vegetables for drying

To prepare vegetables for drying wash in cool water to remove soil and chemical residues. Trim peel, cut, slice or shred vegetables according to the directions for each vegetable. Remove any fibrous or woody portions and core when necessary, removing all decayed and bruised areas.

Pretreating vegetables

Blanching is a necessary step in preparing vegetables for drying; blanching is a process of heating vegetables to a temperature high enough to destroy enzymes present in tissue. Blanching stops the enzyme action which could cause loss of color and flavor during drying and storage. It shortens the drying and rehydration time by relaxing the tissues walls so moisture can escape and later re-enter rapidly. Vegetable can be water blanched or steam blanched. Water blanching usually results in a greater loss of nutrients but it takes less time than steam blanching.

How to prepare vegetable powders

1. Clean the items selected for dehydration cosmetic perfection is unnecessary but trim off any damaged or browned area.
2. Blanch the items to preserve color
3. Shred rather than chop shredded vegetable matter is far easier than hard chunks to grind into powder.
4. Spread the shreds unto a lined dehydrator shelf. Follow manufacturer's directions for drying times.
5. When dehydration is complete allow the shreds to cool before grinding them in a coffee bean grinder.
6. You may find it useful to shake the material from the grinder through a sieve put the larger pieces left behind through a second grind.
7. Store in sealed jars.

Methods of drying vegetables

i. Convective drying

It is the most economical and widely adopted technique in the food industry, although requiring long drying times and high air temperatures, in air drying the heated air meets the surface of the wet material that transfer heat into solid primarily by conduction. The liquid migrates then onto the materials surface and is transported away by air convection.

ii. Vacuum drying

Vacuum drying is a process in which moist material is dried under sub- atmospheric pressures. During vacuum drying water molecules diffuse to the surface and evaporate into the vacuum champers, heat is usually supplied by conduct in to the system at a partial vacuum of about 50-100 M bar to achieve the best product quality.

iii. Microwave drying

Microwave drying is an alternative drying method gaining popularity in recent years for a wide variety of industrial food products; it can be regarded as a rapid dehydration process significantly reducing the drying time.

Benefits of drying vegetables

Dried vegetables are high in fiber and carbohydrates and in fat making them healthy food choice. It increases the shelf life of vegetables.

Conclusion

This learning outcome has covered identification of vegetables to be processed and technologies used in fruit processing, occupational safety standards and standardization requirements.

Further Reading

1. Journal on preserving food; Drying fruits and vegetables, university of Georgia Cooperative extension service.

6.3.5.3 Self-Assessment

Written assessment

1. Two of the following shows methods of drying vegetables except?
    a) Convective drying
    b) Conductive drying
    c) Vacuum drying
2. The following shows the ways in which vegetables are processed. Which is not?
    a) Vegetable pickling
    b) Vegetable crushing
    c) Heat treating and freezing

3. The following factors determine whether the vegetable is worthwhile processing except?
    a) Demand of a particular vegetable
    b) Regular supply of raw materials
    c) The tenderness of picking the vegetable
4. The quality factors of vegetables include the following except?
    a) Colour
    b) Nutritive value
    c) Flavor
    d) Size
5. Which one is not a classification of vegetables?
    a) Root
    b) Leaves
    c) Stem
    d) Texture vegetables
6. The following are factors to consider in selection of vegetables except?
    a) Quantity available
    b) Freshness of the vegetables
    c) Size of the vegetables
7. Which of the following is a process of preparing vegetables for drying?
    a) Washing
    b) Grinding
    c) Filling
8. Differentiate between vegetables and products.
9. Give two nutritional value of vegetable to be considered in selection of vegetables for processing.
10. Blanching is?
11. Give four various classifications of vegetables.
12. Differentiate between vegetables and fruits

Oral Assessment

1. Explain the steps of preparing vegetable powders.
2. Explain the various factors to consider in selection of vegetables for processing.

Case Study Assessment

A certain company has just started its operation of processing vegetables. They would like to have their products compete favorably in the market. You are an agricultural consultant and have been contacted to advice the company. What key sections should the company put into consideration from selection to processing and packaging to even marketing to ensure their products become renowned and best-selling?

Practical Assessment

1. Using the steps to prepare vegetable powder, prepare a carrot powder following the outlined steps.
2. Using a vegetable processing plant participate and identify various ways of selecting processing, grounding, packaging and labeling of the final products. Give a brief report.

6.3.5.4 Tools, Equipment, Supplies and Materials

- Trays
- Juicers
- Blenders
- Sieves
- Mixers,
- Fruits and vegetables

6.3.5.5References

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6.3.6 Learning Outcome No 5: Process fruit into juice, wine and products.

6.3.6.1 Learning Activities

Learning Outcome No 5: Process fruit into, wine and products	
Learning Activities	Special Instructions
5.1 Identify fruits to process into juice as per horticulture technical manual 5.2 Process fruits into juice and products as per juice making recipes manual 5.3 Slice and dry fruits made as per value addition manual 5.4 Process and ferment fruits into wine as per SOPs	Group discussion on ways to identify fruits for processing. Demonstration on processing fruits into juice.

6.3.6.2 Information Sheet No6/LO5: Process fruit into juice, wine and products.

Introduction

The learning outcomes to be covered will include; types of fruits for value addition, types of technologies used in fruit processing, packaging of processed fruits products according to occupation safety standards and standardization safety standards.

Definition of key terms

Fruit processing: Refers to the preparation of fruits for human consumption

Safety standards: Refers standards designed to ensure the safety of products, activities or processes.

Content/Procedures/Methods/Illustrations

5.1 Fruits to process into juice are identified as per horticulture technical manual

Fruits is grown as it has many vitamins and necessary for nutrients for human body. Fruits commonly consumed in daily diets, are a major source of anti-oxidants. Processed from include; jam, paste and juice. In order to get good quality of processed products the quality of fruits should be good. Identifying good and bad quality fruits in the industries manually is the main obstacle as it is time consuming and for high labor cost.

Therefore, it is very important to identify the quality of fruits for processing by using automatic sorting machine for various necessities in industries. Image processing method in industries is used to identify quality fruits. It uses MATLAB software as a tool in image processing, to find the quality of vegetables using various algorithms.

The steps involved in identification of good and bad quality fruits are: image acquisition, processing, segmentation, feature segmentation, feature extraction, feature training and feature matching, finally the quality of fruit is identified.

Image acquisition

An image is analyzed as it is checked. The user is tools to discard that he considers as noise. Image acquisition is done using digital camera and it is loaded and saved using MIL software, the input image got is an RGB image.

Pre-processing

Basically, the images which are obtained during image acquisition may not be directly suitable for identification and classification purposes because of some factors such as: noise, weather conditions and poor resolution of an image and unwanted background. The steps involved in pre-processing are:

i. Input image
ii. Background subtraction
iii. Converting RGB to gray
iv. Converting gray to binary
v. Filtering's

These steps are easily and efficiently done using basic command MATLAB toolbox

RGB image

RGB is one of the formats of color images. Here the input image is represented with three matrices of sizes regarding the image format. The three matrices in each image corresponds to the colors red, green and blue and also says that of how much each of these colors a certain pixel should have.

Background subtraction

It's a process of extracting foreground objects of a particular scene of an image.

Gray image

Gray scale images have one color which is a shade of gray in various ranges in between. Monochrome image is another name of gray image. This denotes the presence of only one (mono) color (chrome). To convert any color image to a gray scale representation of its luminance.

Binary image

Binary image is a digital image which has two assigned pixel values. Two colors used for a binary image black and white. Binary images used in digital image processing as masks or as result of some frequent operations such as segmentation, thresholding and dithering.

Filtering

The purpose of filtering is to smooth the image. This is done to reduce nose and improve the visual quality of the image. Often, smoothing is referred to as filtering.

Segmentation

The purpose of image segmentation is to divide an image into meaningful regions with respect to particular application. Segmentation is based on measurements taken from the image. It may be: gray level, color, texture, depth or motion. As edge detection is a necessary to point out true edges to get the best result from matching that is why it is important to choose edge detectors that fit the best application canny, edge detector is chosen.

Feature extraction

This is grouping the input data objects into a set of features. The features extracted carefully will help to extract relevant information from the input data in order to perform the feature matching.

Feature matching

Feature matching method essentially consists of identifying features in images that can be matched with corresponding features in the other images from which transformation model can be estimated. Feature matching is an important task in the area of image processing. Here correlation method is used for feature matching. The clustered values of good and bad fruits are taken more in number with extracted features. Each value is correlated with one another with specific value for good and bad fruit is obtained.

5.2 Fruits are processed into juice and products as per juice making recipes

The most important steps involved in processing of fruits are:

i. Selection and preparation of the fruit
ii. Extraction of juices
iii. Straining, filtration, clarification
iv. Blending, pasteurization
v. Filling, sealing and sterilization
vi. Cooling, labelling and packing.

For juice concentration, vacuum evaporation is another step-in fruit processing line. The final concentrate can be filled in aseptic bags in drums for export purpose. Clear juices can be formulated, blended and spray dried at best conditions to convert them into readily soluble powders. The types of drink made from fruit can be separated into two basic types.

- Those that are drunk straight after opening.
- Those that are used little by little from bottles which are stored between them.

Different types of drinks are classified according to the following criteria.

Table 14: Criteria for classifying drinks

Type	Description
Juices	Pure fruit juice with nothing added
Syrups	Concentrated clear juices. Normally have a high sugar content
Cordials	Crystal clear squashes
Nectars	Contain 30% fruit solids and are drunk immediately after opening
Squashes	Contain at least 25% fruit pulp mixed with sugar syrup. They are diluted to taste with water and contain preservatives.

Stages of fruit processing

Preparation of raw material

Select mature undamaged fruits. Any fruits that are moldy or under-ripe should be stored and removed. Wash the fruits in clean water. Peel the fruit and remove stones or seeds

Juice extraction

There are several methods to extract juice depending on the type of fruit. Some fruits such as papaya are steamed to release the juice. Apples are pressed and fruits such as mango and guava you extract juice. Fruit pieces are pushed through a perforated metal plate that crushes and turns them into a pulp.

Filtering

To make a clear juice, the extracted juice or pulp is filtered through a muslin cloth or a stainless-steel filter. Although juice is a naturally cloudy, some consumers prefer clear product. It may be necessary to use pectin enzymes to break down the pectin and also help clear the juice.

Batch preparation

When the juice pulp has been collected it's necessary to prepare batch according to chosen recipe. This is very much a matter of choice and must be done carefully to suit local tastes. Juices are sold either pure or sweetened. All fruits contain sugar, usually around 8-10%. The actual levels vary from fruit to fruit and with the stage of ripeness of the fruit.

Pasteurization

All juice products end to be pasteurized a 80-85 degrees Celsius for 1-10 minutes prior to hot filling into the bottles. At the simplest level, this may be carried out in a stainless steel enameled or aluminum saucepan over a gas flamer, but this can result in localized overheating at the base of the pan with consequent flavor changes. It is best to use stainless pans to heat fruit juice once they have been bottled. The bottles are placed in hot water bath which is heated to 80degrees Celsius.

Filling and bottling

In all cases, the products should be hot filled into clean, sterilized bottles. A stainless-steel bucket, drilled to accept a small outlet tap, is a very effective bottle filter.

Quality control

Freshness and quality of the expressed fruit juice is central to the quality of the final product. As soon as the juice is expressed from the fruit, it starts to deteriorate, both as a result of chemical activity and bacterial spoilage. Extracted juice left to stand for long periods of time will start to ferment and may start to discolor due to enzyme activity.

5.3 Fruits are made into slices and dried as per value addition manual

Dried fruit is a good source of nutrients and is filed with vitamins and minerals. Also, it is rich in natural sugar. A variety of fruits to be dried can range from grapes, apples, apricots, pears, peaches, figs, dates, plums and bananas.

General procedure for drying fruits

i. Select firm ripe fruit
ii. Wash the fruits in clean water
iii. Peel and remove damaged and discolored parts
iv. Slice/cut into thin uniform slices or sugar solution
v. Spread on trays and load into drier
vi. Control the temperature by opening the dryer door
vii. Pack the dried product in moisture proof packs
viii. Store in a cool, dry, well ventilated place.

Practical's aspects of fruit drying

To acceptable for both export and local consumption, there are several factors to consider.

- Purchase of quality fresh produce
- Carefully transport and storage
- Proficient preparation of produce
- Correct loading and operation of the drier
- Proper packaging and storage of the dried product
- Achieving good product quality

There are various ways of drying fruits as follows:

Sun drying

This should be avoided as it is very difficult to control the quality of the product. When sun drying is used, the fruit should be dried on the meshed trays or racks that are raised above the ground so that the air can circulate around them. The fruit slices should be turned or removed every hour during the first during the first drying to improve quality.

Shade drying

It is more dependent on movement of the fruit. The drying rack should be placed in apposition that can take advantage of any wind and dry air circulates with ample circulation. Cabinet drier can be used most fruits. Solar drying is dependent on the sun or storing. There is no dry cloudy or rainy condition overnight. This prolongs the drying period and can reduce the quality of small business.

Artificial drying

This is the most controllable method of drying. It is also the most expensive it requires drying cabinet that is heated by electricity, gas or biomass. The advantages are that the drying rate can be carefully controlled regardless of external climatic conditions to make a high-quality dried product.

5.4 Fruits are processed and fermented into wine as per SOPs

Fruit wines are fermented alcoholic beverages made of fruits than grapes. They may also have additional flavors taken from other fruits, flowers and herms. Fruit wines can be still or sparkling. Different types of fruit wines are produced worldwide and include: low alcohol cider style, dry or off-dry fruit wines sweet fruit wine and cryo extracted fruit wine.

The main steps of fruit wines technology include the following:

i. Fresh or frozen fruit reception
ii. Fruit extraction and preparation by crushing, pressing, clarifying and amending.
iii. Fruit fermentation conditioning and conservation and aging

The fruits should be having high sugar and low acidity characteristics which should be adjusted when needed. The fruits are normally delivered to the distillery depending on the season that they are most ripe for example, apples are picked in autumn while strawberries in midsummer.

Determining the process of partial or total removal of stems from the fruit is the next step in fruit formulation. The fruits are then crushed mechanically fermentation stage can be done. Either on the juice or on the solid parts depending on the solid parts on the type of wine desired and fruit used. After fermentation, decanting takes place during this process the supernatant wine is separated from the produced wine lees and is fed by pumps to empty tanks filled with 100% for further stabilization. The next stage is maturation, where decanted wine is kept in maximum capacity filled vessels. After maturation and stabilization, wine is fitted for quality improvement and then decanted into empty tanks.

Wine making multiple step process

(Determining, crushing, fermentation, pumping over and pressing. After the desired timed period for settling, wine is bottled for transportation tanks and distributed to the contact points.

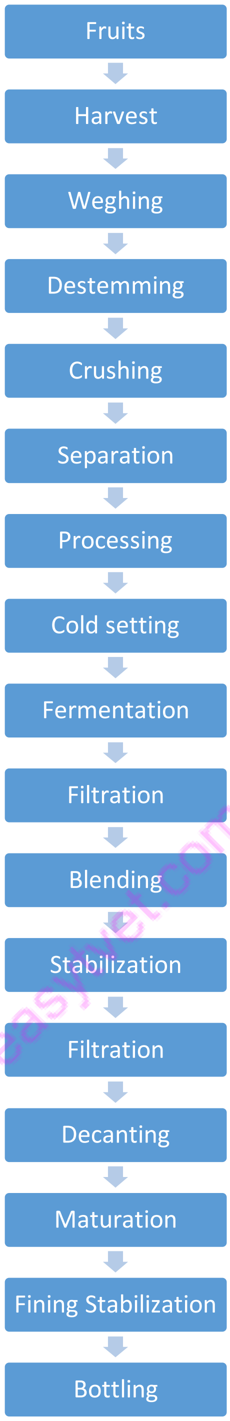

Figure 35: Wine making multiple step process

Conclusion

This learning outcome has covered types of herbs for value addition, technologies used and packaging of the processed fruits products. Occupation safety standards and standardization requirement.

Further Reading

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6.3.6.3 Self-Assessment

Written assessment

1. The various types of drinks include the following except?
   a) Juices
   b) Syrups
   c) Nectars
   d) Filters
2. Stages of fruit processing include the following except?
   a) Filtering
   b) Pre-processing
3. The following are steps of identification of good and bad quality fruits except?
   a) Feature training
   b) Image acquisition
   c) Safety standards
4. Main steps of fruit wines technology include the following except?
   a) Fresh/frozen fruit reception
   b) Fruit extraction and fermentation
   c) Image acquisition
5. Steps involved in processing contain?
   a) Cooling, labelling and packaging
   b) Segmentation
   c) Feature matching
   d) Filtering
6. Differentiate between fruit processing and fruits?
7. The purpose of image segmentation is to
8. Feature extraction involves
9. Give two stages of fruit processing?
10. Name four ways of drying fruits.
11. Explain the various stages of fruit processing.
12. Explain the main steps of fruit wine fermentation.

Case Study Assessment

Most companies that produce the ready to drink juices in Kenya operates at medium-scale level and do not procure the fruits directly to the market. The equipment they need mostly is storage tanks, cold rooms and mixing tanks. The challenges faced by these medium-scale enterprises are the shortage of the juice concentrate high distillation costs and high cost of packaging how can these companies can solve this problem?

Practical Assessment

Using mango fruits select the best quality for drying, dry the fruits as per the drying steps of artificial drying.

6.3.6.4 Tools, Equipment, Supplies and Materials

- Juicers
- Mixers
- Blenders
- Fruits and vegetables
- Deep freezers
- Text books and manuals

6.3.6.5 References

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6.3.7 Learning Outcome No 6: Process Herbal products

6.3.7.1 Learning Activities

Learning Outcome No 6: Process Herbal products	
Learning Activities	**Special Instructions**
6.1 Identify herbs as per small scale horticultural development programme manual 6.2 Process herbs into herbal products.	Group discussion Illustrations of various herbs

6.3.7.2 Information Sheet No6/LO6: Process Herbal products

Introduction

This learning outcome will cover on types of herbs for value addition, types of technologies used in herbs processing, Packaging of processed herbal products, Occupation safety standards and standardization requirement.

Definition of key terms

Standardization: The process of making things of the same type with standards to guide the creation of a good service based on conscious of all parties in the industry.

Value addition: The process of economically adding value to a product by changing its current place, time and form, to a more valuable state.

Content/procedures/methods/illustrations

6.1 Herbs are identified as per livestock production manual.

Herbs refer to any plant with leaves, seeds or flowers used for flavoring, food, medicine or perfume. Examples of herbs include: rosemary, basil, bay laurel, chervil, cilantro, chives, oregano, dill, sage, and thyme and wheat grass. The recommended practice for plant identification is focused strictly on the establishment of a practical, effective model for proper plant identification. It does not cover sustainable or ethical harvesting process concept as ethics relate to providing the proper plant material buyers nor does it address toxicity issues or good manufacturing practices as they relate to activities further up the value chain.

Plant herbal identification

i. Propagation material

Botanical identity of the herbs must be verified WHO also calls for the name of the supplier of the material to be recorded.

ii. Personnel and education

The growers and collectors need to have education training or experience necessary to properly identify the plant materials they are producing.

iii. Harvest/collection/acquisition of material from third party

Material should be verified at harvest/collection acquisition, being careful to watch for contamination with non-target species. If more than one identification method is used the results should be consistent before assuming accurate identification has taken place

iv. Primary processing

World health organization recommends re-confirmation of identity prior to any processing given the additional challenges involved in identifying material post processing. One person should take responsibility for verification as the product moves through the primary processing step; labels should be carefully stored to avoid any potential for misidentification of material.

v. Packaging

Control must be in place to avoid contamination with foreign material; labeling must be clear and contain the scientific name of the plant

vi. Storage and transport

Care must be taken in storage to prevent the mix-up of material. The lot/batch/shipment should be with a unique number.

Recommended practices for plant identification establishment, growth and harvest stage

For herbs plants under cultivation: The producer must have utilized authenticated or certified seeds, transplants seedlings or cutting. He or she must:

a) Retain documentation of authenticity.
b) One crop is grown, conduct visual inspection pre-during and post-harvest to re-confirm correct identity.
c) If produced from seed retain seed sample for each authenticated seed source and crop.
d) Retain representative voucher sample of plant at harvest and reproductive stage for each authenticated seed.

For wild harvested plants

The following concepts should be considered in identification.

- If the harvester is qualified through experience education and training to reliably identify the plant species confirm species against reference.

- Create and retain salvage plan consisting of the practices that will be followed to remove unwanted material from a crop and render it homogenous within acceptable limits.
- Raw material stage (both cultivated and wild harvested. If steps have been followed for identification at establishment growth and harvest stages no further verification required.
- If reliable identification has not been achieved at establishment, growth and harvest stages utilize appropriate analytical methods.
- If raw material cannot be reliably identified, take appropriate remedial action to salvage so discard.
- If salvaged, create and retain salvage plan consisting of practices that will be followed to remove unwanted material from the raw material and render homogenous within acceptable limits.
- Collect a retention sample of positively identified material for each shipment, batch, or lot and label appropriately. Samples should be retained for a minimum of 3 years.

6.2 Herbs are processed into herbal products.

The raw material for herbal processes is herbal material which consists of plant parts such as rhizomes, barks, seeds, fruits, leaves, flowers and stems. Value of herbal materials is related to the content of the active ingredient in the herbal preparations.

Herbal products processing involves both farms and processing facilities. The primary herb processing steps include: drying, size reduction, grinding and sieving. The secondary processing involves extraction with aid of suitable solvents concentration and drying. Products of secondary processing are in the form of whole extract, concentrated extract and powdered extract

Steps in herbal processing

Every part of the plant matures at different times which suggest that the harvesting process should be optimized on the basis of the desired plant parts. There are different stages of herbal processing to produce the final herbal products

i. Preprocessing stage

The plants are dried to remove moisture for preservation, preventing bacteria activity and restricting fungal growth. To increase the surface area of the dried herb plant materials for improved contact with the solvent during the sub sequent extraction process, the dried plants must first be ground. An increased surface area of the dried plant material will improve the performance of the extraction process. Particles of the milled plants can affect extraction yield.

ii. Extraction process

Operating conditions can greatly affect the efficiency of a particular technique. For solid liquid extractions, important parameters include an appropriate solvent system, the solvent to herb ratios; the particle sizes of ground and dried herbs materials, temperature, duration and agitation rate. In some process, solvents are mixed with herbal raw materials normally in the dry powder form and the subjected forces such as heat, pressure or microwave power to enable settle the photochemical to diffuse out of the herb's cells into solvent medium. The solvents are then removed from the mixture, typically via evaporation in a rotary evaporator. Then the crude extract further processed into natural products.

Types of extraction process

i. Supercritical fluid extraction (SFE)

This process is one of the extraction methods in herbal processing due to its ability to extract valuable ingredients from herbs with high yield and good quality. Its favorable features include the ability to perform extractions at near ambient temperatures, which prevents thermal degradation of the substance of interest. Carbon (IV) oxide is one of the solvents which are widely used due to its unique properties such as non-toxicity, no flammability, lack of solvent residue in the final products and lack of reactivity with extraction material and equipment.

One of the advantages of SFE is that the system operates at low temperatures which are ideal technique for studying temperature-sensitive compounds. Possibly lead to discovery of new natural compounds. To minimize waste operation, the spent CO2 can be recycled and reused even for large scales systems. It is very useful in removing pesticides from herbal medicine.

ii. Microwave assisted extraction (MAE)

It is a process that uses a liquid solvent such as water or alcohol, to extract the active ingredients from herbs. The enhanced extraction occurs as the result of changes in the vegetable cell structure caused by electromagnetic waves. The MAE typically results in a short extraction time and high extraction yield. Besides the combination of 2 transport phenomena; heat and mass gradients working in the same direction also contribute to the high yield and short extraction time of the MAE. The microwave assisted extractions has been used to extract the ingredients from the leaves and roots of herbs.

iii. Sonication extraction

In this extraction conditions such as the time and ratio of herbs to solvent share similarities with the MAE process, except the intensity of the ultrasonic equipment which is replaced with microwave power to facilitate the extraction process. The correct choice of solvent coupled with appropriate agitation or heat characteristics are also major factors in optimizing this type of extraction process. The solvent extraction of herbal materials can be through the use of ultrasonic power because of the mechanical effects resulting from ultrasound process. The effect results in improved solvent penetration into the cellular material via improved mass transfer within the herbal ells. In addition; mechanical effects disrupt the biological cell wall, thereby resulting in the release of the cell contents such as herbal oils.

iv. Soxhlet

Soxhlet extraction involves use of a Soxhlet apparatus for the extraction of herbs. The sample is placed in a thimble holder that is gradually filled with fresh solvent from a distillation flask. As the liquid reaches the over-flow level, a siphon aspirates the solute from the thimble holder moving the aliquot back into the distillation flask carrying the extracted analyses into the bulk liquid. The process continues until extraction process has been completed.

Soxhlet extractions are limited by the time required for the extraction process and by the large volumes of extract ant (solvent) required. The solvents can be expensive to remove and can cause environmental problems.

v. Marinated extractions

Marinated extractions method conducted at room temperature. For this technique, the parameters to be considered include the type of solvent, the ratio of dried herbs to solvent and the extraction time. This method requires prolonged, extraction time because it does not use heat or other forces. The extraction of products is obtained by filtering the extracts first.

The advantage of this method is that it requires neither special equipment nor a special location such as a laboratory. The main disadvantage is the long extraction time.

vi. Hot water extraction

It uses hot water for extraction instead of organic solvent. The use of water as a solvent result in lower operating costs for the HWE method because water is a cheaper solvent. As solvent water is relatively cheaper and relatively easier to treat and recover and poses relatively has less environmental issue. The hot water extraction is efficient in extracting essential oils from coriander seeds.

vii. Steam distilled extraction

Steam distillation includes a stem generation apparatus to supply steam to the mixture of solvent and plant raw material. Steam may be supplied at a pressure and the corresponding saturation temperature that is sufficiently higher than the boiling point of the mixture in order to allow evaporation to take place at lower temperatures. Next the evaporated mixture of water and compound flows into a condenser where it is condensed into a liquid mixture and later collected in a separator. The solvent is finally evaporated and separated from the compound using a rotary evaporator.

viii. Packaging herbs

Suitable packaging can slow the deterioration rate and may extend product shelf life. Demand for medical herbs and spices have increased and their derived products has a variety of functions such as herbal medicine, food flavorings and cosmetics in forms of tea, tablet, capsule, tincture, cream, syrup and liquid. If drying is not performed properly it can compromise on the quality of herb products. Variety of packages and approaches has been employed to interact with the food and provide desirable effects. Examples of these include incorporating oxygen moisture and ethylene scavengers for these are ethane-sensitive food and use of carbon.

ix. Oxide of ethyl emitters

Flavor imparting or scavenging chemicals and antimicrobial agents for microbiological safety of food. This approach designed to perform desirable functions other than providing an inert barrier is called active packaging, interactive packaging and intelligent packaging. The use of plastic in the packaging of foods has been increasing at an accelerated rate, because of reduction in the cost of packaging materials due to technological innovations and the inherent properties of plastic films which make them very well suited to food packaging. Labeling of the herbal products is necessary for safety use of herbal formulation by people when they buy it.

Conclusion

This learning outcome has covered identification of herbs and processing of herbs into herbal products.

Further Reading

1. Journal on herbal processing and extraction technologies.

6.3.7.3 Self-Assessment

Written assessment

1. Three of the following are types of extraction process in vegetables. Which one is not?
    a) Sonication
    b) Soxhlet
    c) Marination
    d) Blanching

2. Which one of the following is not a plant herb identification process?
    a) Use of personnel and education.
    b) Propagation material
    c) Supercritical identification.

3. Which one is not a step-in processing of herbs?
    a) Pre-processing stage.
    b) Post-processing stage.
    c) Extraction processing.

4. Which of the following is not a use of herbs?
    a) Medicinal purpose.
    b) Preservative purpose.
    c) Spices.

5. Packaging of herbs involves the following approaches except.
    a) Incorporating oxygen.
    b) Use of carbon(iv) oxide emitters
    c) Five short answer questions

6. During pre-processing stage plant herbs are dried for the following reasons except?
    a) Removing moisture.
    b) Preventing bacterial activity.
    c) Safety of the herbal formulation.
7. What do you understand by the term herbs?
8. Give 2 types of extraction process of herbs.
9. Differentiate between value addition and standardization.
10. Give 2 primary herb processing steps.
11. Name the plant herb parts which are processed to obtain the final herb products.

Oral Assessment

1. Explain any 2 processes of extraction of herbs.
2. Explain how plant herbs are identified.

Case Study Assessment

A certain organic farm is specializing in production of herbs for export and local market as well. Their herbs are mainly used as spices in food. Recently they would like to produce more herbs and diversity the types of herbs being processed and exported, as an extension officer you have been contacted to give advice on how to identify other herbs not found in the farm and how to process.

Practical Assessment

1. Identify various herbs by visiting a botanical garden and note down what you found out.
2. Visit a nearby supermarket or a local market and identify various fresh and processed herbs and note down the names of the herbs.

6.3.7.4 Tools, Equipment, Supplies and Materials

- Herbs
- Clean water
- Sieves
- Buckets
- Solar driers
- Electricity
- Text books and manuals

11.3.7.5 References

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6.3.8 Learning Outcome No 7: Process animal products

6.3.8.1 Learning Activities

Learning Outcome No 7: Process animal products	
Learning Activities	Special Instructions
7.1 Identify animal products as per livestock production manual. 7.2 Process animal products as per livestock products value additional manual. 7.3 Process and package products and label as per standardization requirement.	Group discussion and presentation Field Excursion

6.3.8.2 Information Sheet No6/LO7: Process animal products

Introduction

The learning outcome covers types of animals for value addition, types of technologies used in animal product processing, packaging of processed animal products and occupation safety standards.

Definition of key terms

Value addition: Refer a process of changing or transforming a product from its original state to a more valuable state.

Safety standards: They are standard designed to ensure the safety of products, activities or processes.

Content/procedures/methods/illustration

7.1 Animal products are identified as per livestock production manual

An animal product is any materials derived from the body of an animal. Examples are fat, flesh, blood, milk, eggs and lesser known products. Animal by-products are products harvested or manufactured from livestock other than muscles meats.

General classification of anima products

Animal food: Animal food refers to the edible parts of the animal carcass or those products obtained from the live animal. The animal food comprises of meat, milk eggs and processed product from these as well as the edible parts of the carcass such as kidney, heart, liver and intestines.

Characteristic to consider in selection of meat for processing

Meat is the compositional quality (lean to fat) ratio and the palatability factor such as visual appearance, smell, firmness, juiciness, tenderness and flavor.

a) Visual identification

Visual identification of meat is based on color, marbling and water holding capacity. Marbling is the small streak of fat found within the muscles and can be seen in the meat cut. Marbling has a beneficial effect on juiciness and flavor of meat. Meat should have a normal color that is uniform throughout the entire cut.

b) Smell

The product should have normal smell. This will be different for each of the species ie. Beef, pork, chicken; but should vary only slightly within the species. Any rancid or strange smelling meat should be avoided.

c) Firmness

Meat should appear firm rather than soft. When handling the retail package. It should be firm not tough. It should give under pressure but not actually soft.

d) Juiciness

Water retention and lipid content determine juiciness. Marbling and fat ground the edge helps hold in water losses from evaporation and drip losses. Meat aging can increase water retention and therefore increase juiciness when processed

e) Tenderness

This is linked to several factors such as animal's age, sex or the muscle location One important factor to tenderize meat is by aging. Carcasses are aged by holding then at refrigeration temperatures for extended period of time after slaughter and initials chilling before processing.

f) Flavor

Flavor and aromas are intertwined to create the sensation the consumer has during eating. These perceptions rely on the smell, sour and bitter on the tongue. Meat flavor is affected by type of species, diet, cooking methods and methods of preservation (smoked or cured).

MILK

Milk quality for processing

High quality milk is crucial for processing high quality dairy products.

Per regulations the milk displaying these following characteristics must be discarded

- Inadequate sensory factor (smell, taste and visual)
- High temperature

- Contamination by antibiotic residue and added water
- High direct microscopic count of bacteria
- Inadequate sensory factors (smell, taste and visual.

Milk quality affects the product's taste and shelf life as well as cost of manufacturing.

- Parameters of milk quality includes;
- Somatic cell count
- Milk solid/fat protein lactose
- Mastitis pathogens (e-coli staphylococcus)

How to achieve high quality milk good for processing

Achieving high quality milk is a joint effort of dairy managers and farm personnel. Milk quality is best controlled by proper milking routine that combine daily practices and training of milkers.

Dairies must observe the following:

i. Contaminated milk: Prevention efforts must be made by dairy personnel. Antibiotics, colostrum, high SCC clinical mastitis in cow must be identified and milked out of the system.
ii. Cleaning system: A good CIP program for cleaning and disinfecting the milking system is critical.
iii. Milking system equipment: Milk tanks and milk cooling devise must be maintained.
iv. Milk components: Milk solid must be controlled and monitored in accordance with their destination for examples cheese industry.
v. Cross contamination: There should be no cross contamination between cows. Milking equipment must always be cleaned after appearance of contaminated milk.

7.2 Animal products are processed as per livestock products value addition manual

Meat processing begins from slaughtering. The slaughtering procedures include the following states:

a. Pre-slaughter handling
b. Stunning
c. Slaughtering

Pre-slaughter handling

Stress applied to livestock before slaughter can lead to undesirable effects on the meat produced from these animals: Pre-slaughter stress can be reduced by preventing the mixing of different groups of animals, keeping livestock cool with adequate ventilation and avoiding overcrowding. Before slaughter animals should be allowed to access to water but held off fed for 12 to 24 hours to ensure complete bleeding and ease of evisceration (removal of internal organ).

Stunning

Livestock are restrained in a chute that limits physical movement of the animal. Once restrained, the animal is stunned to ensure a humane end with no pain. Stunning also result to decreased stress of the animal and superior meat quality.

The most common methods of stunning are mechanical, electrical and carbon (IV) oxide gas. The end result of each method is to render the animal unconscious.

Slaughtering

After stunning animal are usually suspended by the hind limb and moved by a convoy line for slaughter procedures. They are typically bled by a process called sticking or by the insertion of a knife into the thoracic cavity. This allows for maximum blood removal from the body. At this point, in the process the slaughter procedures begin to differ as per species.

General aspect of processing meat

Processed meats are products in which the properties of fresh meat have been modified by use of procedures such as mining, grinding and chopping, salting and curing, additional of seasonings and other food materials and in many instance heat treatments. Most of these processes extend the shelf life of meat. Their manufacture in most instances depends on the ability of the mixture to retain water since they are emulsions of protein fat and water.

Reasons for processing meat

- Fresh meat has a limited shelf life even under refrigeration at the most about 10 days to close to 12.
- Fresh meat can be frozen to extend shelf life but it is difficult to keep the texture and other acceptance quality of meat.
- Transportation of fresh meat especially for the international, market is quite costly. Therefore, cost can be minimized with processed meat products.
- Processed meat offer consumers is their favorite products which are easily and ready to eat.

For processor the return is more and provides an incentive to venture into many different products especially that are of different countries.

Milk processing

Milk processing is the procedure that includes various steps to start dairy farms like milk collection from cattle, pasteurization, clarification, homogenization, packing of milk and finally transportation to processing.

Pasteurization

Pasteurization is the first step in milk processing; Pasteurization means heating every particle of the milk or milk product to a specific temperature for a specified period of time (63^0C for 30 minutes). This destroys bacteria and other microorganisms that many affect consumers' health. It makes the milk safe and healthy and also improves the keeping quality so that milk and milk products can be stored for longer periods without being spoilt. The three methods of pasteurization include:

i. Batch pasteurization, 63^0C for at least 30 min (suitable for small scale producer and farmer co-operative.
ii. High temperature short time (HTST) pasteurization, 72^0C for at least 15 minutes. This is suitable for processing large qualities of milk. e.g. more than 250 liters at a time.
iii. Ultra-high temperature short time (HTST) pasteurization. This is used in big factories and requires special machinery. UHT milk can be stored for 6 months even without refrigeration.

Cream separation

The first step in making cream, butter and ghee is to separate cream from the fresh milk. This can be done by gravitational separation or centrifugal separation. Gravitational separation allows the milk to settle. The cream is lighter than the other milk components. It rises to the top and can be separated. Centrifugal separation requires simple machine like a centrifuge. The centrifuge can be treated by hand or by an electric motor.

7.3 Processed products are packaged and labeled as per standardization requirement

Packaging wrappers and material used must not be a source of contamination. Packaging material should be stored properly so they are not at risk of contamination. Wrap and package the food in a way that avoids contamination of products. Any containers, for packaging must be clean and not damaged particularly cans or glass jars. Processed animal products should be authentic. The products must match is description. Mislabeled food decides the consumer and creates unfair competition with manufacture or traders. The description of food refers to the information given about it;

- Name
- Ingredient
- Origin
- Processing

Factors to consider in packaging

Product packaging plays a huge role in successful and sustainable food industry, operation.

1. **Quality and functionality of packaging material**

Packaging is only effective if it protects the products against damage in transit. High quality packaging material must be used to keep products secure till they reach the end customer or distribution facility.

2. **Size, shape and design**

Standard size and shape for product packaging is a good idea. Not only does this improve flexibility and conveniences during storage, handling and transportation but also reduce production cost for packing.

3. **Pricing and cost saving**

The cost effectiveness of packing materials depends on more than just its price. Some packaging types are lighter than others reducing transportation cost, while other are easier to handle and help boost production efficiency.

Distribution and storage

Understanding how a normal product makes it from a producing unit to a storage and distribution facility retail outlets or customer helps you select the right protective packaging considering the distance of shipment need of travel and model of transportation as well as storage condition.

Long-term sustainability

Material and equipment chosen should comply with industry regulation and legal guidelines.

When labeling the following factors are considered:

- Label material costs
- Printing and converting cost which includes the number of color in-line options, sheet or even web printed options.
- Appearance options: What kind of paper to use and what kind of film used.
- Durability: Scuffing resistance, image deterioration water resistance or heat resistance should be considered.
- Production flexibility: Possible need where ease and speed of label line changes over are concerned.
- Cost of label production
- Information need on the label such as how labeling technology link customer to information on the web.

Importance of packaging and labeling of animal products

- Labeling brings identification to products
- Labeling helps spread awareness among the customers about the items they are consuming and also help mention ingredients
- Packaging protect the products from damage
- Packaging promotes the product and provides customer convenience.
- Packaging helps to differentiate animal products from other products.

Conclusion

This learning outcome has covered types of animals for value addition and types of technologies used in animal product processing. It has also covered packaging and occupational standards.

Further Reading

1. Heinz G $ Haul zinger, P. (2007) Meat processing technology, food and agriculture organization
2. Modern Technology of food processing and Agro based industries by NIIR

6.3.8.3 Self-Assessment

Written assessment

1. The parameters of milk quality include the following except?

    a) Stunning
    b) Sematic cell count
    c) Milk solid fat

2. The following are characteristic to consider in selection of meat for processing except?
    a) Smell
    b) Firmness
    c) Texture
    d) Tenderness
3. Fresh meat can be modified by use of the following except?

    a) Crushing
    b) Mincing
    c) Separation
    d) Salting

4. Milk procession consist of the following steps except?
    a) Pasteurization
    b) Cream separation
    c) Ghee Preparation
5. Slaughtering procedure include all the following excepts handling?
    a) Pre-slaughter
    b) Slaughter
    c) Blanching
    d) Stunning
6. To produce quality milk dairies must observe the following which one is an exception?
    a) Prevention slaughter handling
    b) Slaughtering
    c) Blanching
    d) Stunning
7. Differentiate between value addition and animal product.
    a) Prevention efforts to be made on daily personnel
    b) Milk system equipment should be clean
    c) Milk components should contain solid particles
8. Animal by product is..............................
9. Give two characteristics to consider in selection of meat for processing
10. Give two importance of packaging animal products.
11. The parameter of milk quality includes.....................................
    And.................................

Oral Assessment

1. Explain the importance of labelling animal products
2. Describe the steps/ procedures for slaughtering.

Case Study Assessment

A certain beef processing company has been undergoing losses due to unauthentic labelling. They would like to re-label their products and change their packaging. What are the best considerations they should take to ensure good labelling and packaging?

Practical Assessment

1. Visit the school dairy farm and verify the dairy activities. State whether they meet the quality standards.
2. Carry out batch pasteurization of milk-in the dairy farm

6.3.8.4 Tools, Equipment, Supplies and Materials

- Meat
- Hides and skins
- Clean water
- Tanning chemicals
- Tannery equipment electricity

6.3.8.5 References

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CHAPTER 7: CROP PROTECTION/PROTECT CROP

7.1 Introduction

This unit specifies the competencies required to carry out crop protection. It involves; Carrying out disease and pest surveillance, identifying method of pest and disease control, procuring transporting and storing farm pesticides, controlling crop pest/diseases. Disposing expired empty containers and preparing crop protection report. The significance of crop protection is to help farmers reduce crop pest damage and increase crop production. It also help to improve the quality and yield of agricultural produce.

The critical aspects of competency of crop protection to be covered include; Carrying out disease and pest surveillance, Identify method of pest and disease control, Managing farm pesticides and Controlling crop pests and diseases. The basic resources to be used include; diseases and pest identification charts, pictograms, mapping tools, chemicals, PPEs, insects traps, spray pumps, first aid kit, manuals and texbooks.

The unit of competency covers six learning outcomes. Each of the learning outcome presents, learning activities that covers performance criteria statements, thus creating trainee's an opportunity to demonstrate knowledge and skills in the occupational standards and content in curriculum. Information sheet provides; definition of key terms, content and illustration to guide in training. The competency may be assessed through written tests, demostrations, practical assignments, interview/oral questioning and case studies. Self assessment is provided at the end of each learning outcome. Holistic assessment with other units relevant to the industry sector workplace and job role is recommended.

7.2 Performance Standard

Carry out disease and pest surveillance, identify methods of pest and disease control as per the farm plan and crop scouting manual, manage farm pesticides and control crop/pest diseases as per the OSH standards, dispose expired chemical and empty containers as per the safe use of pesticide manual and also prepare crop protection report as per the SOPs.

7.3 Learning Outcomes

7.3.1 List of learning outcomes

a) Carry out disease and pest surveillance
b) Identify method of pest and disease control
c) Procure, transport and store farm pesticides
d) Control crop/pest diseases.
e) Dispose expired chemical and empty containers
f) Prepare crop protection report

7.3.2 Learning Outcome No 1: Carry out disease and pest surveillance

7.3.2.1 Learning Activities

Learning Outcome No 1: Carry out disease and pest surveillance	
Learning Activities	**Special Instructions**
1.1 Scout pest as per scouting manual. 1.2 Identify disease control area according to farm plan.	Ask students to develop a counting frequency for the school farm Guide learners in identifying a disease control area.

7.3.2.2 Information Sheet No7/LO1: Carry out disease and pest surveillance

Introduction

This learning outcome covers the types of crop pests and diseases, their surveillance and mapping as well as the documentation process. Crop pests and diseases have evolved over time proving to be a threat to food security. Climate change in this case has been a major driving force to pest relocation and their mutation is raising a major concern

Definition of key terms

Surveillance: Is the process of monitoring behavior and activities for the purpose of managing or directing

Mapping: It involves timely collection of information regarding plant and soil properties and their requirements. It also involves of application and prescription of site-specific treatment.

Documentation: The act of keeping records on official data or information for future reference

Content/procedures/methods/illustrations

1.1 Pest scouting is done as per crop scouting manual

Pest scouting refers to regular visits to the field to quantify pests' levels and any potential damage. It involves working out for physical evidence of pests and targets insects, weeds, pests, and symptoms of diseases. Crop scouting manual is a guide that helps in identifying and diagnosing pest problems. It is essential since scouting is the backbone of all pest management programs. Before appropriate pest control decisions can be made, a detailed assessment of pest population must be obtained.

Efficient pest scouting requires thorough knowledge of pest and crop biology, pest identification and habits, correct sampling methods and economic threshold. The aim of scouting is to give a complete and unbiased assessment of pest population. The information given has to be accurate since the field scout is the link between the consultants and the growers. The scouting report forms must be comprehensively filled with enough information so that control decisions can be made directly from the report form.

Scouting frequency

The frequency with which visits must be made depends on the type of crop grown and pest present or expected. Field visits must be scheduled such that increases in pest populations are detected as soon as possible. For example, field corn should be monitored at weekly intervals until pollination is completed, at which time scouting frequency can be can be relaxed to at least once every ten days. All this time there is little danger of pest levels exceeding the economic threshold. The field scout should however be flexible schedules to allow revisiting field problems.

Scouting patterns

An M shaped walking pattern is best used on square or rectangular shaped fields. In irregular shaped fields the field scout must keep in mind that they must cover a representative area of the field. Do not sample the edge of a field unless it is specifically recommended.

Equipment for pest scouting

- Scout report forms and cupboard pencils
- Magnifying glass or hand lens for accurate pest identification
- Bags, plastic vials and labels for collecting plant and insect specimen
- Measuring tape
- Reference materials incase problems are encountered in the field
- Spade for digging entire plant for pest identification cooler with ice to keep unknown weed, insect and disease samples fresh until accurate identification can be obtained

Advantages of field scouting

- Helps in making immediate decisions based on the pest and diseases threshold
- Helps in tracking trends of pest within a season
- It is vital in making decisions based on the comparison of results between seasons
- Prepares the farmer for these threats in the future
- Scouting is environmentally and economically viable
- It allows the farmer to predict future threats and problems saving him/her time and money
- Scouting gives the farmer an overview of where exactly to use the pesticides.

Scouting information

Having background information on your crop does not serve as a requirement for scouting but it serves as a great tool for recognizing damage and linking the damage to possible causes

Information can be frequently obtained from personal experience or it can also be obtained from;

- Weather data
- Farm management records
- Other farm managers
- Sail maps

1.2 Disease control area/plot is identified according to farm plan

A farm plan is a document assessing the site-specific aspects of a property and outlining best management practices identified as necessary to avoid potential negative environmental impacts

It contains an assessment of the site and gives clear action/steps developed to meet the farmer's goals while protecting water quality and natural resources

Some of the resources considered are;

- Acreage
- Soil types
- Proximity to stream or water bodies
- Types of livestock or crops
- Farmers goals
- Available resources

A disease control area is defined as the area established to prevent the spread of a disease from an infected area to areas free of the disease

A farm plan also is a process for deciding in the present what to do in the future about the best combination of crops and livestock to be raised through rational use of resources.

Disease control area dictate which specific area must be established as a result of the status of infection and the subsequent surveillance actions that must be performed

A disease control zone defines:

- The physical location and boundaries of the control area, surveillance zone and free area
- The permissible activities in each area that will facilitate accomplishing of immediate goals of any surveillance activities being conducted
- The length of time that each area should be maintained

In the surveillance plan the disease control areas defined are the: control areas, free area and surveillance zone. The control area is further divided into an infected zone and a buffer zone. The area zone for highly contagious disease (HCD) can be used for other diseases as starting point. For non HCDs, the area sizes vary to each situation and depend upon input from collaborating parties.

Table 15:Surveillance plan

Area classification	Premises classification
Infected zone	Infected premises Contact premises Suspect premises At risk premises Monitored premises
Buffer zone	Contact premises Suspect premises Monitored premises At risk premises
Surveillance zone	Suspect premises Free premises
Free area	Free premises
Containment vaccination zone	Suspect premises Vaccinated premises
Protection vaccination zone	Suspect premises Vaccinated premises

Conclusion

This learning outcome covered types of crop pest and diseases, surveillance, mapping and documentation process of crop pest and diseases.

Further Reading

1. www.ophis.usda.gas

7.3.2.3 Self-Assessment

Written assessment

1. The following are equipment for pest scouting except?
   a) Scout report form
   b) Magnifying glass
   c) Measuring tape
   d) Thermometer
2. A disease control zone defines all of the following except?
   a) The physical location and boundary of the control area
   b) The yield
   c) The permissible activity in each area
   d) The length of time that each area should be maintained

3. Documentation is the process of keeping records on an official data for future need.
    a) True
    b) False
4. The following are premises classification except?
    a) Suspect
    b) Monitored
    c) Scouting
    d) Contact
5. Which of the following is a resource used in disease control area?
    a) Scouting
    b) Surveillance
    c) Suspect
    d) None of the above

Short answer questions

1. What is surveillance?
2. What do you understand by the term pest scouting?

Oral Assessment

1. Name resources to be considered in a farm plan

Practical Assessment

Visit a farm and identify the different pests

7.3.2.4 Tools, Equipment, Supplies and Materials

- Mapping tools
- Scouting manual
- Pictograms
- Diseases and pest identification chart

7.3.2.5 References

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Khan.M. & Damalas. C.A.(2015) Factors preventing the adoption of alternatives to chemical paest control. Among Pakistan cotton farmers international journal of pest management 61(1).9-16

7.3.3 Learning Outcome No 2: Identify method of pest and disease

7.3.3.1 Learning Activities

Learning Outcome No 2: Identify method of pest and disease control	
Learning Activities	**Special Instructions**
2.1 Identify pest and diseases to be controlled as per crop scouting manual. 2.2 Map affected areas/plots in accordance with type of pest/disease 2.3 Determine pest/disease control method based on type of pest/disease required. 2.4 Identify, verify and calibrate material supplies tools and equipment as per method.	Written assessment Oral tests Group Discussion

4.3.3.2 Information Sheet No7/LO2: Identify method of pest and disease

Introduction

The learning outcome covers pest and disease control method are areas affected and material supplies tools, equipment and type of pest diseases.

Definition of key terms

Chemical pest/disease control: Refers to the regulation or management of a species defined as pest usually because it is perceived to be detrimental to person's health the ecology and economy.

Cultural pest/disease control: It is the practice of modifying the growing environment to reduce the prevalence of unwanted pests.

Integrated Pest Management (IPM): It is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques.

Content/procedures/methods/illustrations

2.1 Pest and diseases to be controlled are identified as per crop scouting manual

Pests affecting plants

- Locusts
- Armyworm
- Fruit Flies
- Aphids
- Spider mites

- Squash Bugs
- Whiteflies
- Tomato hornworms
- Wire worms
- Cucumber Beetles
- Powdery mildew
- Thripid
- Codling Moth
- Gall mites

Plant diseases

- Bacterial crackers
- Black knot
- Blossom end rot
- Club root
- Cedar apple rust
- Apple Scab
- Anthracnose
- Brown rots

2.2 Affected areas/plots are mapped in accordance with type of pest/disease

Insect pests and fungal diseases can damage shoots, leaves and crowns, which can reduce tree growth and condition. If severe, the damage causes trees to die. Insects and fungi can also reduce woods quality resulting in lower yield and reduced timber prices.

Common pest and diseases

a) Stem borers

These are caterpillars (moth or beetle) that tunnel through and feed on wood, causing damage to branches, stems and trunks.

b) Leaf-chewing Insects

These are beetles and mites. They feed on tree foliage and can cause extensive damage especially to young plants. Symptoms are jagged or rippled leaf edges, reduced leaf area, in distortion and dieback in young leaves and defoliation.

c) Leaf miners and gallers

Leaf- miners feed inside the leaf between the top and bottom surfaces. Symptoms include dried, silvery or brown leaf tissues. This can cause leaves to shed early and a severe infection can cause defoliation.

d) Sap- sucking insects

These insect affects a plant by removing a large quantity of water and nutrients, causing wilted or shriveled growing tips. Symptoms include leaf discoloration, leaf withering or in severe infestations leaf loss. e.g. Insects like-lerps and psyllids.

2.3 Pest/disease control method is determined based on type of pest/disease identified.

1. Chemical control

Chemical pesticides are often used to control pests and diseases or weeds. Chemical control is based on substances that are toxic to the pest involved. When chemical pesticides are applied to protect plants from pest, diseases or overgrowth by weeds, we speak of plant protection products.

Advantages of chemical pesticides

- The use of chemical pesticides is widespread due to their relatively low costs.
- Chemical pesticides are very effective and easy to be applied on crops.
- Chemical pesticides are available in different areas.
- Chemical pesticides are stable.
- Chemical pesticides are generally fast acting which limits the damage done to crops.

Disadvantages of pesticides

- Chemical pesticides they are not only toxic to the organisms for which they are intended, but also to other organisms.
- Chemical pesticides are resistant. They are often effective for only a short period on a particular organism. Organism can become immune to a substance, so they no longer have an effect. They mutate and become resistant.
- Another disadvantage is accumulation. If sprayed, plant are eaten by an organism and that organism is then eaten by another, the chemical can be passed up to the food chain.
- Remains and residuals of pesticides are left behind on crops.

2. Cultural Pest/Disease control method

This method is aimed at reducing the sources of inoculum of plants to infection.

Advantages of cultural pest control

- Uses of indigenous varieties- Traditional varieties are hardier and relatively more resistant to pests. They can withstand harsh environmental condition better than modern hybrids.
- Pest control through the use of Mesh screen (Nylon sets). Younger plants are usually preferred by insect and they suffer significantly from such attacks when compared to older plants.
- Rogueing or pruning. Removal of diseased plants or plant parts prevents the spread of microorganisms to uninfected areas

- Intercropping with aromatic herbs.
- Encouraging insect predators.
- Crop rotation.
- Multiple cropping.

Disadvantages of cultural pest control

- Some are not environmentally benign e.g. conventional tillage.
- May alter crop value or gross income (harvesting, spacing).
- Some are labor energy intensive (pruning, tillage).
- Many conflicts (time, pest).
- Widespread adoption – may be spread.

3. **IPM- Integrated Pest Management**

It is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques.

How IPM works

- IPM focuses on long-term prevention of pest or their damage by managing the ecosystem.
- In IPM, monitoring and correct pest identification help you decide whether management is needed.
- IPM programs combine management approaches for greater effectiveness.

Major components of IPM programs

- Pest identification.
- Monitoring and assessing pest number and damage.
- Guidelines for when management action is needed.
- Preventing pest problems.
- Using a combination of biological, cultural, physical or mechanical and chemical management tools.
- After action is taken, assessing the effect of pest management.

ITK- Indigenous Technical Knowledge: It is a unique traditional local knowledge existing within and developed in a particular geographic area.

Advantages of IPM

- IPM increases crop yield and farmers income.
- IPM reduces the risk of farmers and the public.
- It helps farmers to become self-reliant.
- It helps to reduce the national expenditure for pesticide.
- IPM conserves ecosystem and ensures reliability and stability of farm output.

Disadvantages of IPM

- More involved planning
- It is a family decision- making
- More demanding lawn and garden care
- Time consuming

2.4 Material supplies, tools and equipment are identified, verified and calibrated as per method.

Material and tools used to control pests

- Pesticidal dusts
- Dilute sprays
- Concentrated spray
- Aerosols
- Aerial Equipment
- Apron
- Airborne end
- Spray-plane piloting
- Helicopter equipment

Elements of good equipment

- Should spray out the pesticides from the plane at a uniform rate.
- Should provide for adjustable rates of discharge so that crops get the right number of gallons of spray per acre.
- Should spread liquid in as wide a swath as possible beneath the plane.
- Should avoid putting down too heavy a deposit in the center or at the edges of the spray swath.

Conclusion

This learning outcome covered pest and diseases, the affected plots and areas by pest and diseases, pest and diseases control methods and material supplies tools and equipment used to control pest and diseases.

Further Reading

1. POTTs, S.F. Particles size of insecticides and its relation to application distribution and deposit journal. Econ.Ent.39(6).716-720,1946.

7.3.3.3 Self-Assessment

Written assessment

1. Which of the following is a type of pest?
   a) Locusts
   b) Armyworm
   c) Aphids
   d) All of the above

2. Which of the following is not a pest control method?
    a) ITK
    b) Physical control method
    c) Chemical control method
    d) None of the above
3. Which one of the following is a plant disease?
    a) All of below
    b) Apple scab
    c) Club root
    d) Black Knots
4. Identify from the following tools and materials used to control pests.
    a) Dilute Spray
    b) Aerosol
    c) Pesticides dusts
    d) Water bottles
5. Which one of the following is an equipment for pest control?
    a) Aerial equipment
    b) Spray-plane
    c) Helicopter
    d) All of the above.
6. Identify and explain 6methods of pest control.
7. Highlight different plant pests and diseases
8. What do you understand by the term ITK, chemical control method and pests?
9. Identify ways of knowing the pest affected areas?

Oral Assessment

1. What does ITK stand for?
2. What are the plant pests and diseases that affect trees?
3. What does IPM stands for?

Practical Assessment

Plant disease control through ITK

Prepare a solution from 2kg fresh leaves of papaya in 3-4l of water and keep in overnight. After filtration, this is diluted with 50-60l of water and 250ml soap solution is added to it, it is effective to control brown spot diseases in rice.

7.3.3.4 Tools, Equipment, Supplies and Materials

- Mapping tools
- Flip charts
- Felt pen
- White board

7.3.3.5 References

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7.3.4 Learning Outcome No 3: Manage farm pesticides

7.3.4.1 Learning Activities

Learning Outcome No 3: Manage farm pesticides	
Learning Activities	**Special Instructions**
0.0. Procure farm pesticides based on type of pest/disease identified, mapped out areas and farm procurement procedures 0.1. Transport pesticide in accordance with types of pesticides best practices 0.2. Store farm pesticides in accordance with OSH standards, manufacturer’s manual and work place policy. 0.3. Record farm pests as per SOPs.	Discussion groups of how to store properly

4.3.4.2 Information Sheet No7/LO3: Manage farm pesticides

Introduction

The learning outcome to be covered include; Safe use of pesticides involving handling of pesticides, packaging of pesticides, transportation of pesticides, storage of pesticides and also Occupation safety standards and First Aid skills

Definition of key terms

Pesticide: This chemical substance used to kill repel or control certain form of plant and animal life consider to be pests

Safety standards: They are advisory or compulsory kid down policies to ensuring product activities and processes

Packaging: This is the undoing and protection of product for distribution, storage, sale and use

Content/procedures/methods/illustrations

3.1 Farm pesticides are procured based on type of pest/disease identified, mapped out areas and farm procurement procedures

Provisional guidelines are set for the procurement of hazardous pesticides.

Pesticide formulations fall into; Class 1a or1b of the WHO recommended classification of pesticides by hazard. The guidelines to classification can be grouped under general requirement according to FAO, UN.

General requirements in procuring pesticides

- An undertaking that all pertinent obligation arising under the international code of conduct on distribution and that of pesticide will be most and establish dealing with product liability accepted
- Evidence that goods offered will be delivered safely and in a timely manner, adequate technical support will be provided
- A warranty that each product supplied will be of the same quality as that of offered in response to invitations to submit them
- An undertaking accepting the condition of payment for the same quality of products required
- Where technical support from supplies either is required or considered desirable to facilitate effective, safe handling and use of products and where relevant their disposal and technological support
- In need of registration/ approval scheme for pesticide information based on research conducted locally or under similar climate
- A summary of the data relevant to safety and efficiency of the product
- Information on acute oral and ld50 value of formulated product
- In other countries, registration certificate i.e. Kenya drug board
- Where equations with respect to other equivalent product

Process of Procurement

- Documentation to inviting tender for necessary supplies of the required pesticide that is the consideration and any information supplied to potential suppliers
- Bids to be carried out with conductions relevant on pesticide, bidder, quality of product, conditions for the packing, conditions for labelling
- Processing the tender documents according to the organizational requirements, and procedural requirements
- Arrangement for supply of pesticide by the winning suppler
- Sampling and analysis of the products received
- Going through control measures and requirement

Packing of pesticide

This involves the container size or sizes and the packing specifications conditions for packing

- Bidder must require to demonstrate that package will be in accordance with national requirements, altitude of the international code of conduct on the distribution and pesticide
- Bidder to demonstrate that packing for direct use is in suitable sizes and designs
- The packages should be in a type commonly in use for pesticides
- Inducing closers to be sufficient to produce leakage taking in to account handling during shipment and local transport conditions
- Taking into account possibility of prolonged storage under adverse weather conditions. Storage life is to maximized
- The need that they will satisfy laid down requirements by the relevant international concerned with transport illustration of packing

3.2 Pesticide is transported in accordance with types of pesticides best practices

This is done in accordance with best types of pesticide practices and the pesticide being transported to be sealed and secure.

Precautions taken when transporting pesticides

There are several precautions that should be adhered to when transporting pesticide involving:

- Pesticides should be transported in to back of a truck or pick up and the containers securely tied down. When loading pesticides in cases of leakage and all the containers you should never put pesticide containers in the passage side of the vehicle.
- Wear chemical resistant gloves. This is when loading pesticide in cases of leakage. All the containers should be inspected thoroughly before loading and do not accept containers missing labels. If there are signs of leakage do not accept the container and always be gentle with containers.
- While unloading pesticides do it carefully and never leave them unattended and check vehicle after unloading to make sure there was no leakage or containers damage during transport.
- If transporting hazardous pesticide, always comply with hazardous materials regulation.

Advantages of the good handling of pesticide on transport

- Reduces product loss that is the good handling ensures there is no spillage of loss of any pesticide products while on transport.
- Increase the profit margin. With good handling on transportation no losses will incurred or any damages.
- Prevents other product damages and losses and even prevents any occupational hazards that might arise.

3.3 Farm pesticides are stored in accordance with OSH standards, manufacturer's manual and work place policy.

Farm pesticide are stored in accordance with OSH standards manufacture's manual and place of work as discussed, storage as per OSH standards.

This rare the occupational safety and guidelines for the storage of pesticide according to the OSHs directorate of occupational health service. Whereby the OSH pesticide laws are well written out and drafted out as per constitution guidelines. The OSH division undertakes occupational health surveillance throughout the country

Requirements for storage of farm pesticide

- Limit quality and type of pesticide stored
- Storage of pesticide should not be in areas prone to flooding or in basements and should be accessible in the event of emergency
- Storage cabinets should be kept locked and the door to the storage area should be properly identified with a sign
- Mixing pesticides should be avoided in areas where a spill a leak or over flow could allow pesticides to get into water systems
- Absorbent materials to activate charcoal should be available to quickly contain and clean up any spills
- Washing of pesticide should be done separately
- Materials and safety data sheets for each pesticide should be posted on good accessible and visible location
- An emergency response plan should be developed to detail on action to take and personnel to contact in an event of an accident or spillage at the store
- Stores should have a smoke detection system that is, automatic
- PPEC (Person Protection Equipment) that is, respirator chemical resistant gloves, gumboots, coverall eye wares goggle and first aid kit.

3.4 Farm pests are recorded as per SOPs.
The pesticides in the store should have a proper system of stocking and the reward of stock of pesticides received held and issued

What involves farm pesticides recording?

- No more pesticide should be ordered than the number required that is not excess
- The pesticides received should be well labelled the trade name and manufacturer labeled. The store manager should note that down in the store records
- All movements of the chemical in to out of the store be recorded

Advantages of recording farm pesticides

- Reduction of problems of having excess unused pesticides. This is in cases whereby the storekeeper for instance had not been trained in or failed to use the existing systems.
- During a way of odd out of date expired pesticides. The pesticide has limited shelf-life so if the dates of manufacture and the expiry was entered in to the storekeeper's record then he/she can be able to dispose off any pesticide that have been out of date.
- Increases financial productivity. This is by reducing losses due to the stock that must have been ordered and there are plenty.
- Reduces Hazards. This is both environment hazards when exposed to the environment and also occupational hazards that might have arose due to usage of instant out of date pesticide
- Relevant in times of emerge genies. This is the times whereby in an event of such disasters the volume as pesticide used in farm can be assess and the necessary steps taken to evade any side problems

Types of records systems in farms

The recording systems adopted by farms depend on the side and function of the store. Usually records should be kept separate from the pesticide store

i. **Small stores**

In these there are practices that should allow:

- Date of purchase or Val should be written on each container before being stored
- All the containers received should be checked and ensured that they are proper labelled and that the labels remain attached to the container
- Also, the labels should be readable and clean and the labels in poor conditions should be replaced

- Small scale farmers should also keep invoice, delivery notes and receipts obtained in connection with pesticide purchases away from store
- The farmers should have the material with safety data sheets from the suppliers and manufacturers

Large stores

These are stores above the size of small-scale farmers and require a formal record system and the practices involved here are;

- The records to be kept separate from pesticide stock so that they are not destroyed in the event of a major disaster lifers
- Records may be kept as sheets in a ledger or card index form. Public records adjacent to the stock itself may also be required.
- Records should be accurate and sufficiently detailed to enable replacement. When the storekeeper goes another takes over without need refer to the old one.
- Allowing each consignment. A completely separate record because pesticide have a limited shelf-life so the stock batches brought at different times may vary in functional
- A possible sample position store records sheet should have the following:
    - Reference no
    - Identification of pesticide
    - Source of pesticide
    - Packing and issuing units
    - Date received
    - Notes
    - Stock operation and management
    - Disposal

First aid skills in farm pesticides

Always follow the instruction on safety use of pesticides but in case of spills or accident.

- Splash a lot of water to arouse the chemical
- In case of poisoning learn uncial, toxicology skill or seek immediate medical response

- If you can endure vomiting you also may use it as a first measure
- For flammable chemicals always store them away from fire and in case they catch fire try to identify if the chemical is reactive with water. If not then you can pour water

Conclusion

This learning outcome covered procurement, and transportation of pesticides in accordance with types of pesticides best practices. It has also covered storage and records of farm pest as per SOPs.

7.3.4.3 Self-assessment

Written assessment

1. A pesticide is a chemical compound used to kill certain form of plants or animal called pests
    a) True
    b) False
2. -------------------- advisory policies laid to ensure safety of products
    a) Pesticide
    b) Packing
    c) Safety standard
    d) Storage
3. Which one of the following is not involved in pesticide procurement?
    a) Warranty of the product
    b) Documentation of tender
    c) Carrying out bids
    d) Sampling and analyzing of product
4. The following are requirement of storage of farm pesticide except
    a) Limit quality and type of pesticide store
    b) Lock the storage cabinet
    c) Finessed final productivity
    d) Have material data sheet
5. Which of the following is a precaution in transportation of pesticide?
    a) Process tender
    b) Bidder to demonstrate packing
    c) Provide technical support
    d) Transport in the back of track

6. Records in the farm as per stranded operations procedure should be?

    a) Well stocked
    b) Not recorded
    c) Kept in the same tool
    d) Never updated
7. Store record should contain all the following except?

    a) Reference no

    b) Date received

    c) Stamp

    d) Disposal method

8. List 10 requirements of storage of pesticide

9. Give process of procurement

10. State the necessary precautions to be taken when transporting pesticides

11. Highlight other advantages of recording farm pesticides

12. Give advantage of good handling practices

Oral Assessment
1. List the precautions taken when transporting pesticide

2. What is the importance of stored pesticide?

Case Study Assessment
Visit the farms that carry out pest control activity and check their activities on management of pesticide starting with:

- Procuring the pesticides

- Transportation

- Storage and record of farm pesticides

7.3.4.4 Tools, Equipment, Supplies and Materials
- Chemicals
- Storage facilities
- Record book
- First Aid kit

7.3.4.5 References

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7.3.5 Learning Outcome No 4: Control crop/pest equipment

7.3.5.1 Learning Activities

Learning Outcome No 4: Control crop/pest disease	
Learning Activities	**Special Instructions**
4.1 Adhere to PPEs requirements as per OSH standards 4.2 Identify materials, tools and equipment to be used as per the chosen methods 4.3 Use material tools and equipment as per the instruction's manual. 4.4 Control pest /diseases as per pest/disease identified in a mapped area.	Preparation of required materials and tools to be used.

7.3.5.2 Information Sheet No7/LO4: Control crop/pest equipment

Introduction

The learning outcomes to be covered include; Types of spraying equipment, calibration of control equipment, spray chemical formulation, spraying techniques, use of ppe, occupational safety standards and first aid skills

The student/ trainee should be keen during practical demonstrations as they are the basis of this learning outcome.

Definition of key terms

Calibration: This means to determine, rectify, or mark/graduate an instrument to perform as per expectations of the user.

Equipment: This means anything kept or used for a specific purpose. This can be advanced device or a simple tool used to enable the implementation of a certain activity/role.

Chemical formulation: This is a combination/mixture of chemicals that do not chemically react to create a desirable final product/chemical.

Content/procedures/methods/illustrations

4.1 PPEs requirements are adhered to as per OSH standards

Personal protective equipment is the last line of defense against exposure chemicals/pesticides used in crop pest control. Most of the chemicals are of toxic nature and have adverse effect on human health thus should not be handled without any form of protection.

The PPE include:

Figure 36: Personal protective equipment

- Respirators

- Chemically impervious footwear (gumboots

 

- Hats and face shields

- Goggles

- Gloves

- Body wear/ Apron

PPE Requirements as per OSHA

Each of the PPE equipment should have a specific set of criteria that should be considered when choosing all the above PPE equipment. These are important factors to be adhered to prevent exposure to toxic material.

Gloves requirements

These should be outlined and should cover one's arms to the elbow length. They should be made of chemical resistant material to avoid corrosion. The glove materials of choice include:

- Polyethylene &Neoprene. Good protection from liquid and dry pesticides but is not recommended when using fumigants.
- Butyl. This is good for protection from both dry and liquid pesticides
- Nitrile. This is good for protection from both dry and liquid pesticides but moderately permeable.
- Latex. This material is only effective for dry chemical formulations as it is relatively permeable.

NB: Always check the quality of material of any glove because we use gloves with our fingers. Gloves used should be moderate thickness to increase the durability of the glove.

While the material of choice is in discussion, leather and cotton gloves should not be used. It is also important to check for holes in gloves before using them. Torn gloves should be disposed. Once done with the handling of pesticides, one should wash the gloves with detergents before removing them. After removal, one should wash their hands with detergent or soap and water.

Figure 37: Gloves

Body covering requirements

When considering work attire (body covering), long pants, and long-sleeved shirt can be used with mild chemicals. An overall/Apron is however recommended for use. These should offer protection from splash, spills of liquid solutions and also when handling dry formulations. A good apron should extend from the neck to the knees. These should be made of nitrite, butyl and neoprene for maximum protection. PVC and rubber made aprons can be used as intermediates when the former is not available.

Figure 38:Apron

Boots requirements/ Footwear requirements

It is required that one wears unlined chemical resistant boots that covers your ankles when handling or applying toxic pesticides. Boots with thick soles are recommended. Nitrite and butyl boots offer best protection. The PVC and rubber boots are also available.

NB: Leather boots should not be used. It is also important to wash boots after use.

Respirators

These protect one from inhaling toxic chemicals. They are extremely important in protecting one from fumigation fumes or inhalation of toxic chemicals applied to crops. These include the: Air purifiers and the air supplying respirators. Air purifying respirators protect one from inhaling toxic chemicals by purifying the air one is breathing. They are used in areas where the supply of oxygen is inadequate.

Air supplying respirators are used in situations where the other types of respirators will not provide enough protection. These have an air supply provided directly through a hose directly to the face mask.

Figure 39:Air supplying respirators

Requirements of respirators

- The respirator should fit properly on your face. It should be worn tightly enough to form a seal all around the face. The respirator should fit ones face properly thus avoid using oversize or undersize respirators.
- The respirator should not be over tightened to prevent suffocation.
- The respirator should not be broken or have holes within the filtration system to prevent inhalation of toxic substances.
- Air purifying respirators should always have adequate oxygen supply before use.
- It is important to clean the respirators after intense chemical exposure if they are to be re-used. This helps prevent the inhaling of the previously accumulated chemical fume.
- Store respirators away from chemical solutions to prevent contamination before use as it could lead to suffocation or exposure to toxins.

Face shields

This are used to prevent one's face from contact with toxic pest control chemicals. These could be attached to the respirators in some cases.

Figure 40:Face shields

Requirements for face shield

- Should be able to cover the face even in the presence of a half face respirator.
- Should be made of material that does not react with chemicals being used
- Should be made of material that is easy to manipulate in order to fit the face if glass has not been used.
- The face masks/shields should be transparent in the case where it covers the whole face to facilitate viewing.
- In the case where it leaves space for goggles fitting, it should cover most of the parts and fit perfectly with the goggles leaving no areas unprotected.
- A face shield especially the full-face shield should not be prone to fogging.

Goggles Requirements

Figure 41:Goggles

These are intended for eye protection. They should:

- Fit and form proper seal with the face.
- Protect the eye from any toxic substance
- Offer brow, temple and front eye protection
- Should have a band to hold it to the body
- Goggles should not be prone to fogging to facilitate viewing
- Should be transparent to avoid straining
- Should be made from material that is non-corrosive

4.2 Materials, tools and equipment to be used are identified as per the chosen methods

Methods of pest control

There are different methods of pest control. These are dependent on one's preference. Each of the pest control methods has specific tools and equipment necessary for crop pest/disease control. These include: Organic pest/disease control, chemical control, biological control, mechanical and electronic pest control.

- **Mechanical pest/disease control**

This involves use of physical and mechanical methods to control pests. Tools and equipment used include most of the gardening tools.

a. Machete

b. Gardening fork

c. Jembe

Figure 42: Mechanical pest/disease control

Also, one can use their hands to pick the insects. Fencing and barrier creation are also employed.

- **Organic pest/disease control**

This is the use of organic agents to control pests. Organic control agents can be sprayed using knapsack sprayer for liquid agents or applied physically for dry agents. In dry agents, a spade can be used.

- **Chemical pest/disease control**

These methods are used to control pests when organic/natural solutions are not effective against the disease in question. The tools to be used include: Chemical solutions, PPE Kits, first aid kits, mixing buckets and stirring rods. There are different types of sprayers.

- **Electronic pest control**

This entails the use of electronically powered device that are designed to repel pests. Most of these are used against rodents and insects. These use ultrasonic radio waves and they vary from ultrasonic pest repeller, electronic mouse bugs, mosquito/ insects rejector killer to electronic guns.

Figure 43:Electronic pest control

NB: Although tools have been discussed under chosen method of pest control, it is important to note that some tools/equipment e.g. Aprons cut across all the chosen methods.

There are different types of sprayers, they include: hand pump sprayers, tractor-based sprayers, automated sprayers and the commonly used is determined by the amount of chemical solution that is being used, the spraying technique, recommended pressure, nozzle delivery and the cost of the inputs. Most of these can be categorized into two broad categories either as hydraulic or low volume.

4.3 Material tools and equipment are used as per the instruction's manual.

1. **PPE Kit (Personal protective equipment)**

The personal protective kit comprises of the goggles, facemask, Apron, respirators and foot wear. It is advised that all should be used correctly as per the instruction's manual.

Procedure for using PPE kits

- Inspect all components of the PPE kit and make sure they are working correctly. That is in the case of respirators.
- Check for broken tools/equipment and those with holes and eliminate them.
- Try the apron or overall first and make sure that it fits, it has a zipper or button and that it covers you up to the neck.
- Wear the boots/gumboots made of bulfyl, nitrile, rubber or PVC as they are chemically non-reactive or offer the best protection.
- Tuck in the overall and make sure it makes a tight seal over the boots preventing chemical entry to the boots.
- Check the respirators especially in the case of filter respirator.

NB: Respirators with oxygen tanks are worn last just before the face mask or they come combined with the face mask.

- Wear the goggles and ensure that the band forms a good seal preventing eye exposure.
- Wear the face mask and cover areas not covered by the goggles.
- Wear the hat/head gear in the case it is not integrated to the face mask or apron.
- Wear the gloves last to prevent dexterity when wearing the other PPE components. These should be worn up to elbow height.
- In case of situations dealing with highly toxic chemical solutions, test that your gear is working correctly and does not have leakage points using water. (You can instruct someone to pour/spray water on you with your kit on).
- Clean all PPE kit components after use and store them in a clean dry place once they are dry.

NB: Do not use leather equipment as PPE kits as they get eroded quickly.

2. **Spraying equipment**

These form the largest composition of tools that facilitate pest control. They come in different designs, shapes and sizes. The spraying equipment could be hydraulic or low volume and the choice of the item to be used will be determined by:

- The amount of chemical being used
- Nozzle delivery type
- Size of the fields
- Cost of inputs
- Availability of equipment
- Recommended pressure

Procedure when using spraying equipment

i) Inspect all the spraying equipment for correct functionality.
ii) Check to confirm that all sprayers to be used were cleaned after use and in the case, they were not, clean them before use and rinse those that were previously cleaned.
iii) Check if the nozzles are of desired type and then calibrate them for desired delivery style.
iv) Calibrate all the sprayers considering the recommendations from the instruction manuals.
v) For hydraulic based sprayers, ensure the hydraulic system is working correctly and not interfering with desired collaborations.
vi) Use sprayers that are not leaking to avoid chemical loss.
vii) Ensure that the calibrations on the sprayer containers are accurate to prevent over spraying or under spraying.
viii) Determine the spraying technique to be used before closing spraying equipment and consider which sprayer can best achieve the desired outcome.
ix) Uniform spraying is recommended to increase efficiency and accuracy.
x) Clean the spraying gear after use and store in a clean dry environment.

3. **Chemical formulations and mixing equipment**

Chemicals to be used in pest control vary from time to time in respect to the intended use. There are many chemical formulations but handling of these chemicals is done in a systematic manner to ensure maximum efficiency and reduce probability of an accident occurring.

Procedure when handling chemical formulations and chemical mixing equipment

i) Always wear protective clothing when handling chemical formulations.
ii) Read instructions manual before mixing the chemical formulations for spraying.
iii) Ensure that the mixing bucket/jars and stirring rods are clean before using them.
iv) Measure the correct chemical amount to be used in the case of hand pumps and knapsack sprayer, calibrate correctly and put right amount of chemical in hydraulic sprayers.
v) Ensure that the chemicals being used are recommended and correct in respect to pest/disease detected and human health.
vi) Use mixing equipment that does not corrode with the chemical being used.
vii) Before fully committing on the chemical to use, check for expiry dates and do not use expired chemicals as they could have side effects to the consumers.
viii) Dispose empty chemical containers in a pit and keep chemicals safe in a locked place away from young children.
ix) Do not mix chemicals you are not sure that they should be mixed as it could be dangerous.
x) Chemical formulations should not be exposed to the sun or fire.
xi) Wash the PPE equipment after handling chemical formulations.

NB: should be washed after washing the chemical mixing equipment

4. **Electronic equipment**

These could include electronic pest control equipment, electric pumps or other forms of tools/equipment that require electricity to run.

Procedure when using electronic equipment

Ensure electricity is off when inspecting the equipment for correct functionality or non-conducting gloves (thick).

Calibrate the equipment to desired level before powering the equipment on.

Check for wholeness and avoid using faulty equipment.

Do not use electric equipment around water or rainfall. It is recommended to use electricity around dry areas.

One should use insulated garments to prevent one from possible electric shock that could be lethal.

Read instruction manuals before operating any electronic device/equipment or tool.

Use the correct tool for the correct purpose for maximum benefit.

Always power off your device after use to save electricity and avoid accidents.

Never handle an electric device bare handed especially if it is not insulated and the power is on.

5. **First aid equipment**

These should always be available for basic first aid after injury or accidents. These tend to save lives. They contain pills, bandages and other drugs that help reverse effects of injury/accidents.

Procedure when handling first aid equipment

i) Ensure one's hands are clean when handling a first aid kit.
ii) Open the first aid kit safely to prevent damage of drugs inside or other tools like a thermometer.
iii) Read the instructions manual and use the recommended drugs and dosages where no medical experience has been earned.
iv) Always put first aid kits where they can be openly seen.
v) Do not mix the contents that is, drugs in the first aid kit, remove labels or exchange them.
vi) Ensure to replenish the contents of the first aid kit after the existing ones have been used or have expired.
vii) Ensure that the symptom being treated has been described in the first aid instruction manual.
viii) Do not return contaminated material into the first aid kit as it could harbor disease causing organisms that could affect first aid kit users later.
ix) Clean first aid kit tools and dry them before returning them into the kit.
x) Store the kit away from children
xi) Make sure inventory of first aid kit after use before returning it.

4.4 Pest /diseases is controlled as per pest/disease identified in a mapped area

Different pests have different control methods which also is the case with disease as they are different and control methods can be different. This can be attempted through exclusion, physical removal, chemical control, repulsion and biological means. If identified in an area, below are control methods.

Rodents

There are several ways to control rodents. These include:

1. **Culture/physical and mechanical control**

These entails several aspects for both mechanical and cultural methods. These are:

- Trapping. Make use of rodent trap to capture rodents in the premises.
- Exclusion. This entails making sure that the rodents are not enticed to come to the premises by removal of potential food and water sources and elimination of rodent shelter and harborage.
- Physical termination of rodents where detected can be employed.
- Repulsion through creation of barriers that prevent rodent entry.

2. **Chemical control**

In this method, chemicals are used to poison rodent food or are sprayed in detected harbors/nests to kill them.

3. **Biological control**

The use of naturally sworn enemies to rodents (cats) in premises where rodents have been detected can be employed especially after harvest when food is in storage.

Human pest and animals

The best control method for this class of pests is the creation of a barrier or monitoring where barrier creation is not possible as chemical control would lead to death which is not desirable.

Control methods

- **Fencing**

This is the best form of control against animals and humans. Types of fences will vary depending on the pest. For humans, it is recommended to use mesh wires, electric fences or live thorn fences while in animals barbed and smooth wires can be used alongside live, mashed and electric fences. It is important to note that those group of pests are intelligent and need higher level control methods.

- **Monitoring**

Where fencing is not possible, one can monitor the premises/land from intruders as the humans cannot invade a monitored area. Animals will be scared away when monitoring is done.

Insects

These include flying insects such as aphids, those that live on plants and soil born insects. All of these include: army worms, corn ear worms, two spotted mite, vegetable bugs and thripeworms. Insects can be controlled by employing these methods if mapped in an area.

Physical/ mechanical control

This entails physically identifying and removing the pests by hand. Knowledge on the specific pest is required for the purpose of identification and whether it is harmful so that one should be prepared with gloves and other PPE kits when handling them.

- **Biological control**

This method entails use of biological means to eliminate insects. In this method, one could introduce plants that repel the identified insects together with his/her plants to help repel insects. One could also use other harmless insects that feed on harmful insects alongside making use of other animals. E.g. one could introduce flies to feed on aphids or chicken on established young maize fields to feed on soil insects. Spraying of natural substances e.g. dung on maize could be done to repel worms. Crop rotation could also be employed.

- **Chemical control**

Chemical control is formed around the use of chemical formulations to control pests. The application of chemicals is widely done by spraying liquid mixture all through. Dry and dust formulations are also used in lesser frequency.

The chemical to be used is dependent on the type of insect identified as each insect might have a specifically designed chemical formulation. Where many insects have been identified, broad spectrum insecticides are recommended for best results. Chemical use could turn out to be dangerous and thus it is recommended that one reads the instructions manual before using chemicals. Long terms chemical control is not recommended.

Disease control

There are many diseases in respect to the plants under cultivation. These include: blight, downy mildew, maize steak, carrot nematodes, anthracnose, and powdery mildew among others. These can be controlled using the methods discussed below:

Chemical control

This is the most common method under use worldwide. Although it has side effects, it is preferred because of its efficiency. When a certain disease e.g. downy mildew has been mapped in an area, the chemical formulations necessary for disease eliminations are identified and used as per recommendations. Chemicals are applied in respect to size of affected area as the measurement of chemicals is done per Ha. The dry and dust formulations are also applied in respect to the recommendations. Choice of spraying equipment can be determined by size of area of the disease and availability of inputs.
As chemicals are formulated to deal with specific disease, the correct formulation is used in respect to the disease in question.

- **Biological control**

This method of disease employs the use of natural biological agents to eliminate a disease or control it. The biological agents could be sprayed or planted that is other plants. In the case of the former, spraying with agents or other application methods e.g. smearing is done using components that guard the uninfected plants or cure the disease. Planting of plants e.g. trees around the farm crops also helps control some diseases e.g. blought.

- **Physical control/mechanical**

This method involves destruction of already infected plants in the case of contagious disease. This can be done by: uprooting, chopping of the plant, burning the plants or even crushing the plants before disposing their remains away from the uninfected plants. This method is labor intensive as one has to check all plants to identify those infected and those not infected. It also only focuses on control and not prevention.

Conclusion

This learning outcome covered materials, tools and equipment to be used as per the chosen methods. It has also covered types of spraying equipment, calibration of equipment and various spraying techniques. Therefore, the learner should be conversant with the above topics by now and should show competence in crop pest/disease control equipment.

Further Reading

1. www.ag.ndsu.edu/publication/crops/spray equipment and calibration
2. www.pesticide.montana.edu/reference/ppe

7.3.5.3 Self-Assessment

Written assessment

1. Which of the following footwear is recommended when handling chemical formulations?
    a) Sandals
    b) None
    c) Open shoes
    d) Boots
2. A chemical formulation is a mixture of chemicals that are chemically unstable but form a desired effect
    a) True
    b) False
3. Leather can be used as a material for creating a PPE kit
    a) True
    b) False
4. Electronic pest control equipment can use radio waves to control pests
    a) True
    b) False
5. Which of the following materials should not be used in the creation of PPE equipment?
    a) Nitrile
    b) Butyl
    c) Rubber
    d) Cotton
6. Which is the most used pest/disease control method?
    a) Biological
    b) Mechanical
    c) Chemical
    d) Cultural
7. Explain chemical disease control method.
8. Identify best materials in order of preference for creation of PPE equipment.
9. Identify FIVE equipment used in pest/disease control.
10. Outline requirements for gloves and respirators as part of PPE kit.

Oral Assessment

11. Explain how to control crop disease biologically
12. Outline material used in PPE kit creation
13. How do you calibrate a knapsack sprayer?

Case Study Assessment

Identify a farm/area with an identified disease/pest and employ crop pest/disease control using the correct PPE equipment and other tools necessary for disease/pest control.

1.3.5.4 Tools, Equipment, Supplies and Material

- PPEs
- Manuals
- Textbook
- Spray pumps
- Computers
- Projectors

7.3.5.5 References

Alteri, ,M.A and C.I. Nicholls.(2005).Biodiversity and pest management in agrosystems. New York. Haworth press

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Www.fao.org

7.3.6 Learning Outcome No 5: Dispose expired chemical and empty containers.

7.3.6.1 Learning Activities

Learning Outcome No 5: Dispose expired chemical and empty container	
Learning Activities	**Special Instructions**
5.1 Collect waste and recyclable materials and stored according to OSH standards and workplace policy 5.2 Dispose expired chemicals in accordance with workplace policy, manufacturer's instructions and OSH standards. 5.3 Clean tools and equipment and store as per manufacturers manual 5.4 Demonstrate first aids skills in accordance with safe use of pesticide manual.	Observe and participate in environmental conservation methods

7.3.6.2 Information Sheet No7/LO5: Dispose expired chemical and empty containers.

Introduction

The learning outcome to be covered includes; Types of chemical packaging material disposal methods, environmental management and regulations occupational safety standards and first aid skills.

Definition of key term

Disposal methods: This is the process/act of getting rid of something that is unwanted. It can be solid waste effluent or any other form of unwanted end product that is no more significant in its use

Environmental management: This is a well-organized program that combines/integrates all possible methods/procedures and processes that involve capacity building monitoring and initiatives that aim to promote ecological conservation and reducing disasters that negatively affect our surrounding

Safety standards: These are minimum/baseline measures designed to ensure safety of products, activities, and processes in relation to human usage interaction.

Content/procedures/methods/illustrations

5.1Waste and recyclable materials are collected and stored according to OSH standards and workplace policy

A waste is an unwanted substance or by product discarded as not useful therefore it needs a way of safe disposal

Recyclable materials are the ones that can be reused; they are used to do the same task or a different task.

Recyclable materials include glass cardboards metals plastic tires textile batteries and electronics

Agricultural recyclable materials include plastic bags for packaging

Sources of waste and recyclable materials

Waste and recyclable materials have a range of sources that can be classified into:

- **Organic sources:** e.g. manure and agricultural effluent
- **Heavy metal sources:** This include lead, mercury, aluminum
- **Industrial sources:** These are mainly by products waste resulting from processing that is taking place in industries
- **Agricultural input waste:** e.g. uses of fertilizer rich in nitrogen and phosphorous in excess which finally has a scotching effect on both plants and animals' skin
- **Manufacturing sources**: This include factories dealing in plastic textile woodwork glasswork and metal work.

Types of chemical packaging material

Packaging services for chemical industry include

- Soups packaging materials
- Sprays and general agro-chemicals packaging
- Lubricants and oil packaging
- Bottle cans and jars as packaging materials for various products

Occupational health and safety standards for employees and employers guiding use of chemicals

- **Obligation of employers**

i. Provide and maintain plants and systems and procedures of work that are safe and without risk to health
ii. Proper handling, storage, and transport of chemicals
iii. Provide information, instructions, training and supervision to ensure safety of workers
iv. Provide and maintain safe working environment for workers
v. Inform employees of risks from new technology and imminent danger.
vi. Carrying out regular risk assessment

Employees obligation

- Ensure their own safety and health and that of others who may be affected at work place
- At all times wear protective clothing/equipment for the purpose of preventing risk

- Comply with safety and health procedures requirements and instructions given by a person having power over you
- Report to supervisor any accident incident or any injury
- With regard to any duty or requirement imposed on their employer and cooperative with employer or other relevant person to enable that duty or requirement to be performed
- Administrative control –this controls involvement of management in ensuring management of work. It involves taking personal effort and responsibility to ensure safety in the work place

5.2 Expired chemicals are disposed in accordance with workplace policy, manufacturer's instructions and OSH standards.

Expired chemicals are substance whose date of usage has elapsed and therefore they need safe disposal to avoid affecting health factor.

Health care employees is vulnerable to chemicals especially at work place and therefore the following healthcare procedures are applied by pharmaceutical industries or other users in disposing expired chemicals

Procedure/method of disposing expired chemicals based on OSH

i. **Dilution and pour method**

Involves addition of water into corrosive chemicals such as bleaching agents and hydrogen peroxide to reduce corrosive effect to the body and then you pour to a designated place that is less frequently visited by people

ii. **Proper safety precaution while disposing**

A person should first adhere to personal protection guidelines while handling expired chemicals while ready to dispose them. This reduces risk of harm. This can be use of gloves masks overalls etc.

iii. **Storage solution of specialized collection**

Some chemicals need the advisory measures from certified firms that are best known in dealing with the chemicals and therefore they are able to handle even their disposal based on the chemical risk or regulatory measures about management of the waste

iv. **Recycling automotive fluids**

This is a form of disposing chemicals that can no longer be used by the first beneficiary but can be helpful to the next client

v. **Drain all canisters**

This can be done in control fume chambers to avoid spread to work place where air contamination can occur causing respiratory problems

vi. **Use of expired chemical movable pit**

This can be metallic box like container tightly sealed with a thick dropping of chemicals that are closing it until further transportation to the designated site that has been certified for disposal of the waste

vii. **Thorough cleaning of reusable containers**

Reusable containers having expired chemicals should be thoroughly cleaned with disinfectant and rinsed to wash the expired chemical away. Protective clothing must be worn

Note: Never reuse pesticide containers for any purpose

viii. **Proper labelling and observing dates**

This ensures note of expiry date to avoid using already expired drugs. Some transportation should be done while in transit into disposal site. They should not be carried in passenger vehicles

ix. **Keep chemicals away from grocery**. This avoids food poisoning for home and animals.

5.3 Tools and equipment are cleaned and stored as per manufacturers manual

General procedures for cleaning agricultural tools and equipment

- Physical removal of soils clods in farming tools such as jembes
- Apply foam forming alkaline detergent to the tool's equipment
- Rinse with water with high pressure, this helps to break remains of soil clods
- Buck on the sun to dry to minimize chances of rusting
- For reusable containers, thoroughly cleaning and use of sanitary detergent is used for maximum safety of the product you will store in the container.

Storage and maintenance of tools and equipment

- Grease metal parts
- Tightening weak handles
- Hanging tools in a tool rack and in a tool shade
- Store tools in their original casing
- Dry tools after use and before storage
- Do periodic sharpening

Waste collection method

i. Curbside collection method

This is provision of waste bins especially in sub urban and urban areas as a method of enhancing cleanliness of the environment to avoid negative impact on agricultural potential land and around homestead

ii. Drop off centres

This is a site where individuals can bring their waste as long as they adhere to the regulations. They comply with submission and sorting procedures to enhance proper management especially recycling or incarceration of solid waste.

iii. Buy back centres

These are depots where individual waste collectors, reclaimers and street waste collectors can sell their recyclable waste. These include metal artisan who buy metals for refurbishment

iv. Deposit/refund programmes

This is a program where goods that fail to be processed are returned to the original producer with the hope that he/she can handle best because disposal procedures are only known by the producer.

Waste disposal and management methods as per OSH

- **Opening burning:** This is setting fire on non-degradable waste to minimize them filling up the productive land for agriculture.
- **Sanitary land fills**

These are sites where waste is isolated from environment until it is safe. It is until its degraded biologically, chemically and physically.

- **Fascination**

This is collecting solid into a burning structured incinerator and setting it on fire especially waste that cannot undergo decomposition

- **Composting**

This method is useful for disposal of biological waste

- **Land filling**

This involves a low-lying open area of the city where garbage is collected and dumped

Waste management measures in work place based on occupational safety standards of health

Waste risks can be managed in is work places to avoid harming workers. The following methods can be applied in work places to avoid occupational hazards

- **Elimination of hazard services**

Based on the impact analysis of the waste to human health, elimination can be recommended if the waste has more harm than good

- **Substitution**

If the product that gives out the danger waste has a substitute, then the decision of replacing it can be made to avert more harm

- **Wearing protective**

Every person who works in places exposed to hazards must wear protective gear which mostly comprises of head veil, masks, and ear protective equipment overalls and gloves for personal safety

- **Engineering control**

This involves redesigning the product that results to the waste to come up with an improved and less hazardous results after processing. This can include thorough and refined processing to eliminate toxic or use of anti-toxic in processing the product as part of value addition.

5.4 First aids skills are demonstrated in accordance with safe use of pesticide manual

Pesticide manual safety standards

- Follow label directions carefully
- Avoid sparking and spilling of chemicals and leaks
- Do not eat and drink while using chemicals
- Do not smoke as some may be volatile

Application of first aid skills for safe use of pesticides

- Learn to always follow instructions
- In case of spillage or splashing, use a lot of water in rinsing the chemical

- For poisoning always try to apply clinical toxicology skills or seek immediate response from suitable personnel. You can induce vomiting as a first aid measure
- For flammable chemicals always to store away from fire and in case they catch fire try to identify if the chemical is not reactive with water. If not, you can put off fire using water.

Conclusion

This learning outcome covered collection of recyclable materials, disposal of expired chemicals and cleaning of tools and equipment.

Further Reading

1. Clark, E.E.K, Lery, L.S; Spurgeon, A, and Calvet, I.A (1997).The problem associated with pesticides use by mitigation workers in Ghana occupational medicine, 47(5), 301-308
2. Padgitt, S, Wintersteen, W, and Stones (1995). Agricultural Pesticide exposure. Safety precaution and pesticides attributed illnesses among farmers. Agricultural Health and Safety, 2(12(, 189-94
3. www.youtube.com//pesticide/insecticide/sprayingsafetyprecautionandequipment

7.3.6.3 Self-Assessment

Written assessment

1. The following are sources of waste and recyclable materials except
   a) Heavy metal sources
   b) Organic sources
   c) Industrial sources
   d) Lake nature sources
2. Agricultural pesticide packaging is not part of solid waste
   a) True
   b) False
3. Both employees and employers should adhere to occupational safety standards
   a) True
   b) False
4. Pesticides safety manual is important as a first precautionary procedure in promoting safety in use of pesticides
   a) True
   b) False

5. Gardening tools should not be cleaned and dried after use because of rusting
    a) True
    b) False
6. The following are waste collection methods except?
    a) Curbside collection
    b) Drop of centres method
    c) Bury back centres
    d) Incineration
7. It is advisable to recycle pesticides container
    a) True
    b) False
8. What is the source of waste and recyclable materials?
9. Give three first aid skills applications in pesticides application occupational safety standards
10. State three occupational standards for employees to adhere in work place
11. Give two maintenance of tools for agriculture
12. Name four equipment used for agriculture farming

Oral Assessment

1. What is the importance of guide manual provided in pesticide safety standards?
2. Why is environmental management important?

Case Study Assessment

Trainees to visit a farm and check out the activities carried out and participate in the collection of waste and recyclable materials and how they are stored then participate in disposing the expired chemicals and even cleaning tools and equipment and finally train in first aid skills

7.3.6.4 Tools, Equipment, Supplies and Materials

- PPEs
- Spray pumps
- Chemicals
- Water
- Insect traps

7.3.6.5 References

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7.3.7 Learning Outcome No 6: Prepare crop protection report

7.3.7.1 Learning Activities

Learning Outcome No 6: Prepare crop protection report	
Learning Activities	**Special Instructions**
6.1 Prepare crop pest/disease situation report as per SOPs 6.2 Share crop pest/disease as per SOPs 6.3 Prepare crop protection schedules/activities prepared and doc6.1Prepare crop pest/disease situation report as per SOPs 6.2 Share crop pest/disease as per SOPs 6.3 Prepare crop protection schedules/activities prepared and documented in the journal documented in the journal.	Use practical questions to assess understanding Apply case study technique to improve on trainee understanding.

7.3.7.2 Information Sheet No7/LO6: Prepare crop protection report

Introduction

The learning outcome to be covered includes data collection, data analysis and report writing. Data is collected for the purpose of analysing a situation. The aim of crop protection report is to provide farm with knowledge or crop protection programs in order to improve crop production. Therefore, these trainees should be equipped with this kind of knowledge.

Definition of key terms

Data collection: It is the process of gathering and measuring information on variable of interest in an established systematic fashion that enables one to answer stated problem or evaluate outcome.

Data analysis: It is the process of systematically applying statistical and/or logical techniques to describe and illustrate, condense and recap, and evaluate data. It is an essential component of ensuring data integrity is accurate and appropriate.

Content/procedures/methods/illustrations

6.1 Crop pest/disease situation report is prepared as per SOPs

A report is a structured piece of writing designed to present findings or recommendations to a specific audience. A good report has a clear structure and is written in sections with subheadings. The report structure reflects what was intended to be done or the objectives.

Procedure for preparing a report

i. **Assess the situation:** Determine what information must be covered and from whom is order. To know the dysfunction or other Agricultural Extensions. Make a list of target contact and set a target to contact and report.
ii. **Collect the data:** visit the targeted group of individuals while collecting appropriate data use appropriate date collection tools that fit the situation in question. record your data appropriately.
iii. **Data analysis and report writing**: Analyze the collected data using appropriate data analysis tool. This may include statistical data analysis tool. Write the report; followed with paragraphs arranged in a coherent manner, detailing each decision event and detail. Provide the report to all relevant staff members.
iv. **Follow-up** on the initial situation report with regular progress report if needed.

Data Collection

Data collection is the process of gathering and ensuring information on variable of interest in an established systematic fashion that enables one to analyze a situation in question.

Importance of ensuring account and appropriate data collection

Accurate data collection is essential to maintain the integrity of research.

Both selection of appropriate data collection instruments and clearly delineated instruction for correct use reduce the likelihood of error occurring.

Consequences from improperly collected data

i) Inability to answer the problem accurately
ii) inability to repeat and validate analysis
iii) Distorted finding resulting in waste of resources
iv) Compromising decisions for public policy
v) Causing harm to human participants and animal subject.

Data collection methods

a) Observation

Observation is the process in which one or more people observe what is occurring on some real-life situations. A researcher can visit the farm and observe the situation of crop pest and disease protection.

b) Interview

Interview as a technique of data collection is very popular and extensively used in every field of social research. It involves oral questionnaire involve face to face conversation with the farm and collecting the required data. Interviewing is a relatively more flexible tool of any written inquiry from explanation, adjustment and variation according to the situations.

c) Questionnaire
It is the fastest and simple technique of gathering data group of individuals scattered in a wide and extensive field.

In this method, a questionnaire form is sent usually to the person concerned with request to answer the questions and return the questionnaire.

According to Goode and Hatt, it is a devise for securing answers to questions by using a form which the respondents fill in him/herself. Language barrier is the main challenge of collecting data is this manner.

d) Case Study method
According to Biesanz and Biasenz, case study is a form of qualitative analysis involving a very careful and complete observation of a situation e.g. crop protection.

Data analysis

Data analysis is a systematic process of statistics and logical techniques to describe and illustrate condense and recap, evaluate data. According to Shamoo and Resnik (2003) various analytic procedures provide a way of drawing inductive inferences from data and distinguishing the signal from the noise present in the data.

Types of data analysis

1. Texts analysis (Date mining)
It is a method to discover a pattern in large data set using database or data mining tool. It is used to transform data into analytical information.

2. Statistical analysis
This shows what happens by using past data. It includes analysis, interpretation, presentation and modelling of data. These are two more categories.

a) **Descriptive analysis:** Complete data or a sample of summarized numerical data. It shows mean and deviation to continuous data.

b) **Inferential Analysis:** Analysis sample form complete data. Provides different conclusion from the same data by selecting different samples.

Data Analysis process

i. Data collection
Data is collected using appropriate method. Correct record should be made including collection of date and source of data.

ii. Data cleaning
Data that is irrelevant should be cleaned out. The data which is collected may contain duplicate records, white spaces or errors.

iii. Data analysis
Data analysis tools and software are used to understand, interpret and derive conclusion based on the requirements.

iv. Data interpretation

Data interpretation may appear in simple words, tables or charts. The best course of action is determined.

6.2 Crop pest/disease report is shared as per SOPs

Once a report is ready, sharing is very essential. The report should be shared to specific groups of individuals where the report is relevant to them. The group may include Government extension offices and farmers. The report should be compiled in appropriate method of communication.

Methods of sharing extension crop pest/disease report

i. Individual method

Face to face methods are probably the most universally used. The extension agent meets the farmer at home or on the farm and discusses issues of mutual interest giving farmers both information and advice on crop pest or disease protection. The method is important in developing farmer's individual trust.

Methods of individual's method of sharing report include:

Farm visit: It is the most commonly used and it is important to be clear about the purpose of such visits. Take a lot of time from both officers and farmers

Office calls: The extension officers call individual farmers to provide the report and appropriate advice

Letter: A letter is sent to farm from extension officer giving a detailed report and farmer being advised accordingly.

ii) Group methods of sharing report

Extension officers consider use of groups to pass the message from his/her report.

Advantages

- It is a less expensive as compared to individual methods.
- Individual methods involve too much emphasis which can lead to undue concentration on progressive farmer to the detriment of the poorer farmer

Types of group extension methods

a) Group meetings

An extension officer organizes a meeting with the farmer and provides the report and advice to the group of individuals.

b) Demonstration

Farmers like to see how new ideas work and also which effects they can have on increasing crop production. Using demonstration will be the best way to share the report to farmers.

6.3 Crop protection schedules/activities are prepared and documented in the journal

Plant pests and disease can wipe out farmers hard work and cause significant losses to yield and income, posing a major threat to food security. Pest and disease can easily spread to several countries and reach epidemic proportion, outbreak and upsurge can cause huge losses to crops and pastures, threatening and livelihood of farmers and the food and nutrition security of million at a time.

Crop proportion is therefore necessary in accordance to high crop production. Integrated management should focus on the following points

i) Use resistant repetition varieties, crop sequence, associations and cultural practices that minimize the pressure and maximize biological prevention of pest and disease.
ii) Apply pest and disease forecasting techniques where available.
iii) Maintain accurate record of agro-chemical use.
iv) Assure that agrochemical is only applied by trained personnel
v) Maintain regular and quantitative assessment of the balance status between pest and disease.

Crop protection schedule/ activities

a. Crop rotation: Intergroup

Each king of plant attracts its own particular pest and diseases which soon become established around the crop. Crop rotation helps to eradicate pest and disease that are specific to plants.

b. Use of adequate cultivation technique

Burning plant residues and ploughing the soil is traditionally considered necessary to phytosanitary reason: to control pest, disease and weeds. In system with reduced mechanical tillage used on mulch cover and biological tillage, alternatives have to be developed to control pest and weeds.

c. Disease control or management

Management means a complete set of activities that support each other. These activities are carefully planned and are implemented over several seasons not controlled within a single season.

d. Weed Control

Weed reduce yield by competing with the product for sunlight, moisture and soil nutrients. Weeds can also host pest and disease introducing this harmful organism to plant.

Conclusion

This learning outcome covered preparation and sharing of crop protection report. It also involves preparation of crop protection schedules and activities.

Further Reading

1. Strange, R. N, Scott, P. R (2005). Plant disease: A threat to global food security, Enact, Rev phytopatted. 43 (2005): 83-116.

7.3.7.3 Self-Assessment

Written assessment

1. .... Is the process of systematically applying statistical techniques to evaluate data?
    a) Collection
    b) Protection
    c) Data analysis
    d) Data collection
2. Assessing the situation is involved in preparing a report. True or False?
    a) True
    b) False
3. The following are procedures in preparing a report except?
    a) Collection of data
    b) Analysis and report writing
    c) Presentation of a thesis
    d) Assessment of situation
4. Which is a consequence of improperly collection of data?
    a) Distorted findings
    b) Good decisions
    c) No harm journals
    d) Solving the problem
5. Data collection method involves the following except?
    a) Observation
    b) Interview
    c) Case study
6. Types of data analysis is statistical analysis and population analysis. True or False
    a) True
    b) False
7. Which is not a method of sharing extension reports
    a) Individual methods
    b) Group methods
    c) Group meeting
    d) Shows

8. Highlight the procedure in preparing a report
9. Give the relevance of appropriate and accurate data collection
10. List the types of data analysis
11. State the methods as sharing extension crops pest disease
12. How is a group sharing schedule prepared?

Oral Assessment

1. What are the advantages of appropriate data collection?
2. What methods are used for sharing extension of crop pest or disease?

Case Study Assessment

Trainees to visit a farm and assess the crops protection measure, collect data and analyze, and give report on their findings about the measures.

7.3.7.4 Tools, Equipment, Supplies and Materials

- Note book and manuals
- Computers
- Textbooks

7.3.7.5 References

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CHAPTER 8: PRODUCE HORTICULTURAL CROPS/ PRODUCE HORTICULTURAL CROPS

8.1 Introduction

This unit specifies competencies required to produce horticultural crops. It involves: determining horticultural crops to produce, procuring horticultural crop planting material, managing horticultural crop nursery, managing horticultural green houses, managing drip irrigation system, managing horticultural field and managing horticulture post-harvest. Currrenty, the horticulture industry is growing fastest in the agricultural sector. Therefore, this unit is very important to a learner in that the knowledge and skills acquired from this will be used to produce more of the horticultural crops in the country whether it is during the on season or off season due to innovations in technologies thereby increasing on productivity thus increasing on foreign exchange from the export of the produce.

The critical aspects of competency to be covered include; understanding of different horticultural crops.,understanding of different horticultural planting materials, ability to establish a horticultural crop nursery and ability to manage horticultural crop nursery according to crop water requirement, type of crop quality among others. The basic resouces required for this particular unit include; land, propagation materials, pangas, fork jembe, rakes, shovelwatering can, water hose pipe, drip lines,water tank, nursery trays, pumps chemicals, PPEs, green house kit, harvesting crates, harvesting knifes, harvesting pails and baskets, packaging materials, shade nets, soil containers/ poly tubes, soil sterilizers, soil sampling tools, media among others.

The unit of competency covers seven learning outcomes. Each of the learning outcome presents; learning activities that covers performance criteria statements, thus creating trainee’s an opportunity to demonstrate knowledge and skills in the occupational standards and content in curriculum. Information sheet provides; definition of key terms, content and illustration to guide in training. The competency may be assessed through written test, demonstrations, practical assignments, interviews/oral questioning and case studies. Self assessment is provided at the end of each learning outcome. Holistic assessment with other units relevant to the industry sector work place and job role is recommended.

8.2 Performance Standard

Understanding of different horticultural crops, understanding of different horticultural planting materials, ability to establish a horticultural crop nursery and ability to manage horticultural crop nursery according to crop water requirement, type of crop quality among others.

8.3 Learning Outcomes

8.3.1 List of learning outcomes

a) Determine horticultural crops to produce
b) Select/procure horticultural crop planting material
c) Manage horticultural crop nursery
d) Manage horticulture green houses
e) Manage drip irrigation system
f) Manage horticultural field
g) Horticulture post-harvest management

8.3.2 Learning Outcome No 1: Determine horticultural crops to produce

8.3.2.1 Learning Activities

Learning Outcome No 1: Determine horticultural crops to produce	
Learning Activities	**Special Instructions**
1.1 Undertake Soil sampling as per required crop.	Field Excursion
1.2 Select Horticultural crops in accordance with the farm plan, land, agro ecological zone EAZ.	Group discussion

8.3.2.2 Information Sheet No8/LO1: Determine horticultural crops to produce

Introduction

This Learning Outcome Covers different types of horticultural crops, principles of horticultural, production and good agriculture practices.

Definition of key terms

Horticulture: This is the growing of fruits, flowers, vegetables and other medicinal trees mainly for food, medicinal and ornamental purposes.

Bolting: Early flowering due to low temperatures

Content/procedures/methods/illustrations

1.1. Soil sampling is undertaken as per required crop.

Soil sampling is the analysis of soil to determine its nutrient content, composition and other physical and chemical characteristics such as texture and acidity level of the soil.

Importance of soil sampling

It is important to carry out soil sampling of a particular piece of land before carrying out any crop production because of the following reasons:

- To be able to know nutrient level of the soil so that one is able to know which nutrients lack in the soil.
- To know which type of crop to be grown in a particular soil.

Soil sampling timing

The ideal time to assess soil nutrient status is just before a crop is grown and needs to determine soil nutrient. The following guidelines are used to select an appropriate time to sample the soil. For annual crops grown from late October when the soil temperature has dropped to upto7degrees Celsius and below, collect samples early enough before the short rains season.

For the perennial crops collect samples about one week prior to seeding and fertilization. The tools used for sampling of soil include truck mounted hydraulic coring equipment for samples deeper than 30cm and soil auger, for soil samples less than 30cm deep. The recommended sampling frequency should be annually but this may not be practical depending on the framers need

Methods of sampling

Some of the sampling methods that can be used include:

- Random composite sampling
- Directed random composite sampling
- Benchmark sampling
- Grid sampling

Random composite sampling

This involves taking samples in a random pattern across a field while avoiding some areas such as swampy areas, compost pit remains, under a shade area, the fence among others. This is done by collecting cores from 15-20 sites and separate each core by depth to obtain representative samples for each depth.

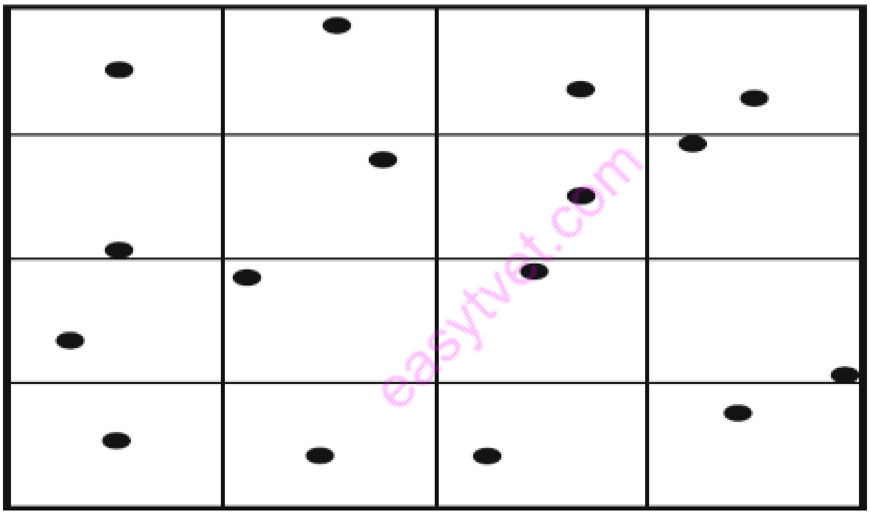

Figure 44:Random composite sampling

https://www.researchgate.net/figure/Example-of-a-simple-random-sample-stratified-using-a-regular-grid-The-strata-all-have_fig2_260427223

Directed random sampling

This is a modified random sampling method. It is mostly used in areas where it is difficult to identify a single dominant area that would represent a whole field.

Procedure of carrying out directed random sample

i. Subdivide the field into management zones based on the unique characteristics. The characteristics might be in terms of yield differences per year.
ii. Take 15-20 cores randomly from each main agent zone. Take as much as possible samples from the field depending on the number of management zone.
iii. Take as much as possible samples from the field depending on the number of management zones. This method is more appropriate for areas with more than one soil type and fields under strip crop management.

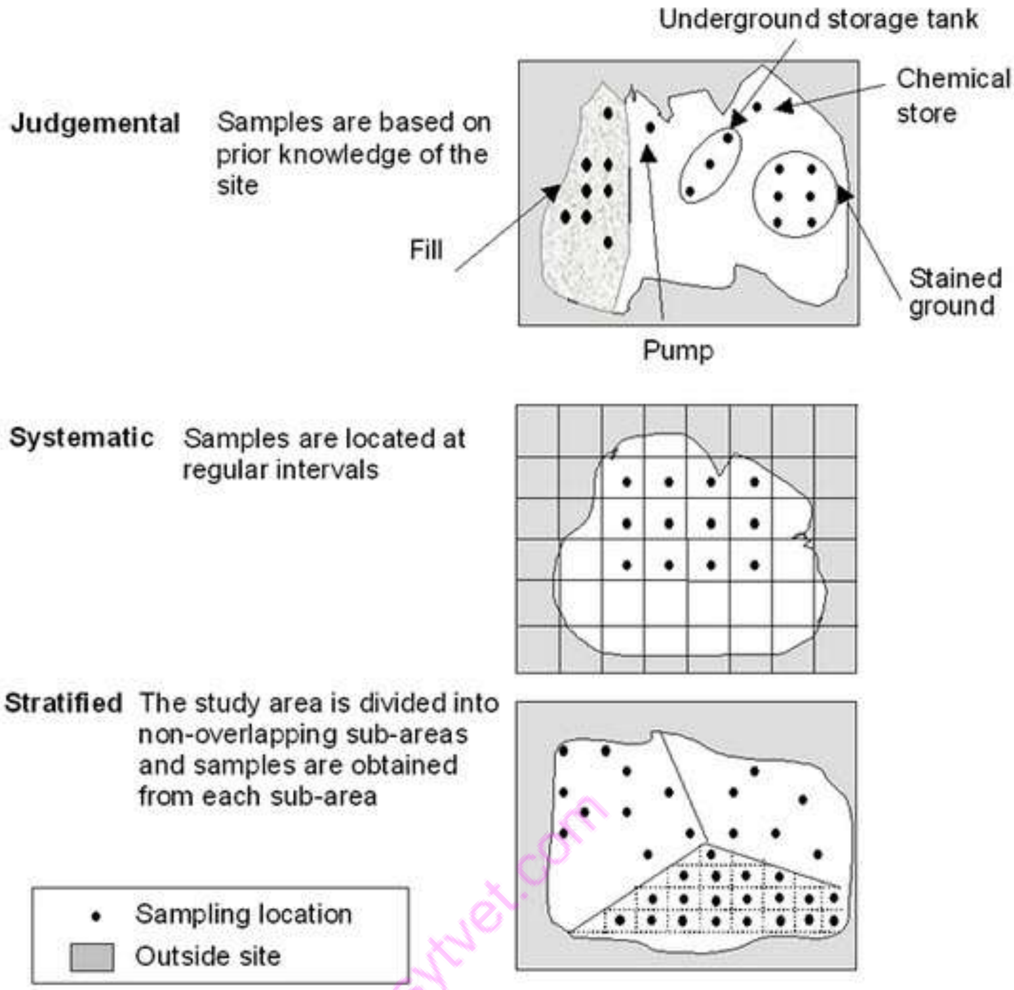

Figure 45: Directed random sampling

https://www.mfe.govt.nz/publications/hazards/contaminated-land-mgmt-guidelines-no5/3-preparing-fieldwork-and-soil-sampling

Benchmark sampling method

This involves selection of a small representative site of a field which is used as a guide for fertilizing the entire field.

Procedure

i. Select sampling sites in a grid pattern within the benchmark area.
ii. Prepare a composite sample for each depth.
  Note, Sampling from same small area each year reduces on the sampling variability and reflects better on the changes in the nutrient levels of the soil.
iii. Mark sampling sites with GPS or any other appropriate means.

Selection of a benchmark sites

- Look at the features such as soil color and landscape to identify where different types of soil occur.
- Select a site that has characteristics similar to most of the field or the dominant type of soil.

- Observe crop development patterns to assist in identifying different soil conditions.
- Differences in crop establishment and vigour are important at the beginning of the growing seasons making a representative location easier to identify.
- The benchmark sites can also be selected based on yield, photos and topographical map.

Grid sampling

This is the most intense soil sampling method which uses systematic method to reveal fertility patterns and assumes there is a topographical reason for fertility patterns to vary within a field.

Procedure

i. Divide the field into small blocks

ii. A sample location within each block is sampled 3-10 times.

N/B: The smaller the sampling unit the greater the accuracy

The benefit of grid sampling is that a field map can be prepared for each nutrient which can facilitate variable rate of fertilizer application.

Table 16: Grid sampling

	r	r	r	r	r
	r	r	r	r	r
r	r	r	r	r	r
r	r	r	r	r	r

r= probe sites

1.2 Horticultural crops are selected in accordance with the farm plan, Land, agro ecological zone EAZ.

Horticultural crops section is guided by general principles of production. The general principles of production to be covered include:

- Climatic adaptations
- Soil aspects
- Biotic factors
- Abiotic factors

Climatic adaptations

These include aspects such as temperatures, rainfall, wind, light.

Temperature

Temperature is very important in growth and development of all plants. It affects many physiological processes such as flowering, pollen viability, fruit set, hormonal balance, rate of maturation among others. Soil temperatures are also important since they determine the rate of microbial growth and development, organic matter decay, seed germination, root development, water and nutrient absorption.

Effects of low temperature

- Retard growth and may lead to death at the plant
- Reduce enzymatic activities and metabolic processes such as photosynthesis.
- May cause early flowering in some vegetables such as Brassica and carrots (bolting).

Effects of high temperature

- Promote vegetative growth in some vegetables thus hiding fruit formation.
- May cause burning of fruits resulting in yield and quality reduction.

Light

Source of energy for plants that is it is important in the process of photosynthesis. It is therefore important to ensure that horticultural crops get the optimum light intensity for optimum growth.

Effects of light

- Affects photosynthesis
- Increases heat head and this way cause heat injury and kill the plant.
- Affects shoot multiplication in tissue culture.

Rainfall

Important aspects of rainfall to be considered include: Amount, distribution and onset. Water requirements of horticultural crops should be known because different crops require different quantities of water at different physiological stages.

Factors to consider in water management

- **Weather:** Monitor the weather and apply when the weather is cool.

Soil type and structure: After drainage that is sandy soil requires frequent watering compared to loamy and clay soils.

Plant roots: Deep rooted crops require less water compared to shallow rooted

Irrigation method: Drip irrigation saves water compared to overhead and furrow.

Physiological stage of crop: For most crops flowering and heading period are most critical because translation and translocation of assimilates will be affected by inadequate moisture.

Cultural practices applied: Mulching prevents water loss through evaporation. Thus, reducing on the frequency of irrigation.

- **Soil aspects**

Most horticultural crops are heavy feeders. Therefore, in order to obtain maximum yields, a grower must have some knowledge on soil nutrient content. The soil for growing horticultural crops should be fertile and well drained. One should avoid rocky areas. Clay soils are not good for horticultural crops in that they get sticky when wet and crack when dry which is not suitable for root and bulb vegetables and fruits which are deep rooted.

- **Soil nutrients**

For optimum growth, there is need for sufficient supply of essential growth nutrients which are divided into macro-nutrients and micro-nutrients. N.P.K. (Nitrogen, Potassium and phosphorous) are most limiting soil elements especially in the tropics although micronutrient deficiencies have been observed in some vegetables and fruits

- **Biotic and abiotic factors**

These are the living and the non-living factors that affect production of horticultural crops.

Biotic factors: The biotic factor include, pests, diseases among others including beneficial organisms such as earthworms, rodents.

Abiotic factor: The abiotic factors include, availability of capital, market, transport, extension services and government policy.

Conclusion

This learning outcome covered soil sampling and selection of horticultural crops in detail. That is from, meaning, methods of sampling with different procedures and the importance of carrying out soil sampling. Apart from the guiding principles of selecting horticultural crops in accordance with the farm plans, land and agro ecological zone is also tackled.

Further Reading

1. Soil sampling and methods of analysis. Article in journal of environmental quality 38(1). January 2009.
2. Journal of horticulture and plant research volume5
3. Guidelines for soil description, fourth editing FAO, Rome 2006

8.3.2.3 Self-Assessment

Written assessment

1. Horticulture the study that includes the following, which one is not?
    a) Fruits
    b) Bees
    c) Vegetables
    d) Flowers
2. Which one of the following is a long day plant?
    a) Sweet potato
    b) Potato
    c) Tomato
    d) All of the above

3. The following are examples of macro-nutrients important in horticultural production, which one is not?
    a) Nitrogen
    b) Zinc
    c) Phosphorous
    d) Potassium
4. The following are methods of soil sampling, which one is not?
    a) Random sampling
    b) Benchmark sampling
    c) Directed random sampling
    d) None of the above
5. Which one of the following is not a factor considered in water management?
    a) Root of a pant
    b) Physiological stage of a crop
    c) Cultural practices applied
    d) Furrow irrigation
6. List down three methods of soil sampling?
7. What do you understand by the term bolting?
8. Name three main branches of horticulture?
9. List down three conditions favoring horticultural production?
10. What do you understand by the following terms?
    i. Soil sampling
    ii. Pomoculture
11. Why is soil testing important to a farmer?
12. What do you understand by the procedure carried out n benchmark soil sampling method?

Practical Assessment

1. Practical investigation to examine soil types and component materials.
2. Carry out soil sampling in your school farm using random soil sampling method followed by soil testing in the laboratory.

8.3.2.4 Tools, Equipment, Supplies and Materials

- Land
- Propagation materials
- Pangas
- Fork jembe
- Rakes
- ShovelWatering can Water Horse pipe Drip lines
- Water tank
- Nursery trays
- Pumps
- PPE
- Green house kit
- Harvesting crates
- Harvesting knifes
- Harvesting pails andbaskets
- Packaging materials
- Shade nets
- Soil containers/ poly tubes
- Soil sterilizers
- Soil sampling tools,Media

8.3.2.5 References

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Norra, S., Fjer, N., Li, F., Chu, X., Xie, X., & Stüben, D. (2008). The influence of different land uses on mineralogical and chemical composition and horizonation of urban soil profiles in Qingdao, China. *Journal of Soils and Sediments*, *8*(1), 4-16.

Schoeneberger, P. J. (2002). *Field book for describing and sampling soils: Version 2.0* (No. 631.47). National Soil Survey Center, Natural Resources Conservation Service,.

8.3.3 Learning Outcome No 2: Procure Horticultural crop planting materials

8.3.3.1 Learning Activities

Learning Outcome No 2: Procure Horticultural crop planting materials	
Learning Activities	**Special Instructions**
1.1. Identify Sources of horticultural crop planting material in accordance with SOPs 2.2 Select Horticultural crop planting materials as per type of crop, quality.	Field Excursion in demonstrating T-budding and grafting

8.3.3.2 Information Sheet No8/LO2: Procure Horticultural crop planting materials

Introduction

This learning outcome covers, types of propagation materials, propagation method and nursery establishment and management.

Definition of key terms

Propagation: The breeding of specimen of a plant or animal by natural process from the parent stock.

Plant propagation: Producing new plants from a parent plant.

Content/procedures/methods/illustrations

2.1 Sources of horticultural crop planting material are identified in Accordance with SOPs.

The sources of horticultural planting materials include:

- Seeds
- Cuttings
- Other vegetative plant parts

These planting materials are divided into two

- Sexual propagation planting materials
- Asexual propagation planting materials

Sexual propagation

This refers to the multiplication of plant by seeds. In a sexual process which it involves the fusion of male and female gametes to produce seeds. It is known as sexual (seed) propagation since the propagation is through seed and also because sexes are involved.

Advantages of seed propagation (sexual)

- Seedlings trees generally live longer, bear more heavily and are harder than vegetative propagated trees.
- Seed propagation sometimes results in the production of chance seedlings with superior characteristics
- Seeds offer convenient method of storing plants for a longtime
- Plants which are difficult to propagate e.g. pawpaw by vegetative method can only be propagated by seeds.

Disadvantages of seed propagation

- Owing to genetic segregation in heterozygous plants, seedlings trees are not uniform in their growth.
- Seedling trees take more time to come to bearing compared to grafted plants
- Continuous seed propagation results to infertility in the progeny.
- Sexually propagated plants have long preparing period

Asexual propagation

Can also be referred to as vegetative propagation. This is the reproduction by means of vegetative parts of the plant such as roots, shoots and leaves other than seed. Sexes are not involved in this propagation. The vegetative organs of many plants have got the ability to regenerate to produce new individuals.

Advantages of a sexual reproduction

- Propagation by vegetative means is some time easier more rapid and economical than seeds.
- Budding and grafting may be used to make a certain fruit adoptable in unfavorable environmental conditions.
- Vegetative propagated materials are usually less vigorous compared to seed propagated.
- Vegetative propagated plants are more precious in bearing.
- Certain injuries can be repaired by means of bridge grafting

Disadvantages of sexual reproduction

- No new variety can be evolved by means of vegetative method of propagation.
- Its more expensive than seeds propagation in most cases.
- Vegetative propagated plants are comparatively less hardy.
- Transmit viral diseases from plant to plant

Plant propagation by separation and division

Many herbaceous species that die back at the end of the growing season have underground food storage organs that survive the dormancy periods. These organs are also vegetative propagation structures that produce new shoots in growing season. The variety of underground storage organs may be grouped into two classes based on how they are propagated: Plant propagated by separation and plants propagated by division.

Plants propagated by separation

Separation is a method of propagation in which underground structures of plants are divided not by cutting but by breaking along natural lines between segments. Separation is breaking away of daughter structures from the parent structure to be used to establish new plants. The two specialized underground structures are bulbs and corns.

Bulb: A bulb is a specialized underground organ that consist predominantly of fleshy leaf scales growing on basal plate.

Types of bulbs

There are two types of bulbs:

- **Tunicate bulb**
- **Non-tunicate bulb**

Tunicate bulb: These are bulbs that have outer bulb scale that are dry and membranous. This covering provide protection from drying and mechanical injury to the bulb. Mostly found in onion and tulip among others.

Non-tunicate bulbs: These are bulbs that do not possess the enduring dry covering. The scales are separated and attached to the basal plate.

Corms: These are bulbs consisting of predominantly modified leaves. A corm is a modified stem examples of plant with corms include: Amorplallus, colocasia, gladielus.

Plant propagation by division: This is a method of propagation of plants using cut section of a particular part like rhizome, tuber, and tuberous root.

Rhizome: This is a specialized stem structure in which the main axis of the plant grows horizontally just below or on the surface of the ground.

Stolon: Describes various types of horizontally growing stems that produce adventitious roots when they come into contact with the soil. Mostly found in mint, bermuda grass among others.

Runner: This is a specialized stem that develops from the axil of a leaf at the crown of plant. It grows horizontally along the ground and forms a new plant at one of the nodes.

Stem tuber: This is a specialized swollen underground stem which possess eyes in regular order over the surface. Propagation by tubers can be done either by planting the tubers whole or by cutting them into sections. Example of a crop propagated by stem tuber is a potato.

Plant propagation by cuttings

Classification of cuttings

Stem cuttings are usually classified into 3 groups according to the particular part of the plant used as cuttings. They include:

- Stem cuttings
- Root cuttings
- Leaf cuttings

Stem cuttings

Can be divided into 4types based on the degree of maturity and lignification of wood used in cuttings.

- Hardwood stem cuttings
- Semi-hardwood stem cuttings
- Soft wood stem cuttings
- Herbaceous stem cuttings

Propagation by layering

Layering is the developing of roots on a stem while it is still attached to the parent plant.

Advantages of layering

- Do not require much care and arrangement like cutting.
- The mother plant supplies nutrient and other metabolites as it remains attached while rooting.

  Disadvantages of layering
- It is a costly method
- It is a slow process
- Limited number of plants can be propagated

Classification of layering

Ground layering

- Tip layering
- Simple layering
- Trench layering
- Stool layering
- Compound layering

Tip layering: Is generally followed in plants which have trailing type f shoots.

Procedure for tip layering

i. Dig a hole 3-4 inches deep
ii. Insert the tip of a current seasons sheet and cover it with soil
iii. The tip grows downward first, then bends sharply and grows upward.
iv. The received tip becomes a new plant
v. Remove the tip layer and plant it in late fall or early springs.
   Examples of plants propagated by tip layering include purple and dark raspberries.

Air layering

Roots from an aerial shoot. The rooting medium is tied to the shoot getting root initiation.

Procedure for air layering Air layering

- Select a healthy branch of previous seasons growth
- At point 15-30 cm back from the tip of the shoot, make a girdle just below a node by completely removing a strip of bark 2cm wide all around the shoot.
- Scrape the exposed surface lightly to remove traces of a phloem or cambium to retard healing.
- In difficult to root species, treat the girdle portion with the recommended growth regulator to induce better rooting.
- Cover the girdle portion with moist propagating medium, sphagnum mass, saw dust.
- Tie the medium around the girdled portion using a polythene sheet.
- Tying should be perfect so that no water can enter treated part.
- Separate the root zone and transplant the layer appropriately after observing the fully developed roots through the transparent sheet.

Propagation by grafting and budding

- **Grafting**: This is an art of joining parts of two independent plants in such a manner that they unite and grow together in a single independent plant.
- **Scion:** the part of the graft combination which is to become the upper portion of the new plant.
- **Root stock:** The part which is to become a root system

Methods of grafting

- Approach grafting
- Veneer grafting
- Epicotyl grafting
- Soft wood grafting

Approach grafting

The distinguishing feature of this method of grafting is that two independent plants on their own roots are grafted together. This method provides a means of establishing a successful union between certain plants which are difficult to graft by any other method as the two plants will be on their own roots till the formation of a successful graft e.g. Guava, Mango etc.

Procedure of carrying out approach grafting

i) Select a healthy shoot having a girth 3.5cm girth on the selected mother plant which is to be used as a scion source
ii) Select a rootstock (raised in a pit) having approximately the same size as that of the selected shoot on the mother plant
iii) On the internode region, her the union is to occur, a slice of bark and wood 2.5 to 5cm long is cut from both the selected stock and scion shoots.
iv) The cut to be given on the stock and scion should be of the same size.
v) **NB**: The cuts should be perfectly smooth so that a close contact of the cambial layers of stock and scion is brought about when they are pressed together.
vi) Tie the two cut surfaces together tightly with a string or cloth.

Budding

This is method of grafting where only one bud with a piece of bark and with or without wood is used as the scion material. The plant that grows after union of the stock is called budding.

Methods of budding

- T-budding
- Inverted t-budding
- Patch budding
- Ring budding

Tissue culture

This is the multiplication of true type plant throughout the year in aseptic condition and in artificial growth medium from plant parts of axillary buds, meristem tips among others.

Advantages of tissue culture

- Helps in rapid multiplication of the type plants throughout the year
- A new plant can be regenerated from a miniature plant part.
- Plants raised from tissue culture are free from diseases.

Disadvantages

- The cost involved in setting the laboratory is very high and may not justify their use in horticultural plants ordinarily.
- Tissue culture techniques require skilled manpower.

Methods of tissues culture

- Meristem culture
- Cell culture
- Embryo culture
- Shoot apex culture
- Pollen grain culture

2.2 Horticultural crop planting materials are selected as per type of Crop, quality,

Different types of planting materials are discussed above in the content1.1 with their merits and demerits. Therefore, it is up to the farmers to select all suitable planting material innermost the type of crop and quality.

Factors considered when selecting planting material

- Cost of the planting material
- Labor requirement
- Viability
- Health of the planting material
- Longevity of the planting material

After all these factors have been considered by the farmers, he/she will be able to choose a desirable planting material suitable for the type of horticultural crop to be planted. After the materials have been selected another operation follows immediately that is planting.

Planting of the selected planting materials

There are two methods of planting:

- Direct planting
- Nursery planting

Direct planting: This is the type of planting is mostly applicable to the vegetative crops which are planted directly to the field. This is possible mostly to the big seeded crops

Nursery planting: This is the establishment of seedlings in a nursery before transferring them to the main seedbed.

Advantages of using nursery

- It is easier to apply management practices e.g. weeding, pest and disease control
- Only clean and healthy seedlings are picked from the nursery and transplanted to the nursery bed.
- It easier to break seed dormancy by picking seedlings that have only grown.

- Allows farmer to gap in order to have a uniform stand.
- The environment at the nursery bed is controlled

Disadvantages

- Its labor intensive
- Time consuming

Types of planting

There are different types of horticultural crops:

- Row planting
- Broadcasting

Row planting: Planting of materials in accordance to the depth rate of planting and spacing between rows and within

Broadcasting: Random scattering of seeds /planting materials in a seedbed

Factors affecting depth of planting

- Type of planting material
- Moisture availability
- Size of planting materials

Factors affecting the size of planting

- Leaf structure
- Type of plant to be grown
- Root structure of a plant
- Branching of stem general size of the plant

Factors affecting the time of planting

- Market
- Soil and weather conditions
- Prevalence of disease

Factors affecting planting time

- Maturity of the crop
- Proximity to the market
- Availability of the market

Conclusion

This learning outcome has covered; types of propagation materials, propagation and methods nursery establishment and management. From the above discussed content, it is evident that the type and quality of horticultural crops is influenced by different practices ranging from selection of planting materials to harvesting time. We can also note that farmer plays a larger role in ensuring all this practice are done correctly during the required period of time so as to have crops that are of good quality at the end.

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2. Beyl,caulaA.andRobert N. Trigianess eds,Plant propagation :concepts and laboratory exercises.Boca Raton,Florida CRCPress,2008.print

8.3.3.3 Self-Assessment

1. *Bryophyllum* I prepared by________
    a) Root cutting
    b) Stem cutting
    c) Leaf cutting
    d) Seeds
2. Asexually propagated plants_____________
    a) Are true to type
    b) Live longer
    c) Bears late fruit
    d) Have large canopy
3. Hardwood cuttings are generally used in__________
    a) One-year old branch
    b) Three-year old branch
    c) Two-year old branch
    d) For-year old branch
4. In ____________layering a partial tongue like cut is given on aa branch.
    a) Aerial layering
    b) Tip layering
    c) Trench layering
    d) Compound layering
5. Air layering is also known as __________
    a) Goo tree
    b) Simple layering
    c) Compound layering
    d) No of the above
6. N trench layering, the whole branch buried in the soil is up to ______cm deep .
    a) 1-2
    b) 3-4
    c) 5-10
    d) 12-15

7. Epicotyl grafting is also called _______grafting
    a) Stone
    b) Wedge
    c) Cleft
    d) Whip
8. Rooted plant on which scion is grafted is called___
9. Joining part of plants together so as to enable them function as one is known as ___
10. In ______grafting, two independent self-sustaining plats are grafted together
11. Older and infertile plants can b rejuvenated through__
12. What is budding?
13. Describe the procedure of t-budding?

Practical Assessment

1. Demonstrate T-budding

Materials required; secateurs, budding knife, root stock, scion budding tape.

Procedure

i. Select and prepare a root stock with the help of secateurs
ii. Make a t-shape cut with the help of budding knife
iii. Gently open the bark of the root stock with the help of bud opener
iv. Prepare the bud with budding knife
v. Insert a shield bud into the t-bud
vi. Wrap this portion with a polythene strip

2. Demonstrate simple layering

Materials required: sharp knife, stone pieces, panga, hooks, polythene bags, secateurs and matchstick

Procedure

i. Select one year old healthy and flexible long-unbreakable shoot near the ground level
ii. At a distance of 15-30cm back from tip, make a sharp slanting inward cut and insert a match stick
iii. Blend the shoot gently to the ground so that the cut part can be inserted into soil.
iv. Cover the rooting region with soil
v. Keep a stone on the part covered with soil in order to retain the layer in place
vi. Drive a vertical stake to the soil by the side of the layered branch.
vii. Tie the branch to the stake with gunny thread
viii. Water the layered portion regularly till rooting starts.

3. Prepare hardwood cutting

Materials required: bunch of bougainvillea, secateurs or sharp cutter, rooting hormone IBA nursery bed.

Procedure

i. Select a health bougainvillea plant.
ii. Select a matured branch of the last season growth of the plant and separate it from the plant.
iii. Remove the leaves over it without damaging the bud
iv. Leave one or two petioles at 5-10cm distance on the branch
v. Cut the branch into cuttings of 10-15cm length with at length 3-4 buds at each cutting
vi. Make a slanting sharp cut at the bottom just below the node and avoid crushing the stem
vii. Dip the basal part in a rooting hormone like IBA of requisite concentration
viii. Plant the stem cutting upright o slanting position in rows as well as within the rows
ix. Keep the newly planted cuttings in partial slide until new shoots sprout from the bud
x. Keep the cutting moist in all times by providing them with adequate air circulation and sunlight
xi. After sufficient rooting transfer the cuttings into a polyethene bag or pot

8.3.3.4 Tools, Equipment, Supplies and Materials

- Land
- Propagation materials
- Pangas
- Fork jembe
- Rakes
- Shovel
- Watering can
- Water Horse pipe
- Drip lines
- Water tank
- Nursery trays
- Pumps
- PPEs
- Green house kit
- Harvesting crates
- Harvesting knifes
- Harvesting pails and baskets
- Packaging materials
- Shade nets
- Soil containers/ poly tubes
- Soil sterilizers
- Soil sampling tools
- Media

8.3.3.5 References

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8.3.4 Learning Outcome No 3: Manage Horticultural crop nursery

8.3.4.1 Learning Activities

Learning Outcome No 3: Manage Horticultural crop nursery	
Learning Activities	**Special Instructions**
3.1. Select Nursery site as per quality of soil, availability of fresh water, landscape, accessibility and wind breaks 3.2 Propagate Horticultural crop in accordance with the kind of plant 3.3Determine Horticultural crop nursery layout per number of seedlings and production system 3.4 Prepare Growing media as per GAPs 3.5 Design Nursery plans as per conveniences in operations 3.6 Clean Horticultural plant nursery area in accordance with horticultural 3.7 Prepare Horticultural crop production schedule is prepared as per requirements	Discussion and brief lecture

4.3.4.2 Information Sheet No8/LO3: Manage Horticultural crop nursery

Introduction

This learning activity covers; nursery cultural practices, crop water requirements and good agricultural practices

Definition of key terms

Nursery bed: A small plot of land specially prepared for raising seedlings or planting materials before transplanting.

Pricking out: Removal of seedlings from a nursery bed to a seedling bed.

Nursery practices: Refers to all activities carried out in a nursery life to raise seedlings.

Seedling bed: A special type of nursery bed used for raising seedlings picked out from the nursery due to overcrowding before they are ready for transplanting.

Content/procedures/methods/illustrations

3.1 Nursery site is selected as per quality of soil, availability of fresh water, landscape, accessibility and wind breaks

Nursery

A small plot land specially prepared for raising seedlings or planting materials before transplanting.

Importance of a nursery bed in crop Production

- Facilitates the production of many seedlings in a small area
- It is easy to carry out management practices in the nursery than in the seed bed
- Excess seedlings from the nursery can be sold to earn income
- It reduces the period taken by the crop in the field
- It ensures transplanting of only healthy and vigorous growing seedlings.

Selection at a nursery site

The following factors are considered when selecting a nursery site;

- Nearness to the water source
- Type of soil; The soil should be well drained, deep and fertile, preferably loamy soil.
- Topography; The topography should be on a gentle slope to prevent flooding and erosion through surface runoff.
- Previous cropping; To avoid buildup of pests and diseases associated with a particular plant family, consider the preceding crops.
- Security; Select site that is protected from theft and destruction by animals
- Protection against wind (strong winds) and heat at the sun; Select a sheltered place to avoid excessive evapotranspiration and uprooting of seedlings.

3.2 Horticultural crop is propagated in accordance with the type of Plant

Propagation

Producing new plants from a planting material.

The types of planting materials are usually propagated (planted) by use of different method depending on the kind of crop to be planted.

There are two main methods of propagation, that is;

- Broadcasting
- Row planting

Broadcasting

This method involves scattering of the seeds all over the field in a random manner. Commonly adapted for light tiny seeds such as those for vegetable crops such as sukumawiki, spinach, cabbages and among others.

Advantages

- It is easier and quicker compared to row planting
- It is cheaper
- Gives a good ground cover

Disadvantages

- Uses more seeds than in row planting
- The seeds are spread unevenly leading to overcrowding of plants in some areas resulting to poor performance due to competition.
- Weeding cannot be mechanized

Row planting

The seeds or any other planting material are placed in holes, drills and furrows in rows. The distance between one row to the other and from one hole to the other is known.

Advantages

- Machines can be used easily between lines
- Easy to carry out cultural practices such as weeding
- Lower seed rates are used
- Easy to establish the correct plant popular

Disadvantages

- Requires some skills in measuring the distance between and within rows
- Does not provide an ample forage cover
- More expensive than broadcasting as it consumes a lot of time

3.3 Horticultural crop nursery layout is determined per number of seedlings and production system

Nursery layout

Refers to different designs used to establish a nursery. There is no standard blueprint for designing a nursery that exists Each nursery will have a unique design based on distinct needs, resources and requirements. Generally, a good nursery should consist of water tank, water pump, pump house, seed and fertilizer, storeroom, implement shade, germination bed areas, seedling raising area, propagation structures among others. A nursery is usually arranged in a series of beds with pathway between them.

The layout should be in a way that enables operations to flow logically through the nursery so as to save labor and time. Reads and paths in the nursery should be carefully planned. The nursery facilities should be kept clean. Every effort should be made to control weeds in and around the nursery as the weeds may host insects and pathogens. Inputs used in the nursery include;

- Containers e.g. polythene bags and pots
- Nursery media
- Propagules e.g. seeds, cuttings, rootstock
- Water and fertilizer
- Chemicals and tools

A layout is determined by the farmers preferences according to the number of crops to be grown, capital, labor, tools and equipment, water, planting materials among others. Therefore, if a farmer has got all the named above materials, he/she is able to choose on which nursery layout to put in his/her farm for growing seedlings before transplanting them to the main seed bed.

Examples of beds prepared as nursery include;

- Sunken bed
- Raised bed
- Level bed
- Germination bed
- **The Raised beds**

Prepared by dumping soil about 10-15cm above ground level. They are commonly established in areas with high rainfall to prevent water logging. These beds are good for crop species that do not require more water for germination.

- **Sunken beds**

Prepared by excavating the soil in bed area. These beds are usually 10-15cm deeper than the normal ground level. This bed is mainly used in areas with scarce water as it prevents overflow of water and conserves moisture.

- **Level beds**

The surface of this bed is perfectly flat with stones, woods or a line of bricks placed at the edges of bed to prevent crumbling in dry season.

- **Germination beds**

Transplant bed, storage bed, seedling bed and cutting bed are other types of beds used in nursery for seedling preparation.

3.4 Growing media is prepared as per GAPs

Growth media

This is any material that enables planting materials to grow to seedlings in a nursery.
The growth medium must be sufficiently firm to hold the seedling or propagules during rooting and supply food and water for the successful growth of young seedlings.
Soil is the very common and cheaper medium used in nurseries.
Sandy soil is used generally in mother bed and vegetative plant propagation media.

The other media used in nursery include;

- Peat soil
- Vermiculite
- Perlite
- Coco peat
- Leaf mold
- Sawdust
- Grain husk
- Sphagnum

Vermiculite

Is mostly used for cuttings.

Sphagnum

Used for air layering.

NOTE: The availability of minerals nutrients is affected by the pit at the growing medium.

3.5 Nursery plans are designed as per conveniences in operations

Plan

Activities to be carried out as scheduled in order to meet the set objectives.

Nursery plan

The activities that are carried out in a nursery for a successful establishment of quality seedlings and propagules.

The successful establishment of quality seedlings and propagules depends upon proper planning and timely execution of activities.

Even though seed storage facilities, propagation structures for external environment control are available during the nursery activities as per natural season will enhance the field planting success of the propagules.

Preparation of species level nursery activity calendar will facilitate the seedling production.

Points to be remembered when planning nursery activities

- Mature fruit has to be collected just prior to its falling and subsequent seed extracted without damages to the seeds.
- Planning of planting materials should be carried out early in the morning or late in the evening.
- Transplanting, watering, weeding and shifting operations in a nursery needs to be done at fixed intervals.
- Hardening of vegetative propagules and dispatch of grown up seedlings should be done on time (proper time).
- Engage only the skilled and trained labor in nursery activities to ensure the success.

- Water storage for lean available periods, mother plant maintenance, for seasonal collection of planting material is some important resource management activity.
- Timely availability of nursery inputs (soil, sand, FYM, biofertilizer, chemical etc.) and their collection in cheap cost period can reduce seedling production cost.
- Each plant species has its own season of establishment.

General scheduling of seedling production in a nursery

Seed collection

Fresh and matured seedlings are collected at its available season.

Propagule collection

This is done as per standard season and method of scion, bud collection specific to the species.

Seed planting and transplanting

This is done during the physiological active period that is rainy seasons.

Seedling dispatch

Starts with the onset of winds (monsoon).

Available periods

Severe drought period, heavy rains, labor shortage, pest and disease outbreak seasons.

3.6 Horticultural plant nursery area is cleaned in accordance with Horticultural Production manual

Nursery is made clean by carrying out various routine managements in the nursery and around the nursery. Some of the routine management practices carried out include;

- Shading
- Thinning
- Watering
- Weeding
- Mulching
- Staking
- Pest and disease control

- **Shading**

Newly established propagation materials must be protected from adverse weather conditions.

The shade can be provided by using shade nest or polythene sheets.

The shading poles should be strong enough to accommodate the sheets that could fall to the beds making it look untidy and hindering growth due to direct contact with the growth medium.

- **Thinning**

This is an important operation that maintains plant density in rows so as to ensure adequate light and air to the plants.

Weak and diseased or damaged plants are pulled out, allowing the growth of healthy and clean seedlings.

- **Watering**

Nursery beds must be watered carefully with the help of fine rose can. (watering can)
After the establishment of plants, watering must be one as per the requirement of individual plants in order to avoid flooding of the bed and areas around the bed which makes it difficult to continue doing the other operations.

- **Weeding**

This is the removal of unwanted plants from the nursery. This is beneficial for the growth and development of seedlings as it prevents competition with the main plants for sunlight, water and nutrients.
The nursery area must therefore be kept free from weeds.
Hand weeding and hoeing are the most common practices used to remove weeds

- **Staking**

This is the practice to support plants growing straight and saving them from bending or lodging. This saves the plants from being blown over due to wind and rain also because of the weight of the stems when in bloom.
Useful in potted plants, as well as grafted and budded plants.

- **De-shooting**

Refers to the removal of all side shoots charging from the base of a plant. The main purpose is to divert the energy of the plant towards the development of its shoots or buds. This is important because it also helps to make the area around the medium of growth clean because there are no leaves overlapping in the soil.
Apart from these, the paths and ways should also be kept clean by clearing the vegetable around for easier movements in between and within the nursery beds. This is done by slashing.

3.7 Horticultural crop production schedule is prepared as per requirements

Horticultural production schedule is prepared as per different plant species requirements and also farmers choice and needs.
Horticultural production schedules start from selection of propagation materials to planting.
What factors are to be considered by a farmer before engaging in horticultural production?
The following are the factors to be considered;

- Cost of production
- Viability of the planting materials
- Availability of labor
- Extension services
- Market
- Good infrastructure
- Government policy
- Availability of materials (resources)

After having all these factors considered, the farmer now comes up with a plan that has to meet the set objectives at the end of the production system.
The plan consists of the following;

- The type of crops to be planted in different seasons
- The type of planting materials available
- The methods to be used for propagation
- The type of resources required for production
- The time required for the crops to grow and mature to meet the market demand
- Skilled labor required in the production process i.e. when carrying out management practices.

NOTE: The schedule is prepared as per the requirements of the crops to be planted in different seasons. So, it is upon the farmer to know what he/she requires before planting a particular horticultural crop for ease of production.

Conclusion

This learning outcome covered; Nursery cultural practices, crop water requirements, good agricultural practices in horticultural production that boosts on its productivity by reducing the chances of crop pests and diseases and also having healthy seedling growing.

Further Reading

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2. Kumar, V. 2011. Nursery and plantation practices in forestry. Scientific publisher. India, January 2007, page 420.

8.3.4.3 Self-Assessment

Written assessment

1. Removal of plants from pots for planting is called
    a) Re-potting
    b) De-potting
    c) Potting
    d) None of the above
2. Application of fertilizers through irrigation water is known as
    a) Surface application
    b) Top dressing
    c) Fertigation
    d) Sub-surface irrigation

3. The common growing medium in plug trays is
   a) Cocopeat
   b) Vermiculite
   c) Sand
   d) Soil
4. Sphagnum is commercially used in rooting medium in
   a) air layering
   b) grafting
   c) budding
   d) cutting
5. The nursery must be free from
   a) Water logging
   b) Fertilizer
   c) Organic matter
   d) Irrigation water
6. The type of nursery bed prepared during the rainy season is
   a) Sunken
   b) Raised
   c) Flat
   d) Furrow
7. Nursery is a practice where planting is raised. (True or False)
8. Are sunken beds are prepared in low from the ground level?
9. When should watering the plant be done?
10. Generally, is seed rate required if seeds are sown by broadcast method? Give reason.
11. What is Hardening?

Oral Assessment

1. What is the common insect-pests in a nursery?
2. What criteria will you follow while selecting a nursery site

Practical Assessment

1. Prepare a raised nursery bed

Material required;

Seed bed, spade, seeds, farmyard manure, watering can, mulching material.

Procedure

i. Select a plot of land which is sterilized
ii. Level the land and make it free from weeds, stumps, stones etc.
iii. The soil of the nursery bed is thoroughly mixed with 5-10kg per sqm of rotten FYM
iv. Prepare drainage channels to drain out excess water
v. Prepare seed bed about 15cm high from the ground level. The width is 1m-1.5m and length of your own desire.

vi. A space of 30-40cm is left between the beds in order to carry out cultural practices smoothly.
vii. Cover the seed bed with mulches and water them slightly using watering can after placing the seeds.

2. Identify different types of growing medium.

Material required;
Sand, compost, coco peat, vermiculite, sawdust, practical file etc.
Procedure

i. Collect different type of growing media available nearby
ii. Identify and label them
iii. Write the use of each type of growing media

8.3.4.4 Tools, Equipment, Supplies and Materials

- Land
- Propagation materials
- Pangas, Fork jembe
- Rakes
- Shovel
- Watering can
- Water Horse pipe
- Drip lines
- Water tank
- Nursery trays
- Pumps
- PPEs
- Green house kit
- Harvesting crates
- Harvesting knifes
- Harvesting pails and baskets
- Packaging materials
- Shade nets
- Soil containers/ poly tubes
- Soil sterilizers
- Soil sampling tools
- Media

8.3.4.5 References

Bhimraj, Bhujbal (Ed). 2012. Resource book on horticulture nursery management, TCMOU, NAIP, ICAR, P 264.

Ratha Krishnan, P. 2008. Nursery management and quality plant propagation in Training manual on "Advances in Agroforestry research and development". 24th November-5th December 2008, NRCAF, Jhansi, PP 85-91.

www. World agroforesty.org.

8.3.5Learning Outcome No 4: Manage Horticultural Green Houses

8.3.5.1 Learning Activities

Learning Outcome No 4: Manage Horticulture Green Houses	
Learning Activities	**Special Instructions**
4.1. Select Green house in accordance with crop variety and value, wind, security and GAP 4.2 Design Greenhouse structure as per farm plan 4.3 Determine Greenhouse working tools as per GAP 4.4 Carry out Greenhouse crop selection in accordance with GAPs 4.5 Undertake Greenhouse nursery propagation in accordance with GAPs 4.6 Undertake Greenhouse field preparation in accordance to GAP 4.7 Carry out Greenhouse irrigation as per Operations and Maintenance Manual 4.8Maintain Greenhouse crop water requirement per Crop Water Requirement Manual	Group discussion on how to select and design green houses Demonstration on the field Field excursion

8.3.5.2 Information Sheet No3/LO4: Manage Horticulture Green Houses

Introduction

This learning outcome covers; greenhouse installation, types of media and preparation, seedbed layout, crop establishment, pest and disease control, watering techniques and PPE.

Definition of key terms

Greenhouse installation: is a structure with walls and root made chiefly of transport material such as glass in which plants requiring regulated condition are grown.

Installation: Putting something into place

Seedbed: A prepared piece of land ready to receive planting materials for growth upto maturity.

Content/procedures/methods/illustrations

4.1 Green house site is selected in accordance with crop variety and Value, wind, security and GAP

i. Research of the size of your local market
   This helps you determine if the market can accommodate additional greenhouse business; it also helps you determine the level of composition.
ii. Determine the crops you prefer and the size of your operation
   Consider the crops that are in limited supply so that you can capitalize on the demand.
iii. Learn the legislation surrounding this farm of agriculture
   This will allow you to rest assured that no one will be any out.
iv. Design the greenhouse
   Pay close attention to solar green houses as they are cost effective.

Factors considered when selecting a site for greenhouse

When selecting a proper site for the greenhouse a number of location factors must be considered before making a final decision on the greenhouse site.

The factors are discussed below:

- **Availability and quality of water**
  Water is one of the most factors looked resource in the establishment of a greenhouse. A sufficient quality and high-quality water is important for the production of greenhouse crops. The need for frequent irrigation requires careful planning and management to ensure that operations have sufficient water to maintain adequate supplies for crop production.
- **Topography**
  The topography of the site affects where a growing structure is built. The surface at ground of the greenhouse should be level. Flat surface is efficient for placing the structure because it facilitates easy adjustments to various mechanical controls in the greenhouse which is economical. The site should also be well drained.
- **Wind breaks**
  This is important because wind breaks reduce infiltration of cold air and convection at heat away from the greenhouse. Wind breaks also reduce the speed at wind that can cause damages to the greenhouse.
- **Climate**
  Climatic conditions have dictated geographical shift in horticulture. The primary limiting factor to crop production in greenhouses is low light intensity during cold seasons.
- **Room expansion**
  A parcel of land larger than the graver's immediate needs should be acquired the ultimate size of the range should be predicted. Area should therefore be predicted figure to accommodate service building, storage, access drives, and additionally extra space should be allotted to cover unforeseen needs.

- **Availability of labor**
  Present and future labor needs should be assessed and should be in accord with labor supply in the area. The greenhouse owner must determine if labor is available to perform both routine and harvest time duties.
- **Infrastructure**
  Proximity to transport network e.g. roads railways access to communication systems and availability of energy must be considered. Greenhouses also need convenient access to materials for growing plants. Transportation requirements to the greenhouse site relate directly to the intended operations size and marketing arrangements.
- **Market accessibility**
  Locating new market is very important for retail growers who rely on customers getting to the greenhouse. The market potential should be explored before building.
- **Legal cogenerations**
  Site selection involves various legal consideration permits, licenses and zoning regulations govern where a greenhouse may be built and even offer dictate what type of building materials to be used. Selecting an appropriate site also involves how the greenhouse operates affects its neighbors
- **Greenhouse orientation**
  Growers optimizing for winter growing should orient their free-standing greenhouse in an east-west orientation meaning the longer glazed side of the green house to face south with the shorter ends facing east and west.

4.2 Green house structure is designed as per farm plan

Greenhouses are used to provide optimal environment for plant growth and development. The greenhouse design must deal with the local outdoor circumstances like; Temperature, humidity, solar radiation, clearance of the sky, precipitation speed of wind and direction of wind.

Components of greenhouse design

Some of the components of greenhouse design include;

- Location
- Orientation
- Site selection
- Structure
- Foundation
- Flooring
- Glazing
- Ventilation facilitates
- Technical equipment

The location and orientation of a greenhouse determine the amount of light that enters it. Determining the best location to put up the greenhouse is important decision.

A suitable greenhouse location will include a spot where the sun hits the greenhouse all day long and the shadows are cast on the greenhouse.

Classification of green houses

1. Free standing greenhouse
2. Gutter connected greenhouse

Free standing greenhouse

Can have different shapes of the roof ranging from gothic, gable and quivered roof shapes.

Gutter connected greenhouse

This is a series of bays with gable of queries arches connected together at the gutter level. Structural materials used for the greenhouse "skeleton" should be strong enough to prevent structural failure during adverse weather condition but kept to a minimum size and number to reduce the amount of shading and to provide for maximum light transmission.

Advantages and disadvantages of free-standing greenhouses.

Advantages

- Easier to programme and maintain the temperature to meet specific crop requirements
- It is easier to ventilate without exposing the plants to blasts of cold air
- Light is uniformly distributed over the entire growing area

Disadvantages

- Occupies more spaces
- More materials are needed to construct side walls
- Limited interior space

Advantages and disadvantages of gutter connected greenhouses

Advantages

i. Occupy less space and have no side walls.
ii. Less material is used in construction due to lack of side walls.
iii. More interior space is available due to lack of side walls compared to most free-standing greenhouses.
iv. Less energy is required to heat and cool the greenhouse because the exposed surface area is reduced.
v. It is a cheaper and therefore more feasible to automate the single consolidated space inside the greenhouse

Disadvantages

i. Difficult to program and maintain temperature to meet specific crop requirement.
ii. Light is not evenly distributed over the entire growing area.

4.3 Green house working tools are determined as per GAP

Tools: materials used to make work easier. Some of the tools commonly used by people with greenhouses include;

- Trowels
- Rakes
- Potting tools among others

These tools perform different functions.

Functions of different tools and equipment insertion the green house.

1. Hand trowel: Transferring dart into pots or planting seedlings and bulks.
2. Garden gloves: Protects the hand from being pricked by thorny plants causing injuries.
3. Hose = spray nozzles: For watering purposes.
4. Rake: leveling of beds, removal of trash from beds.
5. Pruning shears: cutting and trimming of plant parts. Can also be used in harvesting herbs fruits and vegetables.
6. Digging shovel: slight digging of beds.

N/B: Apart from the above mentioned some of the tools used in the greenhouse include;

- Hoes
- Weeder
- Edger
- Wheelbarrow
- Pruning saw
- Watering among others

4.4 Green house crop selection is done in accordance with GAPs

Choice of species and planting materials for greenhouse production should not rely on single farmer initiatives but should be the outcomes of a coordinated programme that for a given area takes into consideration agro environmental constraints technology development and social- economic opportunities. Before selecting crops to be grown in the greenhouse, some fundamental questions need to be answered e.g.

- What to produce
- When to produce
- How to produce
- Where to sell the product

There are two basic options available for farmers that is.

1. Choose a crop species for its high economic potential and develop the most suitable protective growing systems and technology
2. Choose a crop suitable for existing structure within the farm and capitalize on these.

Choice of the crop

Under mild winter climatic conditions greenhouses and protected cultivars concentrate on vegetable productions belonging to the substance family e.g. (tomatoes, pepper, eggplant) and Cucurbitaceae family e.g. melon, squash, cucumber. These crops suit cold greenhouses conditions and meet market requirements

Their success in protected cultivation is due to

- Wide consumption
- Good adaptation to unsteady climatic conditions
- Long cultivation cycles

Crop choice must consider species and genotypes capable of providing specific produce typologies taking account of market and economic conditions crop characteristics and requirements, compatibility between crop and micro climate and soil characteristics and soil borne diseases. All these are summarized below specifically;

- Market requirement
- Economic convenience
- Labour requirements
- Characteristics of protective means
- Possibility of active climate means
- Distance from markets
- Plant dimensions
- Crop requirements
- Soil characteristic and soil borne diseases
- Economic and social context

Choice of the planting material

Green house production is a very dynamic economic sector and must cope with rapid changes in market trends and customer preferences. Planting material choice is important for each crop and specific produce typology. Cultivars proceeding fruits with varying characteristic are not valid alternatives for green house production system which must respond to strict production and market requirements. Cultivates used for greenhouse production differs from these used in open field productions in that they are less exposed to environmental constraints and can express their yield potential better.

Factors considered when selecting a planting material in green house for both growers and traders.

- Potential yield
- Extended harvesting time with constant product
- Quality
- Resistant to biotic and a biotic stress
- Shelf life shield be long.

It is important to choose cultivars that in specific areas adapt to the environmental conditions and technical factors involved in the production process. While the above-mentioned traits are important in green house production it is fundamental to assess their responsiveness under different conditions in the specific growing areas. At global level more than 1000 species are consumed as vegetable. There are several sources of new crops introduced in green house production;

- Species introduced from other countries
- Wild species eaten as vegetables

- Species to date cultivated only in the open air among others

In summary: new crops should:

- Adopt to agro climatic and social/ condition
- Meet consumer requirements
- Be makeable and profitable

4.5 Green house nursery propagation is undertaken in accordance With GAPs

Nursery propagation: this is the planting of cultivars in nursery beds.

Proportion structure: Are structures required for propagating planting materials.

Types of propagating structures

A structure with temperature and ample light such as greenhouse, where seeds can be germinated, cutting are rooted or tissues culture acclimatized.

The unit which the younger tender plants can be moved for hardening off preparatory to transplanting outdoors.

Greenhouses

Greenhouses have been used long back by horticulturists' as a mean for rapid growth of plants and extending the growing seasons particularly in the colder areas. They are also used for whole sale production of floricultural plants, nursery stock of fruit crops and vegetable crops. Most greenhouses are used for propagation but the most suitable type is the one that admits the maximum amount of light. Green houses that run from east- west is the best for better light penetration and consequently preferred in raising seedlings. The greenhouse should be away from shade. Modern greenhouses are well equipped with elaborate structures and have precise control on temperature. Light intensity and humidity. The size of plant of greenhouse depends upon the need of plant propagation

Role of nurseries in horticulture development

- Production of genetically pure nursery stock.
- Expert of nursery stock
- Employment creation.

Types of plant propagation nurseries according to sale

- Retail nurseries: Soil to general public
- Wholesale nurseries: Sell only to business such as commercial gardeners.
- Private nurseries: Produces seedlings according to the needs at institutions or private companies.

According to type of plant grown

- **Fruit plant nurseries**

Fruit crops are mainly propagated vegetable and nee special techniques for propagating as well as maintenance. Fruit nurseries are essential for production of grafts as well as the mother plant aecia and rootstocks.

- **Vegetable nurseries**

All vegetable except from few like potatoes sweet potato, bulbous vegetables and some other are raised by seedlings some are perennial and others are annuals.

- **Ornamental nurseries**
  Ornamental and floricultural crops are nurseries and are propagated vegetative like roses lilies etc.
- **Forest plant nurseries**
  Forest plants are essential for synthesis of gums, honey, timber and fuel and there is lack of forest plant nurseries. Therefore, to save and multiply, the entire lot of valuable forest plants is very essential to preserve and multiply these plants for which a special type of nursery is established.
- **Hi- tech nurseries**
  There is sudden increase in demand for certain commercial plants for example tissue cultured banana. It is not possible to fulfill this requirement by ordinary nurseries practices. There is necessity to have special techniques and methods to meet the demand and only Hi-tech nurseries can satisfy this type of demand.

Physical and financial resources for nursery

Nursery is the base for future horticultural development. The physical resources include: land, water and labour. Transport, market communication facilities and the availability of technical skills. Capital requirement of a nursery should be fulfilled sufficiently and timely.

Types of plant nursery soil

Nurseries grow plants for resale to landscape and to the general public. A nursery can be a field nursery where plants are grown in the soil or a container nursery where plants are grown in different types of growth media. The type of soil required in a nursery depends on the type of crop one needs to grow:

a) **Field nursery soil**
   Mainly produce ornamental shrubs, fruits, trees and perennial flowering plants. The type of soil needed should be fertile and well drains. The soil should cling to the roots of the plant well when the seedlings are transplanted.
b) **Container nursery soil**
   A mixture of sand, peat moss and aged hard wood bark is commonly used for pot mixture line need to be added to the non-soil growth media to balance its pit
c) **Green house soil**
   Sand and organic growth media such as hammered bark and sphagnum peat moss provide a good support for young plants without exposing them to the disease and pest risks found in top soil.

4.6 Green house field preparation is undertaken in accordance to GAP

Green house field preparation: These are the activities carried out in the green house before planting.

The activities are discussed below;

1. **Soil treatment**

   There are various ways of soil treatment before transplanting especially when the soil becomes prone to soil borne pests and diseases. Soil treatment includes the following;

i. Bioxx 5000 = cover the soil for 3-5 day as after application.
ii. Application of methane sodium covers for 14 days.

Procedure for (ii)

Double dig the land and soak with water until 2 feet deep, mix the top soil and subsoil well, let open for 10 days for weeds to germinate and then cover with plastic. Fumigate in the tank and let flow to the field. Allow further flow until completely wet. Leave covered for 21 days, wet again with water and leave open for another 7 days.

iii) Bacmid

Procedure

i. Double dig the land
ii. Incorporate bacmid and mix the soil thoroughly
iii. Cover with polythene
iv. Soak thoroughly and leave covered for 21-28 days
v. Wet again and leave open for 7 days of planting is done immediately it will kill the crops.

N/B: Sunlight raises the temperatures therefore weeds starve by being denied oxygen by covering with polythene.

i. Soil should be well prepared, thoroughly and dug up to 1.5 feet deep to loosen the soil.
ii. Apply one wheelbarrow of manure and mix well with soil to a fine tilth.
iii. The land is then divided into beds of 1m wide compact beds for better water dispersion after which fertilizer such as DAP and NPK are applied to the surface of each bed by sprinkling sparingly.
iv. Raise the bed to 20-30cm high with bottom width of 1m and the top to be 50cm wide.
v. Place the drip time 14cm on either side leaving 52cm in the middle of the top bed.
vi. Do not step on the bed to avoid compaction.
vii. Make holes on the bed top with depth depending on the type of crop to be planted and 4cm from the drip line.
viii. Add Aurum smart fertilizer at a rate of 6gm per hole and mix well before planting the seedlings outside the drip lines at recommended spacing.
ix. Every bed should have 4 wires for support at the bottom and the top tied along the posts.

x. There should be six rows of beds in the greenhouse with a walking path of 30cm wide.

xi. Irrigate at short intervals 6-8 times daily for 15mins for 1 -$1^1/_2$ weeks, long then at intervals to allow for deep rooting.

xii. During rainy season, it is important to continue with irrigation.

Transplanting

Transplant in the morning from 7-9 a.m. and late in the evening when the seedlings are pencil thick. Seedlings are transplanted at a recommended spacing at different types of greenhouse crops. Single stands are recommended for wider spacing but depend on the crop.

Hygiene

Keep the green house clean from dead plant debris papers overripe fruits. Tools to be kept in a central place not scattered. There should be a footbath at the entrance of the greenhouse.

Training in same crops e.g. tomatoes.

This is done early enough to avoid bending. Usually done when the crop is half foot high. Plastic stringer is more recommended and should not be too tight to allow the plot space to expand.

Pruning

DE sucking

Suckers are removed by hand as soon as they appear; hence frequent surveys around the greenhouse are necessary.

Defoliation

Too many leaves increase canopy cover which may be resulting due to high relative humidity hence prone to diseases, therefore old leaves should be removed.

Top pressing

CAN or urea is used to enhance vigor after first harvesting. Trenches are made between rows and the fertilizer is applied, covered and irrigated. Shallow digging is also carried out in order to accrete the soil.

Watering

This is made possible by the use of drip irrigation system and its usually down in the morning and evening.

Harvesting

Starts from the 10^{th} week after transplanting. This also depends on the type of crop planted.

4.7 Greenhouse irrigation is carried out as per operations and maintenance Manual

Artificial application of water to crops

Green house crops are irrigated by means of applying water to the media surface through drop tubes or tapes by hand using a hose pipe, overhead sprinklers and booms or by applying water through the bottom container through sub irrigation. Drip and sub irrigation systems are the most commonly used as it provides greater control over the amount of water applied. There is also reduced potential for diseases and injury since the foliage does not become wet.

Different irrigation systems used in the green house

Drip irrigation

This can be a valuable tool for accurate growing medium moisture control.

Advantages

- Saves water and labor
- Reduces the potential for ground water pollution
- Controls weed growth
- No soil erosion
- Improves fertilizer application efficiency
- Fustigation is carried out easily

Disadvantages

- High installation costs
- High skill in design installation and subsequent operations.
- Clogging of openings may occur as a result of chemical debtor's clay thus hindering watering of crops. Drip irrigation systems eliminations runoff of water missing the pot during overhead irrigation and the volume of water applied controlled.

Water trays and saucers

Water is applied to the surface and is collected under the container through collection trays. Water trays depending on their shape and spacing on the bench can greatly reduce runoff and leaching by containing. The water draining from pots and holding water which misses the pot during overhead irrigation.

Advantage

- They are in expensive and reusable.

Sub irrigation

Sub irrigation systems are an environmentally responsible alternative that conserves water and fertilizer. They are being installed by greenhouse growers to improve product quality to achieve this uniform growth and increase production efficiency. In sub irrigation systems, water and nutrient solution provided at the base of the container rises by capillary actuation through holes in the bottom absorbed by the growing medium.

Advantages

- Water nutrient solutions are contained and recycled.
- Foliage remains dry
- Labor input is reduced
- Uniform watering of all containers
- Pot size and placement can be changed easily
- More vigorous plant growth.

Examples of sub irrigation systems

Capillary that systems

The pots are set on a mat that is kept constantly wet with a nutrient solution. The pots take up the solution through holes at the bottom. The mat is placed on a level bench over a layer at plastic.

Trough system

Plastic or metal troughs are place on existing benches or supported overhead from the green house structure, apart from the mentioned other examples of sub irrigation method include; flood floors, Ebb and flood benches and even lable trays. The choice of an irrigation system is up to the preference of the farmers depending on the types beds found in the green house.

Aspects that should be considered during irrigation of crops in the green house.

- Crop water requirement
- Characterization of the amounts of water used and current irrigation practices.
- Irrigation scheduling of soil grown crops
- Water use efficiency

4.8 Greenhouse crop water requirement is maintained as per Crop Water Requirement Manual

Crop water requirement: This is the quantity of water regardless of its source required by crop or diversified pattern of crops in a given period at its normal growth under field conditions at a given place.

Water requirements for crops in the green house.

Water is essential for the growth and development of living organisms; plant requires certain quantities of water during their life cycle. In shortage of this, the life cycle of a plant will be adversely affected. Data of accurate crop requirement of water is very important for the irrigated agriculture. The knowledge of crop water requirements is also needed for efficient use of limited irrigation water. Water is primarily needed to meet the demand of evapotranspiration (ET) and metabolic needs of the plant. These demands are known as consumptive use (CU)

The evapotranspiration (ET)

It is the amount of water that is lost to the atmosphere through the leaves of the plant as well as the soil surface while consumptive use (CU) is the amount of water used by the growing plant in transpiration and building of plant tissue and that evaporated from adjacent soil or from intercepted precipitation on the plant foliage in any specified time It is expressed in mm or cm.

So, CU= ET = water required for plant metabolic purposes/usually water required for metabolic activities is very small (< 1% of the total water passing through the plant) the CU is generally considered as equal to ET.

Water requirement includes the application losses and water for special purposes e.g. for leaching of excess sales due to irrigation.
So, CU=ET= application losses = water for special purposes.
WR= ET or CU= application= special need.
The formula
WR= IR= ER=S where:
IR= irrigation requirement
ER= effective Rainfall
S= soil
Water requirement for special needs include deep percolation which includes separate and percolation and leaching requirement if soil is saline.

Factors influencing crop water requirement

These includes: crop factors, soil factors, climate factors and crop management practices.

Crop factors

Water requirement differs in different stages or phases of the crop and also with the crop varieties. The flowering requires more water than the seedling stage and even that of maturing stage. The consumptive use also differs due to the differences in height number and size of leaves of different crops.

Soil factors

Evaporation from soils differs owing to the differences in hydraulic conductivity, reflectivity and thermal conductivity. Soil temperature has direct impact on the evaporation, which is affected by the soil color. Reduction in evaporation reduces the water requirement of the crop.

Climatic factors

Evapotranspiration is greatly affected by climatic parameters for example solar radiation, wind, velocity, atmospheric temperatures and humidity. These parameters according to their intensities increase the need of water of a crop.

Management practices

The management factors that are adopted for improving soil productivity with increasing evapotranspiration. This increases the water requirement at a crop. Weeding reduces competition for moisture and increases irrigational interval.

Determination of water requirement for crops

There are several methods of determining crop water requirement. These methods require high level of accuracy availability of equipment and technical knowledge. These methods include;

- Transpiration ratio method
- Depth interval yield approach
- Soil moisture depletion studies
- Water balance method
- Climatologic approaches
- Lysimeter method

Conclusion

This learning outcome covered; Greenhouse installation, types of media and preparation, seedbed layout, crop establishment pest and disease control. It also covered watering technique and PPE. Apart from the above-mentioned field operations carried out in the greenhouse is also tacked under irrigation we can see that the sub irrigation system is mostly preferred compared to the other systems. Crop water requirement is also tackled in details.

Further Reading

1. La malfa, G and Leonard, C. 2001, crop practices and techniques; trends and needs. Acta Hart, 559: 31-42
2. Castilla, N, Hernandez, J and Abou Hadid, A,F, 2004. Strategic crop and greenhouse management in mild winter climate areas. Acta Hart, 633: 183-196

4.3.5.3 Self-Assessment

Written assessment

1) The following are example of tools which one of them is specific to greenhouse
   a) Hand trowel
   b) Trocar and canula
   c) Cutting saw
2) The following are advantages of drip irrigation method which one is not?
   a) There is soil erosion
   b) Saves labor
   c) Improves fertilizer efficiency
3) The following are systems of irrigation used in a greenhouse which one is not the most advantageous compared to the others.
   a) Drip irrigation
   b) Water sources its and trays
   c) Sub irrigation system
4) Which one of the following is an example of sub irrigation?
   a) Furrow irrigation
   b) Capillary neat system
   c) Overhead irrigation
5) The following are factors affecting crop water requirements which one is not.
   a) Availability of labor
   b) Management practices
   c) Crop factors
   d) Climate

6) Identify one of the field preparations undertaken in the greenhouse.
    a) Molting
    b) Hygiene
    c) Bolting
7) A rake as a greenhouse tool is used to?
8) Choices of species and planting materials of greenhouse production should not rely on.
9) Crop choice must consider and capable of providing specific produce typologies.
10) Cultivates producing fruits with varying characteristics are not…………………….
11) The most suitable type of greenhouse used for propagation is?

Oral Assessment

1. Describe the steps followed before starting a green house.
2. State the advantages and disadvantages of free-standing greenhouse.

Case Study Assessment

Imagine you are an extension officer of a particular area and a farmer comes to you to advise him/her on production by greenhouse, what steps and guidelines followed would you advise him to follow before setting up a green house.

Practical Assessment

1. Design a capillary irrigation system as form of sub irrigation;
   Materials;
   - Wick
   - Containers
   - Water etc.
2. Prepare one nursery bed of your choice for green house.
3. Prepare container nurseries using different growth media available in your area apartment soil.

8.3.5.4 Tools, Equipment, Supplies and Materials

- Land
- Propagation materials

- Pangas
- Fork jembe
- Rakes
- Shovel
- Watering can
- Water Horse pipe
- Drip lines
- Water tank
- Nursery trays
- Pumps
- PPEs
- Green house kit
- Harvesting crates
- Harvesting knifes
- Harvesting pails and baskets
- Packaging materials
- Shade nets
- Soil containers/ poly tubes
- Soil sterilizers
- Soil sampling tools
- Media

8.3.5.5 References

Castilla. N. and Hernandez J and Abcu Hadid, A.F. 2004. Strategic crop and greenhouse management in mild winter climate areas. Acta, Hart 633:183-196

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Castilla, N. (2000, October). Current situation and future prospects of protected crops in the Mediterranean region. In *International Symposium on Mediterranean Horticulture: Issues and Prospects 582* (pp. 135-147).

Castilla, N., Hernández, J., & Abou-Hadid, A. F. (2002, August). Strategic crop and greenhouse management in mild winter climate areas. In *XXVI International Horticultural Congress: Protected Cultivation 2002: In Search of Structures, Systems and Plant Materials for 633* (pp. 183-196).

8.3.6 Learning Outcome No 5: Establish drip irrigation system

8.3.6.1 Learning Activities

Learning Outcome No 5: Establish drip irrigation system	
Learning Activities	**Special Instructions**
5.1 Design Drip irrigation as per client specifications 5.2 Set out Lay out of the drip irrigation is set out in accordance with Operations Manual 5.3 Project Greenhouse crop market as per consumer needs 5.4 Establish Drip irrigation as per Operations Manual 5.5 Plan coordinate and control Drip irrigation activities as per farm requirements and SOPs 5.6 Maintain Drip irrigation system as per the Operations Manual 5.7 Use Drip irrigation materials, tools and equipment as per Operations Manual activities 5.8 Monitor and evaluate Drip irrigation is as per the Operational Manual 5.9 Prepare and implement Training programmes are prepared and implemented as per SOPs 5.10 Prepare and share Drip irrigation reports as per SOPs 5.11 Time Greenhouse crop harvest with peak seasons	Illustrations of drip irrigations Discussions Field Excursion

8.3.6.2 Information Sheet No8/LO5: Establish drip irrigation system

Introduction

Drip irrigation is a type of localized irrigation in which drops of water are delivered at or near the root of plants by very low pressure. This chapter covers all the activities involved in drip irrigation from installation to operation and maintenance.

Definition of key terms

Evaluation: Assessing systematically the objectives and possibly a completed project of a program.

Maintenance: The systematic and routine collection of information from project for different purposes

Content/procedures/methods/illustrations

5.1Drip irrigation is designed as per client specifications

Drip irrigation is manly applied in intensive cultivations.

The concept of drip irrigation is to target the roots of the crop rather than the entire cropland area the crop covers. Water is able to reach the deepest roots of the crops through capillarity and gravity. According to EPA drip irrigation uses 20-50% less water compared pop up systems.

Drip design

Before setting up drip irrigation, there are some factors to consider in order to have a successful drip irrigation system. The main purpose of the design of drip irrigation system is to decide the dimensions of the various components of the systems such that, the system provides the required quantity of water at desired uniformity in application while keeping the cost of the system to minimum. To apply the desired amount of water at nearly uniform rate to all the plants in the field. It is essential to design irrigation system that maintains a desired hydraulic pressure in the pipe network and provide the desired operating pressure at the emitter.

The design of the drip irrigation system consists of;

- Selection of emission devices
- Size of laterals
- Manifolds
- Main pipeline
- Filter
- Pump

The design depends on many factors, but will be constrained by several economic factors such as; feasibility, initial investment, labor, return on investment and performance parameters such as the flow rate and desired emission uniformity.

Steps followed for designing the drip irrigation system

i. Inventory of the resources and data collection
ii. Computing of peak crop water requirement
iii. Designing appropriate layout of drip irrigation system
iv. Selection of embitters
v. Hydraulic design of the system in terms of lateral, sub main and main
vi. Horse power of pump

I) Inventory of the resources and data collection

This step involves preparation of inventory of all the available resources and operating conditions. The resources involved include: water resources, land resources, climate.

Water resources: This includes, the quality and quantity of water, the type of water resources i.e. borehole and, tank etc. and also location of water resources is known.

Land resource: This covers the size and the shape of the area to be irrigated. The type of texture and irrigation properties (field capacity, wilting point, bulk density and allowable depletion level). The infiltration rates and topography of the land.
Climate: The climate data is required for computation of crop water requirement.
Crop to be grown: Crop type, planting and harvesting period, crop co-efficient, fertilizer requirement and crop geometry.
In general, the above guidelines can be used to ensure adequate quality of available water for irrigation to fruits and vegetable. However, the area to be irrigated can be decided on basis of water availability and the crop water demand.

ii) Peak crop water requirement

The designing of irrigation system needs the information on the peak water requirement. However, while the system is in operation, the water requirement during specified irrigation interval is required. Peak crop water requirement section describes the method to estimate the crop water requirement. Water requirement is a function of plant, surface area covered by the plant and evaporation rate. The water requirement of the whole area is estimated based on the water requirement per plant and the total number of plants. The crop water requirement, which is maximum during any one of the seasons, is adopted for the system

iii) Layout out of the drip irrigation system

It is possible to apply water to the whole field by drip irrigation method at the same. However, this may result in the requirement of high discharge which may not be available. Therefore, the whole field needs be divided into convenient number of sub units. Each sub unit is the designed separately and operates separately but having a valve at the head of each sub unit.
Number of sub units=total time available for irrigation
Total time of irrigation depends on the hours of electricity available in the region and capacity of farmers to supplement the electricity by other means
The system requirement for each sub units is computed
The layout of the drip system is done considering the shape, size and slope of the land

iv) Selection of emitters

The emitters are to be selected for its discharge. operating pressure compensating non pressure, point source, exit and surface
The selection of a particular emitter depends on;

- Topography
- Desired emission uniformity
- Available discharge
- Source of power e.g. electricity
- Water quality
- Water use efficiency
- Cost
- Type of soil

v) Hydraulic design of the pipe

The pipe network in drip irrigation system consists of lateral, sub main and main.

Water under pressure flows through these pipes and as a result reduces creating the variation.

The emitter discharge depends on the operating pressure available in the pipe, at the emitter connection and this reduces with reducing pressure.

The process of hydraulic design

- Know the operating pressure of the emitters
- Find out the available head loss in lateral and sub main
- Find the lateral and sub main discharge
- Find out the diameter and length of the lateral such that head loose is within allowable limits for the given layout.
- Repeat the procedure for the sub main
- Find out the diameter of the main so that the velocity is within allowable limit

Horsepower requirement of pump

Horsepower (hp)

$$\left(\frac{\text{The formula}}{\text{Horsepowernrequired(hp)}}\right) = \frac{\mathrm{H} \times \mathrm{Qm}}{75\mathrm{xmpxnm}}$$

Where

H= total pumping head (HF+He+H3) M

H_f =total head loss due to friction. Friction head loss in the main + friction head loss in the laterals +friction head loss in accessories, filters and fustigation unit.

H_c=operating pressure head required at the emitter

H_s=total static head

Q_m=discharge of main

$H_{p=}$efficiency of the pump

$H_{m=}$efficiency of motor

5.2 Lay out of the drip irrigation is set out in accordance with Operations Manual

Much of the lay out has been discussed in the design of the irrigation system

Once the layout is finalized as discussed in the content above (5.1) the diameter and length of the sub main and the lateral for each subunit is decided on the basis of the hydraulic system design. The spacing between the lateral depends on the crop geometry for the row crops for the plantation.eg overhead crops. The spacing between the lateral is equal to the row spacing. However, depending on the age of the tree, tree spacing and the soil type. Two layers per row of a tree may be needed. The spacing between the emitter and the on the laterals for row crops is governed by spacing, age and soil type.

5.3 Green house crop market is determined as per consumer projected Needs

Consumer: A person who purchases a product from a buyer

To be able to market the horticultural crops, you should ask yourself what the consumer wants. As a farmer, you should be able to understand different techniques of finding a suitable market for your product. The techniques are discussed below

Crop calendar to show seasonality

This will enable the consumer to know when to expect the produce and off-season period. This calendar can be used to compare these periods when an area is able to supply the produce with the periods when market prices are likely to be high. It can also be used to compare seasonality of areas production with that of the competing area.

Cost of production calculation

Cost of production data and figures of the sales can be used to draw up crop budgets. These can be used by the farmer to predict the potential profits of different crops.

Production location maps

Maps of the production location help farmers to understand whether to re-clusters where particular products are produced. This can also help the farmer to produce when others are producing crops off the season. These maps are also useful for discussion with traders and can be used to identify locations where the farmers could group together in order to sell to traders' diagram to describe marketing channels, providing information about traders' price trends over the year understanding your marketing. Information about the demand for different products

All these techniques when used and followed by horticultural farmers will enable them to have reliable market for their products. Apart from this the farmer also know the consumers choices and preferences of the produce. Value chain followed by the farmer also affects the market prices.

Before you market your produce, you should ensure that they are safe for consumption. This is by involving the standardize boards so that consumer health is assured.

The products should have the following consumption information to enable the consumer buy without question

- Varieties appearance and taste
- Grading and quality standards
- Seasonality and supply patterns
- Typical prices and price patterns
- Packaging
- Sales trend

Farmers always complain about poor prices and this is predictable finding at any field season. Inadequate prices may reflect high marketing cost a lack of demand. It may be possible to improve prices by lowering the unit cost of marketing and promoting more competition between buyers by improving negotiating by farmers and by organizing access to new market opportunities.

5.4 Drip irrigation is established as per Operations Manual

Before establishing drip irrigation system, the farmer should be able to plan for design and layout of drip irrigation system.

The design of drip irrigation follows the following steps

i. Inventory of the resource and data collection
ii. Computing of peak crop water requirement
iii. Designing appropriate layout of drip irrigation system
iv. Selection of emitters
v. Hydraulic design of the system in terms of lateral, sub main and main
vi. Horse power of pump

After designing drip irrigation system, then setting up the layout then follows.

It is possible to water the whole field though it may in the requirement of high requirement of high discharge, which may not be applicable. Therefore, the whole field is sub-divided into convenient subunits. Each sub unit is then designed and operated separately by having a valve at the head of the sub-unit.

After laying out the drip irrigation system one is supposed to select emitters suitable for irrigation, this depends on the design of the emitter and the choice of the farmer. Choose the hydraulic design of the pipe network, in the main and the sub main. Where water from the tank flows in them under pressure available in the pipe at the emitter connection. After selecting the hydraulic design, a computation of the pump is then done to enable water flow in the pump to the pipes with easy of irrigation purposes.

5.5 Drip irrigation activities are planned, coordinated and controlled as per farm requirements and SOPs

Drip irrigation system consists of various components, which are designed properly as per the specifications. After designing the components, they are to be installed properly. Many of the problems of drip irrigation occur because of poor installation. The system needs to be maintained and operated properly for obtaining longer life of different components of the system and trouble-free operation.

The drip irrigation activities include the following

Installation

The main item in the installation of the system include; installation of control head, comprising of the pumping set, non-return valve, water meters, filters, fertigation equipment, flow control and release valve. The other items of installation include the mains, submains and laying out drip tape or lateral with drippers. While installing the control head or the network, the minimum number of accessories such as elbows, reducers and others should be used f or proper maintenance of the system and to reduce unnecessary head loss in the system due to the connections.

Installation of filters and fertigation equipment

i. A support in the form of hard base along with fittings should be used for the installation of the and hydro-cyclone fitters to avoid any vibrations due to load
ii. The fitter size should be in accordance to the capacity of the system and should match with the pump discharge as undersize will lead to loss.
iii. The delivery pipe of the pump should be connected directly to the hydro clone or sand fitters followed by the fertilizer equipment and the screen fitter, all the equipment should be installed to the main pipe
iv. Once the sand fitter is connected to the essential requirement. suitable arrangement to collect and dispose of the bypass material should be made.
v. In pressurized irrigation system the fertilizer injections units are located between the sand filter if required and the screen filter.

Installation of mains and sub mains

Except for fully portable system, both mains and sub mains made from PVC must be installed underground at minimum depth of about 0.5 m such that they are unaffected by cultivation or by heavy harvesting machinery.

- Compute the time of operation of different sub units, based on the climatological data of the previous days or from the average historical data.
- Prepare the time schedule for various valves and operate accordingly to release the desired quantity of water.
- Compute the volume of water to be applied for each subunit and ensure that the desired quantity of water is applied.
- Check the pressure of the pressure gauges regularly.
- For the system involving the operation of the valves hydraulically, ensure proper setting of the hydraulic water valve.
- Operate the heading valve to begin irrigation.
- Checking the system components for proper operation randomly for the discharge
- Measure the emission uniformity to the system at least at the start of the irrigation season.
- The chemical and fertilizer injection season equipment to ensure the application of the desired quantity and concentration.
- Installation

Maintenance of drip irrigation

Periodic preventive maintenance of all the components of the drip irrigation system is required for successful operation of drip irrigation system. The emitter functioning, welting pattern and leakage of pipes valves and fittings should be checked regularly
Placement of the emitters should be done on broken ones. If the mains and sub mains are made out of materials other than PVC such as HDPE or GI
These may not need to install them below the ground surface; however, it is advisable to install them underground. It is importance to remove mud and other impurities in the pipe before fitting out mains and sub mains and get valves. A ball is provided at the

inlet and of the sub main, after the ball valve the air release valve is provided. A flush facing the slope of the sub main to facilitate sub main flushing. After installation of the main and the sub main and sub mains layering of lateral is done. Punching of the lateral and fixing the emitter follows later.

Operation of drip irrigation system

When the system is in use, it is required to operate properly for long and trouble-free use of the system.

Guidelines of the drip irrigation system

Keep the design, evaluation and testing information from the designer, installer and clean the clogged emitters to allow for of flow of water in drip

Clean the filter of the drip to prevent clogging of the emitters which reduces on performance

Clean water though venture or other injectors for 10-15 mins before and after fertilizer application

Types of treatment drips

- Flushing
- Chemical treatments- further divided into
- Acid treatment
- Chlorine treatment

5.6 Drip irrigation system is maintained as per the Operations Manual

Drip irrigation should be maintained for proper efficiency. Some of the maintenance and operation carried out in drip irrigation includes;

For perennial crops: The drip horse should be lifted periodically if the drip is used on the surface. So that leaves, soils and debris do not cover the hose. If the house is not lifted root can grow over the horse affecting the flow of water to crops. Leaks can occur unexpectedly due to damage by insects, animals or farming tools. Systematically monitor the lines for physical damage. It is so important to fix holes as soon as possible to prevent uneven irrigation. If the rate of the water flow declines progressively during the season the pipes may be slowly plugging resulting in severe damage of the crop. Therefore, once a month, flush the drip lines by opening the far ends of the portion of the types at time and allowing the higher velocity water to flush out the sediments.

5.7 Drip irrigation materials, tools and equipment are used as per Operations Manual activities system

Components for a drip irrigation system

Hose connector with short valves

This connector allows drip system connected at all to keep the system connected at all times. You can still use the regular garden hose without removing the drip system.

Timers

Turns the water on and off. This offers more proof means of controlling the system, rather than simply turning the facet manual.

Back low preventer
This is required to prevent water from your water supply when the system is turned off
Fitter
Screens out particles that could clog the holes in the drip system
Pressure regulator
This reduces the pressure to lower pressure required by the drip system
Hose fitting
Connects the pressure regulator to the tubing

Tubing
There are two different types of tubing
 Blanks tube – has no holes
 Emitter tubing –has holes

Emitters
These are drippers, sprayers or drip line
They are available with different floe rates to accumulate the need of the plant
Types
Dripper
Used to water individual plant
Bubblers
Often used for larger plants e.g. roses, tomatoes, because it delivers more water in less time
Sprayer
Use sprayer to water ground cover or densely planted beds
Soaker drip line
Tubing with build in drippers, great for vegetable gardens and row of plants
Tubing stake
 Prevents emitters from clogging
Riser stake. Allows emitters to be placed above the plants
 Common tools used are pipe cutters, which cuts the desire length
Hole punch Punch holes in tubing wherever you want to install emitters. These are the things /apparatus making up the drip.

5.8 Drip irrigation is monitored and evaluated as per the Operational Manual
Evaluation: Assessment of efficient impact relevance and sustainability of a project
Monitoring: Ongoing analysis of project progress towards achieving planned results with the purpose of improving management decision making
Objective of irrigation system
To learn a layout sketch of an operation is invisible for making notes during evaluation. Pressure is an important measure of application uniformity; a portable pressure gauges can be used. A relatively simple way to measure application uniformity is by using cater

cans. To understand methods by which an irrigation system can be evaluated. The irrigation system can be evaluated each year to check uniformity of pressure and water application.

Purpose of evaluating and monitoring

- To provide accountability to the partners, according to the set objectives that is improved reliable and equitable distribution of irrigation water
- Evaluated to check on clogging pipes and unclog them
- Also, to find if the water being used for the irrigation purposes is healthy or it requires some treatment

5.9 Training programs are prepared and implemented as per SOPs

Training: Passage of knowledge and skills to you group of people using different methods.

Training programs: Activities designed for training a group of people in specific skills. Training programs for irrigation allows farmers to be conversant with the type of irrigation, the irrigation system to adopt in this case drip irrigation, people are taken through the training in order to understand;

- Basic equipment for proper irrigation
- How much water should be applied?
- How to prevent leaching
- Use an irrigation schedule program
- Use of soil moister sensors
- Well testing to estimate energies efficiency of the system
- Basics of drip irrigation

From the training the farmer will come up with knowledge and skills concerning, component, management and maintenance of drip irrigation system. Explaining to them on what is expected to be done on the farm because they have the knowledge.

5.10. Drip irrigation reports prepared and shared as per SOPs

Report: This is a summarized information about a project. After using the drip irrigation system, a farmer, needs to write a report on how efficient the system is. The report should contain the efficiency and the challenges of using drip irrigation system. Any other information concerning the system can also be noted down for further improvement. The report written should be shared to people concerned and solutions made to the system, which in return boasts productivity thus, profitability.

5.11. Greenhouse crop harvest is timed with peak seasons

Harvesting can be done due to many reasons in order to meet market demand. The timing, techniques and conditions of harvesting can significantly affect prices. Most horticultural crops are grown in the green houses therefore production is done off season. This is important to a farmer because at this time the market demand is high the key issues to be looked at include;

- Maintain quality

- Maximizing shelf life
- Supplying produce when and as the market demand

Harvesting and prices

Harvesting early in the season can be carried out to take advantage of the opportunities for high prices. Taking advantage of the short term marked opportunities require close links with the market.

Harvesting and crop maturity

The life of the crop and its suitability for long-term storage is affected by the maturity of the crop at the harvest. The optimum harvesting for most crops depends not only on the climate and distance of the market but also the variety and the growing conditions. Crops with larger shelf life are most preferred by consumers therefore famers should harvest crops that are mature and fort the market.

Harvest quality

Growers often do not understand the handling on the quality of the produce when it reaches the market. Harvesting should take place when the crop and the climate is coolers and the plant has the highest moisture content. If the transport is a problem the harvest should be rescheduled to avoid produce being left for too long. Harvest a specific crop in the ideal times depending on the variety. When the crops have reached the season when farmers have produced the same type of crop it is advisable to carry out value addition through processing of the produce into different produce so that they do not go on a loss of high supplies and demand.

Conclusion

This learning outcome covered; Installation, operation and maintenance of drip irrigation system. From this we come to know the tools materials and equipment required in the process and which skills to be used in managing and maintaining the drip irrigation system.

Further Reading

1. Jonson.M,E. 1983. Design and opetation of farm irrigation systems. revise printing,Agr.Mone ,no,3. St josephs .
2. Nakayoma.F,S. AND Bucks . D.A.1986.Trickle irrigation of crop production, Design Operatiom and management. New York

4.3.6.3 Self-Assessment

Written assessment

1. In which one of the following systems, the waterfalls drop just at the position of the root crop?
   a) Sprinkler
   b) Drip irrigation
   c) Sip irrigation
   d) All of the above
2. What type of crops cannot be cultivated with drip irrigation?
   a) Rice
   b) Sukuma wiki
   c) Banana
3. The following are the types of emitter used in drip irrigation which one is not?
   a) Drippers
   b) Bubblers
   c) Hoop stake
   d) Mister
4. The following are the method of cleaning the emitter, which one is not?
   a) Flushing
   b) Chlorination
   c) Acid treatment
   d) Sipping

5. One of the following is performance parameter that is evaluated in the field, which one is it?
   a) Field application efficiency
   b) Type of crop
   c) Climatic factor of the area
6. Drip irrigation is the
7. The concept of drip irrigation is to target ……………of the crops
8. It is essential to design irrigation system that maintains a……in the pipe network
9. The emitter discharge depends on ……….in the pipe at emitter connection
10. The pipe network in drip irrigation system consists of?

Oral Assessment

1. What are the factors to consider when selecting a particular emitter?
2. Describe the maintenance of drip irrigation

Case Study Assessment

1. Imagine you are working with irrigation system Installation Company. Formulate guidelines that will help you to know the type of system to be installed for your client.

Practical Assessment

1. Demonstrate drip irrigation materials
2. Use it to construct drip irrigation system on different crops and show how long it takes for the water to get finished in the container

4.3.6.4 Tools, Equipment, Supplies and Materials

- Land
- Propagation materials
- Pangas
- Fork jembe
- Rakes
- Shovel
- Watering can
- Water Horse pipe
- Drip lines
- Water tank,
- Nursery trays
- PumpPPEs
- Green house kit
- Harvesting crates
- Harvesting knifes
- Harvesting pails
- baskets, Packaging materials
- Shade nets
- Soil containers/ poly tubes
- Soil sterilizers
- Soil sampling tools

8.3.6.5 References

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8.3.7 Learning Outcome No 6: Manage Horticultural field

8.3.7.1 Learning Activities

Learning Outcome No 6: Manage Horticultural field	
Learning Activities	**Special Instructions**
6.1 Establish Horticultural farm in accordance with Horticultural Crop Production Manual 6.2Determine Soil nutrition requirement for horticultural crop and enhanced 6.3Establish Horticultural crops as per crop extension handbook 6.4Undertake Horticultural crop husbandry as per Crop Extension Manual and GAPs 6.5 Harvest Horticultural crop in accordance with GAPs 6.6 Undertake Horticultural crop post harvesting management as per Post Harvest Handling Manual	Discussions and group presentations. Field excursion

8.3.7.2 Information Sheet No8/LO6: Manage Horticultural field

Introduction

This learning outcome covers; crop rotation program, land preparation, soil fertility management, pest and disease control, harvesting, safe use of pesticides and security measures. In management of agricultural field same of the main areas to be covered include the following practices: establishment soil nutrition requirement, establishment of horticultural crops, crop husbandry and harvesting of the horticultural crops.

Definition of key terms

Crop rotation: Practice of growing a series of different types in the same area in sequenced seasons.

Soil fertility management: Practices carried out in the soil in order to improve on its fertility.

Crop husbandry: This is aspects of crops from seed planting, field operations, harvesting and past harvest operations and marketing of products.

Content/procedures/methods/illustrations

6.3Horticultural farm is established in accordance with Horticultural Crop Production Manual

Establishment of a horticultural farm is the coming up with a horticultural farm following different guidelines.

Before setting up a farm there are some guides that must be followed that will help in understanding a successful horticultural.

Factors considered when establishing a horticultural farm

The factors to be considered before starting up an agricultural farm include:

- Soil factor
- Choice of land
- Ecological potential
- Proximity to the market
- Adequate water supply
- Planting system

Soil factor

The type of soil determines the type of crop that can be grown in that particular area. Soil analysis should be done so that you have information on the type of soil, its fertility, its depth among other characteristics.

Climate

The climate of the locality should be suited for the growth of fruits and vegetables. Carry out extension services to require the types of crops suited for different climatic conditions.

Irrigation facilities

Most of the horticultural crops are raised under irrigation. So, the water facilities should also be taken into consideration.

Nearness to the market

This factor saves the overhead charges in transport and gives close touch with market tastes.

Availability of labor

Large horticultural farms are usually situated away from the population. Therefore, it will be necessary to ensure that adequate labor is available for the operations.

Cost of the land

This comes about after listing all the requirements and has been satisfied. This should never be the prime consideration in the extra cost paid for the foregoing amenities in more than repaid in the long run.

Availability of land
This is one of the important considerations in horticultural establishment as it is the basic to all the other practices.
Availability of infrastructure
Infrastructure in terms of transport and communication network is an important factor to consider as this will help in accessing the required materials into and out of the market.

Steps in establishment of a horticultural farm

i. **Cleaning of the land**

Preparation of the soil depends largely on the condition, previously grown crops and growers plan. If the land has been under cultivation and has been well maintained, nothing further may be required.

ii. **Leveling**

This is important for efficient irrigation, drainage to check soil erosion and to improve appearance.

iii. **Fencing**

This is necessary for protection of the crops from stray animals, human trespassing and also for security purposes.

iv. **Wind break plants**

This is provided to reduce velocity of wind which causes loss of bloom, wind erosion and evaporation of moisture and keep arch and warm.

v. **Roads and drains**

This are laid out according to the plan prepared in advance taking convenient levels into consideration. Main irrigation channels also have to be glutted.

vi. **Tillage**

This including subsoil should be done thoroughly since it cannot be done after planting without disturbing the roots of the trees.

vii. **Selection of plants from the nursery**

Healthy crops are the ones selected to be grown on the main seed bed.

viii. **Planting**

Done after all the activities have been successfully done. The method of planting largely depends on the farmer.

6.2 Soil nutrition requirement for horticultural crop is determined And enhanced
Soil nutrition requirements
This is the nutrients that a soil has that can accommodate crop production. Soil nutrients are important for healthy plant growth.
The nutrients are classified into two

a) Macro nutrients
b) Micro nutrients

Macro nutrients are required by plants in large quantities and they include (N.P.K).

Micro nutrients are required by plants in small quantities i.e. zinc, Tin. Etc.

Nutrient management is crucial in order to increase or maintain crop yields on an agricultural land. To most crop needs throughout the year growing season. Soil fertility must be constantly high.

Deficiencies of the nutrients will impact crop quality and knowing these will assist in determining the amount and type of fertilizer required. This means that the soil testing should be carried out. Plant tissue analysis may also be used as a method for measuring nutrients levels of plant during their growth. This analysis is a useful tool for growers looking to understand the effectiveness of their fertilization practices. Beyond accounting for adequate amounts of essential plant nutrients, growers should be aware of a variety of other factors that will impact nutrient uptake and availability. Soil chemical and physical properties, such as parent material, texture, organic matter content or permeability will greatly impact the accessibility of certain nutrients for plant uptake, water content is also important because nutrients available to plants are dissolved in the soil solution. Excess water may however deplete soil oxygen leading to an increased concentration of carbon dioxide.

The pH of soil also affects concentration of certain mineral elements or their availability for crop intake. Soil acidification or a decrease in the pH may be caused by long-term fertilizer applications and other crop management practices. To account for this, farmers may consider applying lime or other amendments to increase on pH. For most crops, a neutral pH is required as it allows for the accessibility of nutrients. Lack of accessibility to nutrients can also be caused by environmental or soil conditions. Some nutrients may be lost from a system due to leaching, volatilization or runoff. Nitrogen may be leached from the agricultural system. These losses occur often with drainage after rain or irrigation events. All the macro and micro nutrients are susceptible to the effects of runoff and erosion.

6.3 Horticultural crops are established as per crop extension hand Book

Horticultural crops such as fruits and vegetables are established as per different considerations. Before establishing horticultural crops. One should first select the site.

Selection of site of horticultural crops.

The following are factors to be considered before selecting a site for an orchard.

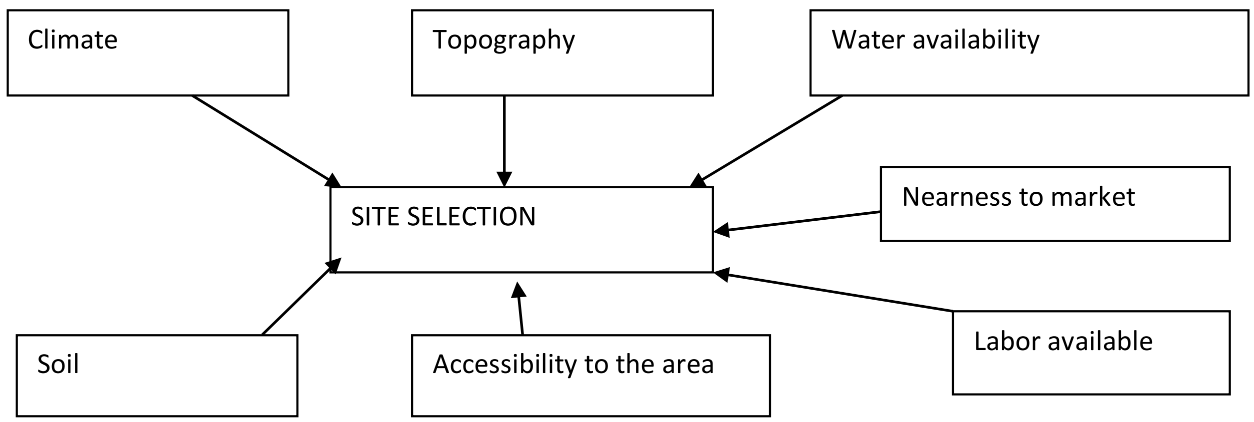

Figure 46:Selection of site of horticultural crops

Climate: The climate of the area should be suited to the horticultural crops chosen.
Soil: Few prospective sites should be examined for both physical and chemical

Properties: This means that one should carry out soil testing.
Nearness to the market: This one will save on transportation cost of produce to the market and materials from the market.
Availability of labor: Establishment do crops require labor in different farm operations such as nursery management, planting and other field practices.
N/B: With all these factors considered, a farmer is now able to establish his/her crops of choice in a particular area.

6.4 Horticultural crop husbandry is undertaken as per Crop Extension Manual and GAPs

Crop husbandry: Deals with the various aspects of crops from seed sowing, on field and off field operations, harvesting, threshing, storage and marketing of the products.

Subdivisions of crop husbandry

Crop husbandry is sub-divided into:

- Agronomy
- Horticulture
- Forestry

In our case we are going to discuss on horticulture as this is our area of interest.
Horticulture deals with various aspects of vegetable, fruits and ornaments. Horticulture is further subdivided into different branches which include:

- Floriculture
- Olericulture
- Pomiculture
- Land scaping

Olericulture: This is the production of vegetables.
Pomiculture/pomology: Deals with fruit production, orchard layering and their management.
Floriculture: Deals with growing and maintenance of flower plants for cut flowers industry and aesthetic purposes.
Landscaping: Application of horticulture towards beautification of land through lawn layering and maintenance.

6.5 Horticultural crop is harvested in accordance with GAPs

Harvesting

Principal of harvesting

Harvesting should be completed during the coolest time of the day, which is usually early in the morning. The harvested produce should be kept under a shade. The produce should be handled gently. Crops destined for storage should be as free as possible from skin breaks, bruises, spots, rots, decay and other deteriorations. Bruises and other mechanical damage not only affect appearance but also provide entrance to decay organism as well.

Packaging of Horticultural crops after harvesting

Packaging in situ

This is packaging done from where the crops are grown. This is done to prevent physical damage to produce and be easy to handle.

Packaging in a packaging house

This is done away from where the crops are planted. Possibly in a warehouse or store.

Grading of horticultural crops

This is done according to different characteristics which include:

- Quality
- Size
- Appearance

6.6 Horticultural crop post harvesting management is undertaken as Per Post Harvest Handling Manual

Fruits and vegetables are marketable so long as they maintain their quality to a level that is acceptable by consumers. The post-harvest storage technologies are aimed at maintaining the quality of vegetable as long as possible

Impact of temperature on post-harvest life of horticultural crops

Temperature is the single most important factor in maintaining quality after harvest. Refrigerated storage retards the following elements of deuteriation in perishable crops.

- Aging due to ripening, softening and textual and color changes
- Undesirable metabolic changes and respiratory heat production
- Moisture loss and the resultant wilting
- Spoilage due to invasion by bacteria, fungi and yeasts
- Undesirable growth such as potato sprouting

Impact of storage temperature on respiration rate

- One of the most important functions of refrigeration is to control the crops respiration rate
- Respiration generates heat as sugars, fats and proteins in the cells of the crop are oxidized

- The loss of these stored food reserves through respiration means decreased food value, less of flavor, less of salable weight and more rapid deterioration
- The respiration rate of a product strongly determines its transit and past harvest life
- The higher the storage temperature, the higher the respiration rate

Pre-cooling

This is the first step in good temperature management. The field heat of freshly harvested crop is usually high and should be removed as quickly as possible before shipping, processing and storage.

Methods of pre-cooling

i. **Room cooling:** This is where produce is placed in an insulated room equipped with refrigeration units. This method can be used with all commodities but it is slow compared to other methods.

ii. **Forced air cooling:** Fans are used in conjunction with a cooling room to pull cool air through packages of produce.

iii. **Hydro-cooling:** Dumping produce into cold water or running cold water over produce is an efficient way to remove heat and can serve as a means of cleaning at the same time.

iv. **Top or liquid icing:** This is particularly effective on dense products and palletized packages that are difficult to cool with forced air. Icing method works well with high respiration commodities e.g. broccoli and sweet corn.

v. **Vacuum cooling:** Produce is enclosed in a chamber in which a vacuum is created. This system works best with leafy crops such as lettuce which has high surface area to volume ratio.

Other aspects related to post harvesting management of horticultural crops include:

i. Sanitation: this important to avoid infections by pathogens.

ii. Ethylene: a plant hormone that accelerates the ripening process thereby reducing post-harvest life.

iii. Modified atmosphere: Reduction of CO2 and increasing on CO2 concentration in the storage room.

iv. Controlled atmosphere: Controlled modification of oxygen and carbon dioxide in the atmosphere.

Conclusion

This learning activity covered; crop rotation program, land preparation, soil fertility management, pest and disease control, harvesting, safe use of pesticides, security measures as activities carried out in horticulture production in order to increase on productivity.

Further Reading

1. FAO, 1986. Improvement of postharvest fresh fruits and vegetables handling. Regional office for Asia and pacific. Maliwan Mansia, Phra Atot road, Bangkok, 10200, Thailand.

8.3.7.3 Self-Assessment

Written assessment

1. The following are the factors to be considered when starting up horticultural farm, which one is not?
    a) Soil factor
    b) Climate
    c) Rainfall reliability
2. One of the following is a step in establishing a horticultural farm which one is it?
    a) Wind break plants provision
    b) Marketing
    c) Availability of land
3. Selected plants from a nursery to be planted in the horticultural farm have got the following characteristics apart from?
    a) Healthy
    b) Attacked by pests
    c) Viable
4. The following are examples of nutrients that are used by plants for growth. Which one of them is a micronutrient?
    a) Nitrogen.
    b) Phosphorus.
    c) Zinc.
5. The following are factors that affect nutrient uptake in plants which one is not.
    a) PH concentration
    b) Type of soil
    c) Water content of the soil
    d) Nutrition requirement
6. The following are subdivisions of crop husbandry, Horticulture, Agronomy and Forestry. Olericulture falls under which type of husbandry.
    a) Horticulture
    b) Agronomy
    c) Forestry
7. Amongst the following which one is not a pre-cooling method?

   a) Room cooling
   b) Forced air cooling
   c) Open air cooling
   d) Hydro cooling
8. Harvesting sound is completed during the time of the day.
9. What are the types of packaging in horticultural crop production?
10. Bruises and mechanical damage not only affect appearance but also?
11. Why is infrastructure important in horticultural production?
12. Pomiculture is the production of?

Oral Assessment

1. Discuss the factors considered when establishing a horticultural farm?
2. Discuss on storage of horticultural crops.

Case Study Assessment

Visit a horticultural farm around your area and note done the post-harvest practices done to the produce. Ask questions on why certain practices are being done.

Practical Assessment

1. Practice post harvesting management of horticultural crops under the following sub headings.
   a) Sanitation.
   b) Ethylene.
2. Carry out hydro cooling method of pre-cooling in harvested horticultural crops in your areas.

8.3.7.4 Tools, Equipment, Supplies and Materials

- Land
- Propagation materials
- Pangas
- Fork jembe
- Rakes
- ShovelWatering can Water Horse pipe Drip lines
- Water tank
- Nursery trays
- Pumps
- PPEs
- Green house kit
- Harvesting crates
- Harvesting knifes
- Harvesting pails and baskets
- Packaging materials
- Shade nets
- Soil containers/ poly tubes
- Soil sterilizers
- Soil sampling tools,Media.

8.3.7.5 References

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Buntain, B., & Bickerton, G. (1999). The US Department of Agriculture Food Safety and Inspection Service's Activities in Assuring Biosecurity and Public Health Protection. *Annals of the New York Academy of Sciences*, *894*(1), 44-47.

Kader, A. A. (2004, June). Increasing food availability by reducing postharvest losses of fresh produce. In *V International Postharvest Symposium 682* (pp. 2169-2176).

Ofor, M. O., & Ibeawuchi, I. I. (2010). Sun-drying—a low cost technology for reducing postharvest losses. *Academia Arena*, *2*(1), 56-59.

8.3.8 Learning Outcome No 7: Horticulture postharvest management

8.3.8.1 Learning Activities

Learning Outcome No 7: Horticulture postharvest management	
Learning Activities	**Special Instructions**
7.1AdhereHorticultural crop safety and quality to as per Post harvest Manual 7.2Undertake Pest control Manual 7.3 Undertake Horticulture crop storage in accordance with Post harvest Manual 7.4 Determine Marketing opportunities as per farm marketing strategy	Group discussion Field excursions

8.3.8.2 Information Sheet No8/LO7: Horticulture postharvest management

Introduction

This learning activity covers; Post-harvest handling, packaging, processing, transportation, pack house operations, storage and marketing.

Definition of key terms

Packaging: The science art and technology of enhancing or protecting products for distribution, storage and sale use.

Post-harvest: This are the activities carried out after harvesting the agricultural crops.

Content/procedures/methods/illustrations

7.1 Horticultural crop safety and quality is adhered to as per Post Harvest Manual

- Horticultural crops such as fruits and vegetables play significant role in human nutrition, in terms of vitamins, minerals among other nutrients.
- Increased consumption of a variety of agricultural products on daily basis is recommended because of associated health benefits.

Both qualitative and quantitative losses occur in horticultural commodities between the harvest and consumption.

The qualitative losses include:

- Loss of edibility
- Nutrition quality loss
- Caloric value loss
- Loss consumer acceptability of fresh produce

These losses are much difficult to assess than the quantitative losses. Quality standards consumer preferences and purchase ng power vary greatly across countries and culture and this difference influence marketing and magnitude of post-harvest losses. Quality and degree of excellence is a combination of attributes, properties or characteristics that gives value in terms of the intended use. The relative importance given to a specific quality attribute varies in accordance with the commodity concerned with quality assessment.

Important quality attributes to different individuals

Producers

Producers are concerned with qualities such as:

- High yield
- Good appearance
- Ease of harvest
- Ability to withstand long distance shipping to markets

Wholesalers and retail market.

the qualities looked by wholesalers and retail market include:

- appearance
- firmness
- shelf life

Consumers

Consumers on the other hand classify horticultural product on the basis of:

- Appearance on the time of I natal purchase.
- Subsequent purchase depends upon consumers satisfaction in terms of flavor and quality of the edible parts.

Factors that contribute to various qualities of agricultural products

1. **Appearance quality factor**
   These may include shape, size, color, glass with no decays or defects. Defects come about as a result of damage by insects, deceases, birds etc.
2. **Texture quality factor**
   These includes firmness, crispiness, and toughness depending on the commodity. Textural qualities of horticultural crops are not only important for their eating and cooking quality but also for their shipping ability.
3. **Flavor**
   These include sweetness, sourness, bitterness, aroma, and off flavors.
   Flavor quality involves perception of the tastes and aromas of many compounds.
4. **Nutritional quality factors**
   Fresh fruits and vegetables play a significant role in human nutrition, especially as a source of vitamins and minerals.

Safety factors

A number of factors threaten the safety of fruits and vegetables.
The factors include:

- Naturally occurring toxicants e.g. glycoalkaloids.
- Natural contaminants such as fungal toxins.
- Heavy metal e.g. mercury.
- Environmental pollutants e.g. pesticide, insecticides.
- Microbial contamination.

N/B: Microbial contamination is a number one safety concern but most consumers rank pesticides as the most important safety concern. Organic fertilizers such as chicken manure should be sterilized prior to their application to fruits and vegetables so that to avoid the risk of contaminating fresh produce with Salmonella listeria and other pathogens. Commodities that tough soil are more likely to be contaminated than those that do not come into contact with the soil. The best approach to achieving and maintaining the safety of fresh fruits and vegetables is to focus on limiting potential contamination during growth, harvesting, handling, treatment ,packaging and storage, strict adherence to agricultural practices, good hygiene practices, careful handling and washing of all produce to be consumed raw and the strict observance of proper sanitary measures.

7.2 Pest control is undertaken in accordance with Post Harvest Manual

This learning outcome reviews some of the post-harvest technologies related to pest control and outlines the recommended practices for pest management.

The post-harvest pest control techniques

Post-harvest pest can be controlled by different methods which include:

- Heat and cold
- Sanitation
- Use of pesticides
- Controlled modified atmospheric treatment

a. Heat and cold

- Certain fungi and bacteria in their germination phase are susceptible to cold, infections can be reduced by treating produce with a few days of storage at the coldest temperatures. The commodity can withstand without incurring damage.
- On the other hand, brief hot water dip can also be effective especially for reducing the microbial load for crops such as plums.
- Cold treatment can control some insects, pests and are currently used to control fruit flies.
- For produce packed before cold storage treatment, package vents should be screened to prevent the spread of insects during handling.

- Hot water dips can be used for direct control of insects. Fruits should not be handled immediately after heat treatment.
- Whenever heat is used with fresh produce, clean cold-water showers should be provided to help return the fruits to their optimum temperatures as soon as possible.

b. Sanitation

Washing with chlorinated water can prevent decay caused by bacteria, mould, and yeast on the surface of the produce. Calcium hydrochloride and sodium hypochlorite are commonly used. The effectiveness of chlorine increases as pH is reduced from pH 1+0 pH8 but lower pH chlorine becomes unstable.

c. Pesticides

A wide variety of chemicals can be used to control pests after harvesting of the produce.

Ways which chemicals are used.

- Dips
- Sprays
- Dust
- Applied on pad of absorbent paper

N/B: Always follow the instructions and be aware of the recommendation for use. It may differ by state and commodity.

What to consider when using chemical cost control

- Cost
- Availability
- Regulations for proper use
- Residue tolerance

It is recommended to try and avoid or reduce on chemicals for pests' control.

d. Controlled modified atmospheric treatment

For commodities that tolerate high levels of carbon (IV) oxide (CO_2), carbon (IV) oxide enriched in air can be used to control decay-causing pathogens such as Botrytis cinereal. The effectiveness of insecticides' atmospheres depends on the temperatures, relative humidity duration of exposure and life stage of the insect.

7.3 Horticulture crop storage is undertaken in accordance with Post Harvest Manual

Storage is an essential and unavoidable part of the crop production process.

Importance of storage

- Protects the produce from insects and pests.
- To be consumed and stored for large period of times.

Fruits and vegetables grocers work diligently to ensure that they bring the best quality products to the market.

Methods of storage of agricultural products.

i. **Cold storage**

Storage where temperatures are lower than ambient temperatures. The fruits stored under cold storage allow more shelf life than those stored in ambient temperatures.

ii. **Controlled atmospheric storage**

In this type of storage carbon (IV) oxide is higher than oxygen levels.

iii. **Modified atmospheric storage system**

This is the practice of modifying the composition of the internal atmosphere of package in order to improve the shelf life.

iv. **Hypobaric storage**

In this type of storage life of several fruits and vegetables is increased significantly by reducing pressure under refrigeration. Apart from the above-mentioned other methods of storage include; can, drying, curing and salting, freezing and common storage.

7.4 Marketing opportunities are determined as per farm marketing strategy

- Marketing is a very important aspect in Agricultural production.
- Marketing is the process by which the space between the producers and the consumers is bridged.
- The process involves transport and techniques for minimizing crop loses. An effective distribution system will also require the establishment of rural business such as truck drivers and packaging manufacturers, contractors and wholesalers.
- The marketing chain is a two-way process i.e. produce flows to the market and money from the market flows back.
- In horticultural farming where prices are rarely regulated, financial viability depends as much upon the business and marketing skills as on the farmers technical expertise.

Crucial points that govern a market

- That the whole market process has to be customer oriented.
- The marketing is a commercial process and is only suitable if it provides all the participants with profit.

Important characteristic of horticultural crops

- They are mainly eaten for their contribution to the flavor of food and for the supply of nutrients.
- They are not basic food commodities; people will not buy if the price is too high.
- The consumption levels vary depending on the selling price and the income of the buyer.
- Many of the crops are not traded in large volumes and there is limited market.
- Products are perishable which means that there is always reduction in the quality if not sold immediately.
- The products are normally traded in a very open market where the price is determined by the demand and supply.

Techniques which can be used to maximize farmers produce

a) Improving the quality and presentation of the produce
b) Identifying the highest price buyer
c) Negotiating from strengths
d) Scheduling production when there is limited competing supply

Techniques available to minimize risks

- Selling a proportion of products at farm contract.
- Growing a crop range which includes a mix of high and low risk products.
- Investing in technology which increases yield stability therefore income stability.

Conclusion

This learning outcome covered the post-harvest operations carried out after the produce has been harvested which included post-harvest handling, packaging, processing, transportation, pack house operations storage and marketing.

Further Reading

1. Kitinoja, L (1999) Costs and benefits of fresh handling practices perishables handling
2. Quarterly, special issue: Costs and benefits of post-harvest technologies, No 97: 7-13

8.3.8.3 Self-Assessment

1. Horticultural products include the following. which one is not?
    a) Tea
    b) Flowers
    c) Vegetables
2. The following are ways in which chemicals are used. Which one is not?
    a) Dip
    b) Sprays.
    c) Dust.
    d) Broadcasting method.
3. The post-harvest pests can be controlled by different techniques. Which among the following is a technique of controlling pests?
    a) Heat and cold.
    b) Controlled atmosphere.

4. Which one of the following is not a method of storage of agricultural crops?
    a) Controlled atmosphere.
    b) Hypobaric storage.
    c) Cold storage
    d) Hot storage.
5. What factors among the following can be considered when using chemical pest controls?
    a) Cost.
    b) Hygiene.
6. Fruit production is under which part of plant husbandry in horticulture? _________
7. The hydrocooler normally used are of two types. Which are they?
8. The methods of harvesting of fruit crops include?
9. The types of maturity indices used in judging the maturity of fruits and vegetables are.
10. What is the difference between physiological maturity and horticultural maturity?

Oral Assessment

1. Discuss on the handling operation after harvest.
2. Enumerate the types of maturity indices used for judging the maturity in fruits and vegetables.

Case Study Assessment

1. Visit a cold storage or CA storage facility in your locality and enlist the fruits and vegetables stored.
2. Visit fruit orchard or vegetable garden during harvesting and find out the methods of harvesting used by farmers.

Practical Assessment

1. Visit a horticultural collection center. Carry out practical activities involved in the following subheadings.
    a) Packaging
    b) Grading and sorting
    c) Storage

2. Visit a market nearby that has got a collection of agricultural crops in terms of fruits and vegetables and list down the factors that contributed to you buying the crops in terms of quality.

8.3.8.4 Tools, Equipment, Supplies and Materials

- Land
- Propagation materials
- Pangas
- Fork jembe
- Rakes
- ShovelWatering can
- Water Horse pipe Drip lines
- Water tank
- Nursery trays
- Pumps
- PPEs
- Green house kit
- Harvesting crates
- Harvesting knifes
- Harvesting pails and baskets
- Packaging materials
- Shade nets
- Soil containers/ poly tubes
- Soil sterilizers
- Soil sampling tools
- Media.

4.3.8.5 References

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CHAPTER 9: MANAGE FARM/MANAGING FARM

9.1 Introduction

This unit specifies competencies required in managing agricultural and livestock farm. It involves; preparing farm strategic plan, managing human resources and managing farm finances. The knowledge and skills gained from farm management helps farm owners in maximizing annual returns on investment and long-term capital appreciation.

The critical aspects of competency to be covered include; demonstrate understanding of farm activities, ability to prepare a farm budget, demonstrate understanding of sources of funds,ability to prepare financial records.Basic resources required include; flip charts, note books, ruler, text books and manual, projectors and computers.

The unit of competency covers three learning outcomes. Each of the learning outcome presents; learning activities that covers performance criteria statements, thus creating trainee's an opportunity to demonstrate knowledge and skills in the occupational standards and content in curriculum. Information sheet provides; definition of key terms, content and illustration to guide in training. The competency may be assessed through written test, demonstration, practical assignment, interview/oral questioning and case study. Self assessment is provided at the end of each learning outcome. Holistic assessment with other units relevant to the industry sector workplace and job role is recommended.

9.2 Performance Standard

Manage farm as per; farm procedures and requirements, accounting procedures, identified laws and regulations, farm plan and in accordance with SOPs, farm communication strategy, farm budget and enterprise requirements.

9.3 Learning Outcomes

9.3.1 List of learning outcomes

a) Prepare Farm Strategic Plan
b) Manage Farm Human Resources
c) Manage Farm finances

9.3.2 Learning Outcome No 1: Prepare farm strategic plan

9.3.2.1 Learning Activities

Learning Outcome No 1: Prepare farm strategic plan	
Learning Activities	**Special Instructions**
1.1. Farm activities are identified as per farm plan 0.2. Farm budgets are prepared as per the activity schedule 0.3. Sources of funds are done as per budget prepared.	Prepare to visit a nearby farm and identify various farm enterprises. Demonstrate various examples of farm budgets.

9.3.2.2 Information Sheet No9/LO1: Prepare farm strategic plan

Introduction to learning outcome

This unit covers; Strategic planning (meaning, importance, tools of planning and planning process) and farm business plan.

Definition of key terms

Strategic planning: The art of formulating business strategies, implementing them and evaluating their impact based on organizational objectives.

Farm business plan: A process and product of developing an overall vision and mission for the business.

Tools of planning: They are instruments that to help guide organizational action steps related to implementation of an initiative, program or intervention.

Content/procedures/methods/illustrations

1.1 Farm activities are identified as per farm plan

Farm activities constitute a body of procedure carried out by a farmer according to set out plans. They include rearing of livestock and various farm activities including haying, harvesting crops, spraying fields, seeding, tilling fields, breeding cows, vaccinating calves, pasturing livestock and feeding livestock among others.

Importance of farm activities

It helps to keep track of the past farm performance and be in a better position to make good plan. The farmers are able to identify the strengths and weaknesses of the various farm activities. The decisions that farmers make when planning the enterprise for the future include:

- What area of land to be used?
- How much the farmer wishes to produce
- When the crops should be produced
- How much labor should be needed to carry out specific activity

The amount of inputs and materials to be used can also be determined easily.

Planning process

Planning means working things out before they happen, some forward-looking planning decisions are immediate. Before making a change based on the weaknesses or strengths of the farm activities, the farmer should estimate what the result of that change would be. The farm activities are market-oriented beginning by determining what buyers want, in what form and when they want it.

1.2 Farm budgets are prepared as per the activity schedule

Farm budget is a statement of estimated income and expenditure. Budgets are used to decide whether a proposed plan will effectively increase profit in the farm.

A farmer can use budget to decide between two or more alternative enterprise and even to make the whole farm plans.

Formulation of farm budgets has the following planning process:

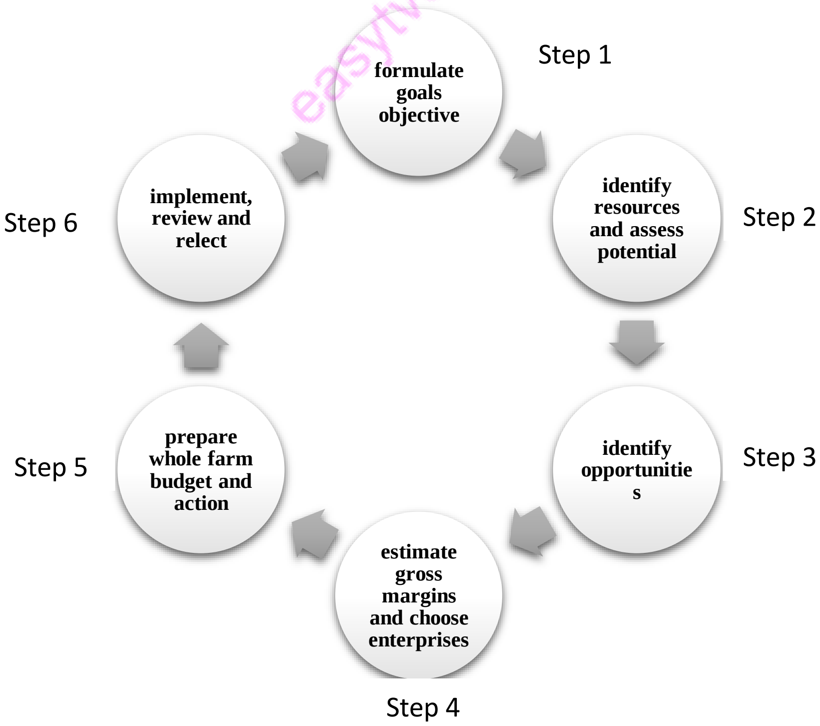

Figure 47:Formulation of farm budgets

Step 1: Formulate goals and objectives

It begins with identification of the farm household goals and a listing of the priorities of various farm activities. It consists of a single goal; maximization of profit of competing enterprises; increasing profit and leisure.

The basic questions that the farmer might ask include what are the family's needs and what is the best way to provide for them.

Step 2: Identify resources and assess potential

The farmer should be encouraged to make a map of the farm. The map shows the current crops and record the soil types and conditions for each plot on the farm. The record serve as a guide to what crops are suitable and what area may be grown and what yields to expect. The farmer identifies problems related to importance such as land products. The farmer identifies weaknesses in management of the business for example excessive debt, high variable costs, depreciation and the use of high labor. The proposed plan must fit in with the available land, labor and financial capital and with the farmer's ability as a manager.

Step 3: Identify opportunities

Choosing an enterprise must take into account market opportunities even if the resource inventory shows that certain crop and livestock enterprises are technically possible. The ideas and suggestions for activities can come from discussions held with the other farmers which could provide important sources of new information.

Step 4: Estimate gross margins and choose enterprises

Estimates are made of the income and variable costs for each of the alternative possible plans. Based on the gross margins and other factors, the most profitable and viable enterprise should be selected. The gross margins should be prepared on the basis of the most limiting resource. The gross margin for each potential enterprise should be calculated on a per unit basis (hectare, person-day).

Step 5: Prepare whole farm budget and action plan

A whole farm budget checks the effect of changes in the cropping pattern and introduction of new enterprises on the economic viability of the entire farm.

The decision requires agreement among the following physical characteristics of the resource base, market opportunities, use of other resources (labor and capital) available to the farmer.

Step 6: Implement, review and reflect; putting the plan into action

The period during which the plan is put into operation is usually the most difficult and requires very careful management. The farmers need to reflect on the outcomes of the plan, evaluate it in terms of the goals set at the beginning of the planning process and assessing the degree to what the plan meet those objectives.

Types of farm budget

There are three basic types of budget that can be used in the farm business management process. Each budget provides different information to the manager for use. The budget format if properly defined and used, the budget format permits the manager to use economic logic to answer questions of what, how much, and when resources should be used.

The three types of farm budgets are:

- Whole-farm budget
- Enterprise budget
- Partial budget

Whole-farm budget: It is a detailed summary of the major physical and financial features of the entire farm business. Whole-farm budgets identifies the component parts of the total farm business and determine the relationships among the different parts both individually and as a whole.

An enterprise budget: It is a statement of what generally is expected from a set of particular production practices when producing a specified amount of product. Consists of a statement of revenues from the expenses incurred in the production of a particular product. An enterprise budgets documents variable and fixed costs. It is useful in calculating profitability and break-even values.

Partial budget: Useful in analyzing effects of a change from an existing plan. It is only considering revenue and expense items that will change with a defined change in the plan.

Importance of farm budget

Farm budgets enables the farmer/ farm manager to:

- Experiment through simulation with possible outcomes of a given organizational change before resources are actually committed to the change.
- Uncover cost. Items that might otherwise be overlooked.
- Learn to better organize and re-organize.
- Seek credit from lending organization.
- Refine the present organization.
- Identify production practices to be used to produce each of the enterprise.

1.3 Sources of funds are done as per budget prepared.

Budget loans to agriculture can be financed by different sources of funds such as farmer household savings, capital markets, budget allocation by the government agricultural cooperatives and societies, bank loan, non-governmental organization among others. Small scale holder farmers can get loans from banks which have low financial costs and stable supply. The objective is to increase income for small holder farmers and agro-based micro and small enterprises. Farmers and farm managers write proposals to non-government institutions for funding. They can also obtain loans from agricultural cooperatives and societies for example Agricultural finance corporation (AFC). AFC is mandated by the government to provide credit for the sole purpose of developing agriculture. AFC develops agriculture and agricultural industries by giving loans to farmers co-operative societies, incorporate groups and private companies. Farmer household savings and profits can be used to run the various farm activities for example to purchase of farm inputs and machinery. The government also allocates funds for subsidizing various farm inputs which are hence affordable for the farmers produce enabling the farmers to obtain income.

Conclusion

This learning outcome covered; Strategic planning, it's meaning, importance, tools of planning and the strategic planning process. It also covered farm business plan

Further Reading

1. Journal; South African Geographical journal; Farm planning pages 49-52

9.3.2.3 Self-Assessment

Written assessment

1. Identify the best definition of planning.
    a) An integrated process in which plans are formulated, carried out and controlled.
    b) Devising ways of achieving the objectives of an organization
    c) Setting an organization's objectives and the means of reaching them.
    d) The core activity of planners and planning department
2. Which one of the following does not show decisions that farmer make when planning the enterprise for the future?
    a) The amount of labor needed
    b) The area of land to be covered
    c) Formulating goals and objectives
    d) The time the crops will be produced
3. The following shows examples of farm budgets which one is not?
    a) Enterprise budget
    b) Multiple budget
    c) Partial budget
    d) Whole farm budget
4. The following best explains the importance of farm budget. Which one does not?
    a) Enable borrowing from lending organizations
    b) Identify production practices to be used

c) Know how much the farmer will produce
d) Refine the present organization

5. Which of the following is not a step for formulating planning process in budgeting?
   a) Identify opportunities
   b) Plan a statement of estimated income and expenditure
   c) Estimate gross margins and choose enterprise.
6. What do you understand by the term strategic planning?
7. Name four sources of funds for farming activities
8. Differentiate between whole farm budget and partial budget
9. Give two importance of farm budget
10. List five farm activities

Oral Assessment

1. Explain the various sources of funds to agricultural farms.
2. Describe the importance of farm budgets.

Case Study Assessment

You have been contacted by a certain agricultural firm which has just recently been started and would like to obtain funds to boost their farm activities, they also require knowledge on budgeting the available resources on the farm. You are an agricultural consultant what advice would you give them and why?

Practical Assessment

Prepare a simple farm budget with well illustrations

9.3.2.4 Tools, Equipment, Supplies and Materials

- Flip charts
- Note books
- Ruler
- Text books and manual
- Projectors
- Computers

9.3.2.5 References

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9.3.3 Learning Outcome No 2: Manage farm personnel

9.3.3.1 Learning Activities

Learning Outcome No 2: Manage farm personnel	
Learning Activities	**Special Instructions**
2.1. Source for personnel as per farms procedures and requirements. 2.2. Coordinate performance management resources, learning and development of personnel in line with farm human resource policy. 2.3. Prepare farm budget as per accounting procedures. 2.4. Undertake internal and external communication in accordance with farm communication Strategy. 2.5. Enforce compliance with legislation and SOPs as per identified laws and regulations.	Discussion on ways of sourcing personnel. Field discussion (Visit a school farm enterprise dealing with livestock)

9.3.3.2 Information Sheet No9/LO2: Manage farm personnel

Introduction to learning outcome

This unit covers; human resources management (Meaning and Importance), performance contracting, monitoring and evaluation, staff recruitment and conflict resolution.

Definition of key terms

Human resource management: The practice of recruiting, hiring, deploying and managing an organization's employees.

Performance contracting: It is a process that and agencies, in order to make them more accountable and enhance prudent use of resources in provision of quality services to citizens.

Staff recruitment: Refers to the process of hiring staff to carry out various activities in an organization.

Conflict resolution: Informal or formal process that two or more parties use to find a peaceful solution to their dispute.

Content/procedures/methods/illustrations

Sourcing of personnel

Sourcing refers to the process of finding resumes within the recruitment process. Recruiters both third party and corporate need to find qualified personnel through a variety of methods. Sourcing has more than one recruitment methods. The way in which these methods are used depends upon a wide array of factors which include;

- The types of candidates needed
- The preferences of the hiring authorities or recruiters
- Past success or lack of success
- The resources at the disposal of the person (or people utilizing the strategy)
- The personnel available to utilize the strategy

The sourcing techniques mainly used by recruiters are:

- Sourcing candidates through a recruiting database.
- Sourcing candidates through various social media platform- recruiters can form a platform hoping to source high quality candidates and recruit them.
- Source candidates through online job postings.
- Sourcing candidates via referrals
- Source candidates from within the organization
- Source candidates through a recruiter network

Human capital plays a vital role in making a farm competitive in today's business environment. The employees should not be neglected rather they should have benefit packages and good living conditions for them to be motivated to fully make them become competent.

Performance management development of personnel is coordinated in life with farm human resource policy

Performance management is the process of creating a work environment or setting in which people are enabled to perform to the best of their abilities. It is a whole work system that begins when a job is defined as needed, it defines interactions with an employee at every step of the way in between major cycle and occurrences. Performance management helps managers and their employees to see eye to eye on expectations, goals and career progress and how those align with the vision of the farm business. A formal performance management represents an industry wide initiative to understand and qualify how employees in the farm are doing and how well they are doing it. It emphasizes learning and development for higher level of workplace performance.

Benefits of performance management to employees, managers and organization.

i. **Improved communication**: Employees and managers communicate more regularly to discuss company objectives and overall progress.
ii. **Reduced stress:** Employees aren't stressing about impressing a manager though some random task and managers aren't worrying about offending employees for not performing.

iii. **Established rules**: Employees and managers more easily understand the process and stipulations for how performance appraisal are performed.

Objectives of performance management

- Monitoring whether the expected performance results are achieved or not.
- Ensuring that the organization is complying with the minimum legal environment requirements.
- Sustain excellence in performance by motivating employees to setting goals that align with organizational strategies.
- Formulate strategy, determining the objectives of the org.

Expected outcomes of performance management.

- Employees should have a clear understanding of what is expected of them and how their goals will contribute to the company's overall achievements. Expectations should go beyond the job description and entails a range of expected outcomes.
- What goods and services should the job produce?
- What effect should the work have on the farm enterprise?
- How should employees act with clients, colleagues and supervisors?
- What organizational value should the employees demonstrate?
- What process or methods should the employee use?

Ways of getting the most of out of the enterprise performance management program

- Define professional development plans. Supervisors and employees work together to create development plans. The plan focuses on skills aimed at mastering the job or on professional development. Employees should have a say in what new things they should use to the company's/ farm's benefit.
- Create measurable performance. Based objectives and expectations. Employee should understand and give input on how each objectives success is to be measured.
- Expectations fall into two categories.
- Results: goods and services produced by the employee in the farm is often measured b objectives or standards.
- Actions and behavior. Methods used to make a product or perform a service and the behaviors and values demonstrated during the process.

2.3 Farm personnel budget prepared as per accounting procedures

A complete farm financial system is composed of a set financial statement and planning budgets. The four planning budgets used to record financial details are:

- Cash flow budgets
- Partial budgets
- Whole farm budgets
- Enterprise budgets

Preparation of each budget requires access to detailed data on farm enterprises, production methods, sources of farm revenue, costs for each enterprise equipment and facility conditions, inventory of suppliers, sources of farm income and insurance and tax records.
Preparation of farm personnel budget falls under enterprise budget which represents the estimate of receipts (income) costs, and profits associated with production of agricultural products.
The enterprise budget is used to:

i. Itemize the receipts (income) receive list of inputs and production practices required by an enterprise
ii. Evaluate the efficiency of farm enterprises
iii. Estimate benefits and costs for major changes in production processes
iv. Provide the basis for a total farm plan
v. Support applications for credit

Enterprise budget should contain receipts for every product and by-product of the enterprise.
In case of crops this may mean listing two distinct products like grain crop.
Enterprise budgets contain several cost components. Costs used should reflect market values and the productivity of enterprise resources (land, labor, capital and management). Determining the costs of production practices can be difficult these differences arise because production costs are unique to each farming operation. An important financial distinction is the concept of variable and fixed costs.

Variable costs: They are those expenses that vary with output within a production period and result from the use of purchased inputs and owned assets. Example in crop budgets include expenses for seed or plants, fertilizer and lime, pesticides, fuel, machinery repairs and maintenance, crop insurance, hourly or seasonal labor, marketing and interest operation on operating capital.
In livestock budgets they include expenses for feed herd, health, breeding, labor, marketing and interest on operating capital. If land and buildings are rented, they should be included as a variable cost.
Other terms used to describe variable costs include cash costs (expenses), direct costs and out of pocket costs.

Fixed costs: They do not vary with level of output and result from ownership of assets that will not change in the short run. They include depreciation, taxes, interest on investment land, repairs on fixed assets and insurance. Depreciation should be accounted using the straight-line method based on actual years of use and typical salvage values rather than accelerated methods allowed for income tax purposes. Sometimes a management fee or a pro-rated cost for salaried employees is also included as a fixed cost. In direct, non-cash or overhead costs are other terms used to describe fixed costs.

Total costs = variable cost + fixed costs

To be financially viable an enterprise must earn a profit above total costs in the long run. In a short run it must receive a price that generates a return at least equal to variable costs. Also referred to as having positive gross margin or return over variable costs. In the long run, however, market price and yield need to be high enough to cover total costs of production including fixed costs

Break even analysis

Enterprise budgets are useful for performing break even analysis for prices and yields. Break even analysis is computed as follows

$$\textbf{Break-even price} = \frac{\textbf{Project total costs}}{\textbf{Expected yield}}$$

This is the minimum price per unit required to cover all projected costs at the expected yield. Provides one with marketing price target that you must receive on average to cover all your costs in the current production year.

$$\textbf{Break-even yield} \quad \frac{\textbf{Projected total costs}}{\textbf{Expected cost price}}$$

This is the minimum yield required to cover all projected costs at the time expected price per unit. It provides one with a production target that must be met to cover all costs in the current financial year.

Break-even yield helps to analyze alternative production options and decide if a given enterprise is a good choice given the growing conditions on the firm operation.

2.4 Internal and external communication is undertaken in accordance with farm communication strategy

Internal communication is information and ideas exchange within the organization

External communication is communication between members of the organization with the outside party.

In the process of management communication plays a prominent role because in the absence of effective communication, no superior-subordinate relationship will thrive as well as employee's commitment towards organization also depend on it.

i. Internal communication

There are different types of internal communication, which include:

- Leadership and top-down communication
- Bottom-up or two-way communication
- Peer communication/horizontal communication
- Culture communication
- Change communication

Leadership and top down communications
They are always for a reason. When the communication rises from the top management to staff. Top down communication is used to inform staff of the overall business strategy and direction, and therefore are largely company wide and traditionally formal in their nature. Under this category, we tend to see communications including:

- Company updates
- Formal announcement
- Performance or progress
- Business strategy overviews
- Company accolades, awards or recognition

Bottom up communication
It involves transfer of information from the staff to the top management. Bottom up requires the organization to facilitate:
Ideation: For staff to put forward suggestions or ideas
Employee feedback: presenting something to staff and requesting their input or creating a process space for staff to air concerns and complaints.
Question and answers: When staff require further information or clarification.
Staff surveys and pulse surveys to gauge employee sentiments, engagement or mindset.
Polls or staff votes: To gather popular opinion or input on specific issues.
The best organization don't talk at their employees; they talk with them.

Peer to peer communication
This refers to the ability to collaborate with others, finding a peer who can provide help or share knowledge or simply build connections with the colleagues all make for more engaged and productive. Different channels are suited to different types of peer to peer communication for example collaborating on a project or a piece of work peer communication can cover. Team or community including the sharing of information and files, discussion imagery, events and more. Story telling or sharing of knowledge and experiences for example through blogging or within a discussion forum. Problem solving and ideation.
Connecting with individuals who can help or provide knowledge on a specific topic or task.
Culture communication
Organizational culture is defined as the shared values, beliefs, perceptions held by employees within an organization.
Culture communication can cover everything from: Company mission and values, initiatives, campaigns, events and policies such as charity events or commitment to environmental initiative.

ii. External communication

External communication is the transmission of information between a business and another person or entity in the company's external environment. Example of these people and entities include customers, potential customers, suppliers, investors, shareholders and society at large.

Importance of external communication

- It enables the organization to communicate its intent and message for them.
- Spreads the news about the agricultural products and services. It focuses on spreading news and information about the corporation to the public, customers and company stakeholders. Common examples of external business communication include direct mailings, financial records, press releases and news letters
- It defines the public perception. External communications such as newsletters, media stories and press releases let the public know about the company workplace, philanthropic and environmental efforts which serve to strengthen the public relations efforts of a company.
- It also helps to reach new customers. Internet has become a valued resource in reaching new customers. However, there is possibility of public backlash such as negative comment posting but in the long run the benefits far outweigh the risks.

2.5 Compliance with legislation and SOPs is enforced as per identified laws and regulations.

Regulatory compliance is adherence to laws, regulations guidelines and specifications relevant to its business process by the organization's laws establishing agricultural authorities or ministries may also include a labor-related mandate.

The various farm units/ enterprises have different regulations as follows:

The government provides various agricultural acts and regulations which must be adhered to by the agricultural company from production, processing and marketing. In production, the government has set laws on how various enterprises of the organization operation with respect to environmental conservation and job allocations. Some scheduled crops have fixed prices which require an enactment to purchase any such crops to producers of such crops as planted in the calendar year in which the order is made for example;

CAP 318 of the Kenyan agricultural law contain fixing of prices and guaranteed minimum prices for scheduled animal products.

Variation of prices after special review. The minister varies any prices or guaranteed price fixed for any period at the last annual or special review or any price agreed with the representatives of producer for any period.

Importance of compliance with legislation to the organization and the external market.

Organization compliance is very important because it forms part of your organization's duties with respect to the community it belongs to while building trust. In the area of safety certain products and utilities must comply with standards in order to protect people. When organization trains itself to abide by proper code of conduct, errors and misunderstandings can be prevented while providing everyone with a healthy atmosphere not only within the organization/company but also the company it serves.

Conclusion

This learning outcome covered; human resources management, its meaning and importance. It also covered performance contracting, monitoring and evaluation, staff recruitment and conflict resolution.

Further Reading

1. Journal on agriculture Act CAP 318 (Rev. 2012)
2. Journal on introduction to farm planning budgets for new and beginning farmers-Virginia cooperative extension.

9.3.3.3 Self-Assessment

Written assessment

1. The following shows various ways in which personnel are sourced in an organization which one does not?
    a) Sourcing within the organization
    b) Sourcing through connections with management of the organization
    c) Sourcing from various social media platforms
2. Two of the following shows importance of performance management. Which one does not?
    a) Established rules
    b) Explain professional development plan
    c) Reduced stress
3. Expected outcome of performance management include all the following except?
    a) What goods and services should the job produce?
    b) What process should evaluate the efficiency of farm enterprises?
    c) How should employees act with clients, colleagues and supervisors?
4. Which one is not an example of farm budget?
    a) Whole-partial budget
    b) Partial budget
    c) Cash flow budget
    d) Enterprise budget

5. The following are examples of variable cost, which one is not?
    a) Expenses on various commodities
    b) Insurance on crops
    c) Income from sales
6. Differentiate between external and internal forms of communication
7. Name two types of farm budgets
8. Give two objectives of performance management in an organization
9. What do you understand by performance contracting?
10. Give three functions of human resource manager in an agricultural firm.

Oral Assessment

1. Explain the various forms of internal communications
2. Explain the expected outcome of performance management in an organization

Case Study Assessment

An agricultural firm has lost two of its workers/ staff to another agricultural firm, the company therefore wishes to recruit two workers to work on the livestock enterprise and crop enterprise. You are the human resource manager how are you going to source out the best candidate fit for the various positions and why? What measures are you going to take to ensure that workers are satisfied with work and their needs met?

Practical Assessment

Visit the school agricultural enterprise dealing with livestock on production of various crops identify the variable and fixed costs and compute a break-even analysis.

9.3.3.4 Tools, Equipment, Supplies and Materials

- Flip charts
- Note books
- Ruler
- Text books and manual
- Projectors
- Computers
- Staff registers
- Masters roll

9.3.3.5 References

C GAP- working group on savings mobilization 1998. Proceedings of the Africa conference- savings in the context of microfinance Kampala, Uganda, Eschborn

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WOCCOL/ USAID, 1992. Financial planning and Budgeting. Training manual of the small farmer organizations strengthening project in Honduras.

9.3.4 Learning Outcome No 3: Manage farm finances

9.3.4.1 Learning Activities

Learning Outcome No 3: Manage farm finances	
Learning Activities	**Special Instructions**
3.1. Prepare farm budget in accordance with enterprise requirements 3.2. Identify financial priorities in accordance with farm budget 3.3. Control and monitor financial operations in accordance with SOPs 3.4. Maintain financial records as per SOPs	Field Excursion (Visit a nearby farm and identity various enterprises in terms of financial priorities) Demonstrate how farm budgets are prepared.

9.3.4.2 Information Sheet No9/LO3: Manage farm finances

Introduction

This learning outcome covered; farm accounts sources of finance, financial accounts balance sheets, farm records, sales records, purchase records, production records and financial documents.

Definition of key terms

Farm records: A document used to keep account of different activities, events materials regarding the farm operations.

Financial documents: These are formal records of financial activities and position of a business, person or other entity.

Farm accounts: They are statements of money paid out or received for goods and services used farming business.

Content/procedures/methods/illustrations

3.1 Farm budget is prepared in accordance with then enterprise requirements

A farm budget is a statement of estimated income and expenditure. A process of estimating costs, returns and the profit of a farm or a particular enterprise. Before preparing, a farm budget a farm plan must developed. The farming plan can be divided to two stages namely;

i. Analysis and consideration of the factors that influence the choice of branches of production
ii. The choice of branches of production

Available resources must be analyzed namely; the farm, buildings and equipment, capital, labor and management. The following factors are applicable and demand careful analysis and consideration when developing a farming plan

- The available resources
- Marketing aspects
- The relationship between production branches
- Specialization as opposed to diversification

A farm budget based on enterprise requirements will form an enterprise budget. An enterprise budget includes all cost and returns associated with producing one enterprise on particular manner. Enterprise per acre or per head to facilitate comparisons among alternative enterprises. An enterprise is any activity, which results in a product used in the farm or sold in the market examples of enterprises, includes an acre of wheat, a cow producing calves and an acre of maize.

Enterprise Budget Construction

Procedures and assumptions used in constructing an enterprise budget affect the way it is interpreted. For budgeting process, most regions are divided into production areas. These production areas are grouped by production practices/land areas to reflect similar soil weather economic conditions. Budgets are constructed for most of the major crop and livestock enterprises found in a particular area.

Enterprise Budget Components

Every enterprise budget has three main parts; income, variable costs and fixed costs.

Income

Income is identified in the first section of the budget. Income, shows the products produced the quantity and unit of each product and the expected price per unit. Total income (revenue) per product is quantity multiplied by income per unit price. Most budgets are blank for users to enter expected income. The purpose of the enterprise budget may affect the yield and price estimates.

Variable (Operating)costs

Variable costs are the second set of values in the budget. Variable are those cost that vary with changes in production. They are grouped according to stage of production. Within each stage of production, operations are listed in the order they are performed such as harrowing, disking and sowing seeds.

Types of variable costs are; non-cash and cash costs are incurred for items such as fuel, bailing twine and repairs on cash costs are incurred for labour supplied by the farm operator. Unless otherwise stated, most budget treat labour as if it is operator labour therefore non-cash.

Fixed (ownership) Costs

The fixed ownership of costs is shown in the meet section of the budget. They represent costs that are incurred, weather the production of enterprise occurs or not once the land machinery and equipment necessary for the enterprise have been obtained. Fixed costs are often referred to as ownership costs or sunk costs. It should be emphasized that if the enterprise budget is for a new enterprise and necessary land, machinery and equipment have not yet been, these ownership costs are still available at that point by not producing or by not obtaining the assets. Cash costs in fixed costs include cash leases, insurance and taxes on machinery, equipment buildings and land. Cash fixed costs consist of interest and depreciation, where all interest is treated as opportunity costs. Depreciation provides a means of spreading replacement cost over the useful lives of machinery and equipment.

Table 17: Examples of a Budget:

Year 1

Hay establishment production cost and returns		
Year one	No. of tones	Total cost
Gross income		
Oat hay	3 tons @sh 60000	Ksh. 180,000
Total cost		Ksh. 240,266
Net projected returns		Ksh 60260

Year 2

Year 2		
Gross income	2.5 @6500	162500
Oat + alfalfa hag		
Year 1 cost	6026	6388
Other costs		31868
Net projected returns		ksh. 22006

Importance of Enterprise Budget

It provides production targets that the farmer must produce to cover all costs for production targets that the farmers must produce in order to cover all costs for production of a specific enterprise. It estimates the full economic cost and returns. Helps to show cash flow budgets to estimate seasonal cash inflows and outflows.

3.2 Financial priorities are identified in accordance with farm budget

Financial priorities-they are referred to as things that should come first or should be allocated finances in a company or agricultural firm. If the company is serious about reaching its goals a series of smaller goals or milestones have to be reached first. That is why financial priorities are important to make it possible for a company to progress towards true financial freedom. When setting financial priorities in a farm these questions out to be looked at.

- Should they be set in terms of raw profit?
- Which growth has been achieved in the previous years and months?
- Is the path of the farm crucial foe the general farm production?

Goal Driven Priorities

Financial goals are important in the beginning, when they represent the steps between the idea of business and sustainable financial reality. Without careful ambitions (but realistic) goals in place, it is unlikely that farm will get off the ground-even if it is selling. Financial priorities should be in line with the set financial goals.

Layered Goals

Determining where exactly to set goals is the most challenging part and will vary from business to business and product to product. It is important to establish a farm range of numbers with the low and representing, what you need to achieve and high end representing, a new plan and ideal accomplishment. The priorities should be realistic about what the business needs to do for survival. To establish low end or minimum goal experiences have to reckoned that surpass that number professional expenses like materials, paid hours of labor, hosting fees etc. are obviously parts of the calculation.

Sticking to Set Priorities and Goals

Whatever financial priorities set they must be firm having the gray area between the low and high ends will give the room to accommodate realities. With a partner or group of partners, they must be sure open, precise and clear conversation about financial goals. Every partner should have an input when it is time to establish him or her. Have an honest conversation about what set priorities and goals are realistic and will move the farm business to the next level.

Starting out

Common mistake new entrepreneurs in farm make in business is setting financial priorities to the farm sections that do not have a high profit margin and are less crucial to day to day activities in a farm. However, there are constraints in financial priorities in a farm which include

- Inadequate or ineffective policies
- Conversion of production market and price risk of provided farm products.
- Lack of expertise of financial institutions in managing agricultural loan portfolios

Development of agriculture requires financial services that can support; larger agricultural investments and agriculture –related infrastructure that require long term funding.

3.3 Financial operations are monitored and controlled in accordance with SOPs

Financial operations refer to execution of joint finance mission to provide financial advice and guidance. Support of the procurement process providing pay support and providing disbursing and proper monitoring of financial operations, are crucial. Because it allows one to make timely well and informed decisions in resource to changing conditions. Reviewing operation indicators should be done every month and conduct more thorough analysis the farm’s performance to objective set out at the beginning of the year are compared basing on long term strategic plan. Financial operation indicators fall into five categories;

- Growth- Are the sales and profits of the firm increasing or decreasing year over year look for a trend.
- Liquidity- Can the farm meet its short-term obligations
- Profitability-It is the business making enough profit compared to other similar operations.
- Average – It is the farm business taking advantage of financing to operate and grow?
- Activity-They are the assets of the company managed effectively.

Monitoring of financial operations takes place in the following ways

Operations of key financial statements

The basic reports that every farm business needs to produce are the balance sheet and the profit and loss statement. They are not only vital indicators of the performance of the business but they are also required statutorily. They give overview of financial health of business. It tells the business owner everything that they need to know about how their enterprise is fairing on.

Preparation of inventory records

The farm business may invest heavily on machinery equipment and raw materials. They should maintain accurate inventory records; it shows how much stock was purchased. In addition, how much was used for making the final products, how much money went to waste and whether any farm equipment has gone missing at any point of time. It tells them weather they need to purchase more raw materials and enable them to calculate input/output ratios and stock turnover ratios.

Preparation of working capital statements and financial ratios

Business should ask the finance teams to put together regular working capital statements and periodic calculations of current ratios and quick ratios. This will tell them how any assets they have, as compared to their liabilities, and how many assets they can convert quickly to cash.

Preparation of fund and cash flow statements

Fund flow statements and cash flow statements are vital reports for business that tell them just how much liquid cash is coming into a business. There are many receivables that are marked as revenues, in the balance sheet but in closer examination, they reveal that they are some way off from being converted into hard currency and a business can only run with proper earnings.

Analysis of marketing experiences

How much money is being spent on advertising and does the returns justify the expense or is it merely an unwanted cost for the company. How much money is being spent on other marketing avenues and how many leads are being converted into proper sales.

Competitive Analysis.

Financial indicators of the company should be compared with those of another farm business so that they know how the farm is fairing. May be their competitors are able to costs and increase revenue in ways that this business had no thought of yet.

Importance of Financial Operators

It ensures that an organization is conducting business at peak efficiency and ability. it helps to improve and helps clients the efficiency and accuracy of forecasting, planning and analyzing, close and financial reporting proceeds ultimately close enabling the focus to shift to higher value activities for driving business growth.

It also helps enterprise performance management to provide clients with actionable information and robust tracking capabilities to manage corporate performance, enhance management reporting and improve decision making for driving growth while streamlining the budget the planning and forecasting processes.

3.4 Financial records are maintained as per SOPs

F financial records means all books of account and other financial data and information and includes all such records, data and information stored electronically digitally or non-computer related media. Maintenance of financial records refers to keeping records up to date with current financial transactions maintenance should be in accordance with generally accepted accounting principles. Financial records are made up of two key components namely;

- Evidence of your income and expenses
- Your accounting system or ledger system

These components together, should be designed and organized in a matter that helps

Evidence of Income and Expense

This evidence can exist in many forms, but the more precise and thorough the documentation the company has the better. Example of financial documentation include; monthly bank and credit card statements, invoices, and bills that organizations has paid. Pay roll processing documents receipts for your documents and or bank transactions, bank deposit slips, deposit logs, purchase approval forms, cancelled cheques, expense reports, reimbursement requests and petty cash slips.

When planning the organization of your financial records it is important to think of the ways in which to use them and who might need to access the information. The people who might need access to the financial record include;

- Board of director: They may be legally responsible for your financial management.
- Staff and volunteers: They are involved in program management or financial management who should be able to participate in monitoring your organizations financial health.
- Current donors: They want to ensure that their funds are used in a way that they authorized.
- Local and federal government: They receive registered organizations to file annual returns and undergo regular audits.

Setting up a Filling System

Given the presence of many different kinds of financial documents, it is imperative that the organization have an organized system for the records. The filling system should allow retrieval of records at some point when referrals need to be made. Regardless of which categories you use to file records the documents should be divided up to further categories for example the organization must keep track of incoming funds divided into files for each grant with a separate file for individual donations.

Tracking Receipts: The organization should have a clear written policy, governing how funds are spent. In no case should only one person be in charge of handling funds or approving expenditures in senior to the person who spends the funds in order to keep track of the approvals these simple forms should be available.

Purchase order: A form used by stuff person to request funds to pay for a purchase of goods and services should include at a minimum the name of the stuff person name of the firm and services and goods.

Deposit tag: Contains list of funds to deposit such as donations or grant funds.

Table 3: Example of a balanced sheet

Financial measures 12/31/2015	
Balance sheet amount	Income statement
Current asset 8500	Gross revenue 60000
Current liabilities 4200	Operating expenses 16250
Total assets 70000	Labor 12,500
Total liabilities 42000	Internet expense 3750
	Depreciation 2000
	Net 25500

Conclusion

This learning outcome covered; farm accounts, types of farm records, financial documents i.e. various types of financial documents

Further Reading

1. Journal on farm budgets farm plan, total budget and financing budget page 73-78
2. Journal on financial recording for farmers and ranchers AGEC-302

9.3.4.3 Self-Assessment

Written assessment

Multiple-choice questions

1. The following are factors considerable and demand analysis when development a farming plan which one is not?
    a) A farm budget
    b) Operation resources
    c) Specialization as opposed to diversification
2. Which one of the following does not enterprise budget?
    a) Fixed cost
    b) A whole farm budget
    c) Income
3. Which one of the following best explain one of the should be looked at when setting a financial priority?
    a) It is the path of the farm crucial for general production.
    b) Should they be set in terms of losses
    c) Which growth has not been achieved in the previous years and months?
4. The following shows steps of locating finances to an agriculture, which one does not?
    a) Goal driven priorities
    b) Sticking priorities
    c) Fixed ownership priorities
5. Enterprise budget is constructed a per?
    a) Per acre
    b) Per several enterprises
    c) per two heads producing different entities
6. Differentiate between farm records variable and land fixed cost.
7. Give two examples of fixed ownership
8. Differentiate between farm and budget financial statements
9. Give three component of enterprise budget development

Oral Assessment

1. Explain how an enterprise budget is constructed
2. Explain how monitoring of financial operations takes place

Case Study Assessment

A certain agricultural farm has been making profits over the past one year. Due to their good performance donor wishes to expand their farm enterprises has allocated them find. As a farm manager you have been given the assignment of identifying the best performing enterprise to allocate funds. What priorities and factors would you consider in allocating finance?

Practical Assessment

1. Prepare a balance sheet of the school dairy unit and show it relates to the whole farm budget by visiting the farm and as a volunteer request for dairy unit records.

9.3.4.4 Tools, Equipment, Supplies and Materials

- Flip charts
- Note books
- Ruler
- Text books and manual
- Projectors
- Computers
- Ledger books
- Receipts
- Voucher
- Balance sheets

9.3.4.5 References

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