NATIONAL OPEN UNIVERSITY OF NIGERIA

COURSE CODE : AGR 202

COURSE TITLE :
INTRODUCTORY AGRICULTURAL ENGINEERING

COURSE GUIDE

AGR 202
INTRODUCTORY AGRICULTURAL ENGINEERING

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1.0 INTRODUCTION

Introductory Agricultural Engineering is a second year two (2) credit unit's degree course available to all students offering Bachelor of Science (B.Sc.) Agricultural Science. It may be taken by students who wish to know more about Agricultural Engineering.

Introductory Agricultural Engineering is a formal instruction in the science that deals with basic application of engineering in agriculture in organised institutions of learning. It is aimed at using engineering knowledge to solving practical agricultural problems. Agricultural Engineering is an essential aspect of our educational set up because it educates youths on the impact and opportunity in the engineering and agro-business. It also exposes them to vast store of knowledge available for anyone contemplating owing or managing a farm.

Introductory Agricultural Engineering refers to how the whole process of instruction is expected to occur.

2.0 THE COURSE

This course consists of modules which are subdivided into units. This course guide tells you briefly what the course is all about. What course materials you will be using. It also suggests some general guidelines for the amount of time you are likely to spend on each unit of the course in order to complete it successfully.

It gives you guidance in respect of your Tutor – Marked assignment (**TMA**) which will be made available in the assignment file. There will be regular tutorial classes that are related to the course. It is advisable for you to attend these tutorial sessions. The course will prepare you for the challenges you will meet in the field of agriculture.

Course Aims
This course aims to provide an understanding, appreciation, relevance and the application of basic tools which are based on engineering principles in agriculture.

Course Objectives
To achieve the aims set out, the course has a set of objectives. Each unit has specific objectives which are usually included at the beginning of a unit. You should read these objectives before you study the unit. You may wish to refer to them during your study of the unit to check on your progress. You should always look at the unit objectives after completing a unit. By so doing you would be able to locate your bearing and level of attainment of the objectives of the unit.

Below are the comprehensive objectives of the course as a whole. By meeting these objectives you should have achieved the aims of the course as a whole. After going through this course, you should be able to:

- Appreciate the concept of Agricultural Engineering.

- Know what Agricultural Engineering is all about.
- Relate Agricultural Engineering to how it affects the farmer.
- Appreciate the importance of a workshop in a farm setting and know the basic tools that should be found there and their functions.
- Know the function of an internal combustion engine and the various component parts that make up an engine and their functions.
- Explain the two common engine types and the differences in their working
- Appreciate the terminologies used in describing what is happening in an engine during operation.
- Differentiate between the two tillage systems commonly practised and the implement available for each type.

3.0 WORKING THROUGH THE COURSE

To complete this course, you are required to read each study unit of this study material and read other materials which may be provided by the National Open University of Nigeria. Each unit contains assessment exercises for this course and at certain points in the course you should be required to submit assignments for assessment purposes. At the end of the course, there is a final examination. The course should take you about a total of 17 weeks to complete. Below you will find listed all the components of the course, that you will have to do and how you should allocate your time to each unit in order to complete the course on time and successfully.

I would advice that you avail yourself the opportunity of attending the tutorial sessions where you have the opportunity of comparing knowledge with peers.

THE COURSE MATERIALS
The main components of the course are:

1. The Course Guide
2. Study Units
3. References
4. Assignments
5. Presentation Schedule

Study Units
The course is divided into Modules that are made up of units. The study units in this course are as follows:

Unit 1	Agricultural Engineering
Unit 2	Agricultural Engineering Education in Nigeria
Unit 3	Areas of Application of Agricultural Engineering
Unit 4	Workshop
Unit 5	Materials of Construction
Unit 6	Workshop tools
Unit 7	Internal Combustion Engine
Unit 8	Components of an Internal Combustion Engine

Unit 9 Engine Operation
Unit 10 Tillage
Unit 11 Primary Tillage Equipment
Unit 12 Secondary Tillage Equipment

The first unit focuses on the concept of Agricultural Engineering which is based on mans ability to harness resources for his comfort in farming activities. The second unit gives a brief on agricultural engineering education in Nigeria. The third unit highlights the areas of application of agricultural engineering.

Units four is a brief introduction of what a workshop is and units 5 and 6 talks about the some workshop tools and materials for construction.

Unit 7 talks about an internal combustion (IC) engine, which is a device to release energy in some form of fuels like petrol, diesel etc. Component parts that make up an internal combustion engine with their functions are given in unit 8. Some significant terms are used to describe the operation of an IC engine, and these are presented in unit 9.

In unit 10 you will learn about tillage and the two types of tillage practices. Units 11 deals with the type of implement used for primary tillage and their maintenance and care. Unit 12 deals with the type of implement used for secondary tillage and their maintenance and care.

Each unit consists of one to two weeks work and includes an introduction, objectives, reading materials, exercises, conclusion, summary, tutor-marked assignment (**TMA**), references and other resources. The unit directs you to work on exercises related to the required reading. In general, this exercise questions you on the material you have just covered. Together with TMA's, these exercises will help you in achieving the stated learning objectives of the individual units and of the course.

Presentation Schedule
Your course materials give you important dates for the early and timely completion and submission of your TMA's and attending tutorials. You should remember that you are required to submit all your assignments by the stipulated time and date. You should guard against lagging behind in your work.

Assignment File
In your assignment file, you will find all the details of the works you must submit to your tutor for marking. The marks you obtain for these assignments will count towards the final mark you obtain for this course. Further information on assignments will be found in the Assignment File itself, and later in this Course Guide in the section on assessment. There are many assignments for this course, with each unit having at least one assignment. These assignments are basically meant to assist you to understand the course.

4.0 ASSESSMENT

There are three aspects to the assessment of the course. First are self-exercises, second are the tutor-marked assignments and third is the written examination/end of course examination.

You are advised to be sincere in attending the exercise. In tackling the assignments, you are expected to apply information, knowledge and techniques gathered during the course. The assignments must be submitted to your tutor/facilitator for formal assessment in accordance with the deadlines stated in the presentation schedule and the assignment file. The work you submit to your tutor for assessment will count for 30% of your total course work. At the end of the course, you will need to sit for a final or end of course examination of about three hours duration. This examination will count for 70% of your total course mark.

Tutor-Marked Assignment (TMAs)

The TMA is a continuous assessment component of your course. It accounts for 30% of the total score. You are required to submit at least four (4) TMAs before you are allowed to sit for the end of course examination. The TMAs would be given to you by your facilitator and returned after you have completed them.

Assignment questions for the units in this course are contained in the assignment file. You will be able to complete your assignment from the information and materials contained in reading your study units and references. However, it is desirable to demonstrate that you have read and researched more into other references which will give you a wide view point and may provide a deeper understanding of the subject.

Make sure that each assignment reaches your facilitator on or before the deadline given in the presentation schedule and assignment file. If for any reason you cannot complete your work on time, contact your facilitator before the assignment is due to discuss the possibility of an extension. Extension will not be granted after the due date.

End of Course Examination and Grading

The end of course examination for Introductory Agricultural Engineering will be about 3 hours' duration and has a value of 70% of the total course grade. The examination will consist of questions, which will reflect the type of self-testing, practise exercise and tutor-marked assignment problems you have previously encountered. All areas of the course will be assessed.

Utilize the time between finishing the last unit and sitting for the examination to revise the whole course. You might find it useful to review your self-test, TMAs and comment on them before the examination. The end of course examination covers information from all parts of the course.

Course Marking Scheme

Assessment	Marks
Assignment 1 -4	Four assignment, best three marks of the four account at 10% each = 30% of course marks
End of course examination	70%
Total	**100% of course Materials**

How to get the most from this course

1. In distance learning, the study units replace the university lecture. This is one of the great advantages of distance learning; you can read and work through specially designed study materials at your own pace, and at a time and place that suits you best. Think of it as reading the lecture instead of listening to the lecturer. In the same way a lecturer might give you some reading to do, the study units tell you when to read, and which are your text materials or recommended books. You are provided exercises to do at appropriate points, just as a lecturer might give you an in-class exercise.

2. Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit, and how a particular unit is integrated with the other units and the course as a whole. Next to this is a set of learning objectives. These objectives let you know what you should be able to do, by the time you have completed the unit. These learning objectives are meant to guide your study. The moment a unit is finished, you must go back and check whether you have achieved the objectives. If this is made a habit, then you will have significantly improved your chances of passing the course.

3. The main body of the unit guides you through the required reading from other sources. This will usually be either from your references or from a Reading section.

4. The following is a practical strategy for working through the course. If you run into any trouble, telephone your tutor or visit the study centre nearest to you. Remember that your tutor's job is to help you. When you need assistance, do not hesitate to call and ask your tutor to provide it.

5. Read this Course Guide thoroughly, it is your first assignment.

6. Organise a Study Schedule. Design a "Course Overview" to guide you through the Course. Note the time you are expected to spend on each unit and how the assignments relater to the units. Important information, e.g. details of your tutorials, and the date of the first day of the semester is available at the study centre. You need to gather all the information into one place, such as your diary or a wall calendar. Whatever method you choose to use, you should decide on and write in your own dates and schedule of work for each unit.

7. Once you have created your own study schedule, do everything to stay faithful to it. The major reason that students fail is that they get behind with their course work. If you get into difficulties with your schedule, please let your tutor know before it is too late for help.

8. Turn to units 1, 2 and 3 and read the concept, introduction and the objectives for the units.

9. Assembly the study materials. You will need your references and the unit you are studying at any point in time.

10. As you work through the unit, you will know what sources to consult for further information.

11. Visit your study centre whenever you need up to date information.

12. Well before the relevant due dates (about 4 weeks before due dates), visit your study centre for your next required assignment. Keep in mind that you will learn a lot by doing the assignment carefully. They have been designed to help you meet the objectives of the course and therefore, will help you pass the examination. Submit all assignments not later than the due date.

13. Review the objectives for each study unit to confirm that you have achieved them. If you feel unsure about any of the objectives, review the study materials or consult your tutor. When you are confident that you have achieved a unit's objectives, you can start on the next unit. Proceed unit by unit through the course and try to space your study so that you can keep yourself on schedule.

14. When you have submitted an assignment to your tutor for marking, do not wait for its return before starting on the next unit. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments, both on the tutor-marked assignment form and also the written comments on the ordinary assignments.

15. After completing the last unit, review the course and prepare yourself for the final examination. Check that you have achieved the unit objectives (listed at the beginning of each unit) and the course objectives (listed in the Course Guide)

5.0 TUTOR AND TUTORIALS

There are 14 hours of tutorial provided in support of this course. You will be notified of the dates, times and location of these tutorials as well as the names and phone number of your facilitator, as soon as you are located a tutorial group.

Your tutor or facilitator will mark and comment on your assignments, keep a close watch on your progress on any difficulties you might encounter and provide assistance to you during the course. You mail your tutor-marked assignment to your tutor before the schedule date (at least two working days are required). They will be marked by your tutor and returned to you as soon as possible.

Do not hesitate to contact your facilitator by telephone, e-mail and discuss problems if you need assistance.

The following might be circumstances in which you would find help necessary. Contact your facilitator if:

- You do not understand any part of the study units or the assigned readings.
- You have difficulty with the self-test or exercises.
- You have a question or problem with an assignment or with the grading of an assignment.

You should try your best to attend the tutorials. This is the only chance to have face to face contact with your course facilitator and to ask questions which are answered instantly. You can raise any problem encountered in the course of your study. To gain much benefit from course tutorials prepare a question list before attending them. You must learn a lot from participating in active discussion.

6.0 SUMMARY

Introductory Agricultural Engineering is a course that intends to provide you with the concept and instructional methods. Upon completing this course, you will be equipped with the basic knowledge of Agricultural Engineering and what it entails. In addition, you will be able to answer the following type of questions:

- The concept of Agricultural Engineering.
- What are the responsibilities of an Agricultural Engineer?
- Give examples of the expectation of the farmer from Agricultural Engineering in the community.
- Discus the importance of workshop tools.
- Of what significance is the internal combustion engine?
- Discuss the importance of the component parts of an internal combustion engine.
- Be able to differentiate between the spark ignition engine and the compression ignition engine.
- Know what tillage is all about and the different types.
- How do you care and maintain the types of tillage implement?

Of course, the list of questions that you can answer is not limited to the foregoing lists.
We wish you success in the course and hope that you will find it both interesting and useful.

Wishing you the best of luck.

CONTENT

MODULE 1

INTRODUCTION

UNIT 1 AGRICULTURAL ENGINEERING

CONTENT

1.0 INTRODUCTION

Agricultural engineering is the application of engineering principles to any process associated with producing agriculturally based goods and management of our natural resources. The discipline concerns itself with development of labour-saving, farm

machines, farm buildings, irrigation and drainage systems, and processes for preserving and converting agricultural products to useful feed, and fibre products. Thus we can see that contrary to the erroneous understanding of many people, agricultural engineering is not synonymous to tractorization. Why people have thought that agricultural engineering is synonymous to tractorization is because the earliest engineering intervention had much to do with the reduction of drudgery with the use of tractor, for a very long time.

2.0 OBJECTIVES

By the end of this unit you should be able to:

- Stimulate your interest in agricultural engineering;
- Acquire basic knowledge on what agricultural engineering is all about;
- Know why agricultural engineering is different from any other engineering discipline;
- Know why Agricultural Engineering is not synonymous to tractorization;
- Know the different options under Agricultural Engineering;
- Educate a novice on what agricultural Engineering is all about.

3.0 MAIN BODY

3.1 The Concept of Agricultural Engineering

Man was created with a catalogue of materials of both living and non-living things intended to provide comfort for him. Man's ability to recognize this fact cannot be underestimated, and thus the expertise to harness the relevant materials in engineering to bring about this comfort. Because each of the catalogues of

human problem and desires would require a unique approach to solving it, it will therefore require the use of many engineering branches. Some of which are Building, Civil, Electrical, and Mechanical engineering. The problems often encountered in Agriculture are such that the expertise of a single branch of engineering, some of which is outlined above, is insufficient to provide the needed solution. The expertise of more than one of the branches and varied combinations may be required to solve such a problem. It is for this reason that agricultural engineering emerged. Agricultural Engineering is therefore the application of any or all branches of engineering knowledge to the extent that such knowledge may be used in farming in all its ramifications and in rural living.

3.2 Objective of Agricultural Engineering

The overall objectives of Agricultural Engineering is to provide a conducive working environment for the farmer and assure him that there is dignity in farming, improve his economic situation and make food available in adequate quantity and quality at the right time of need and at a reasonable cost to consumers. These objectives are pursued through one or more of the following:

(a) Reduction in farm hazards: The causes of these hazards are identified and solutions given. This ensures that the farmers labour is not in vain.

(b) Reduction of drudgery in agricultural operations: Agricultural engineering intervention is to develop machines and equipment that can be used in performing agricultural operations to reduce stress on farmers.

(c) Ensuring the availability of agricultural products all year-round: To meet all year-round demand of seasonal crops, they have to be processed and stored. Structures for long – term storage have to be built.

(d) Enhancement of the quality of life for the farmer. Agricultural engineering provides conveniences on the farm, such conveniences include farm houses, good farm roads etc.

3.3 Options in Agricultural Engineering

Agricultural Engineering embraces a variety of speciality areas. As new challenges, technology and information emerges, speciality areas are transformed, new ones re created, with many overlapping with one or more other areas. Areas of specialization of Agricultural Engineering include:

3.3.1 Farm Power and Machinery Engineering

This aspect of Agricultural Engineering deals with the design, maintenance and repairs of plant and machineries, transporting and processing machines for biological materials, other power units such as water pumps, electric power generation sets, small engines etc.

3.3.2 Structures and Environmental Engineering

This aspect deals with the development of farmstead and infrastructures which include farm houses, access roads, animal housing, green houses, storage structures and water handling facilities such as dams and canals.

3.3.3 Soil and Water Engineering

Where does water go after it falls on the soil? This aspect deals with the recommendation of good soil and water conservation practices, design and management of irrigation, drainage and erosion control. This know-how is used to ensure soil conservation and enable crops grow more efficiently while reducing erosion and protecting water quality.

3.3.4 Crop Processing and Storage Engineering

Over thirty percent (30%) of produce of various agricultural crops are lost annually during storage and processing because the experts in crop processing and storage are not engaged in the agro-industries. This option therefore, deals in the design, construction and maintenance of crop processing and storage equipment and systems.

3.3.5 Food Engineering

This is a specialized area dealing with processes and machinery required for processing agricultural products into food

The discipline of Agricultural Engineering is currently undergoing major and important changes as it responds to perturbations in the global economy. These changes are as a result of some technologies that are still unfolding. These Emerging Technologies include; Information Technology; Biotechnology; Environmental Engineering and Renewable Energy.

4.0 CONCLUSION

Agricultural Engineering is the bedrock of agricultural development and its neglect is a potential threat to the future survival of any country. Most of the countries who in recent times cried out for international aids are where the agricultural system has failed either due to drought, insect invasion or low agricultural input. Interestingly, most of these problems are what agricultural engineering as a profession could have arrested given the facilities and challenges. The profession has great potentials to solve most of the problems facing agriculture especially in developing countries.

5.0 SUMMARY

In this unit you have learnt that:

- Agricultural engineering is the application of engineering principles to any process associated with producing agriculturally based goods and management of our natural resources.
- Agricultural engineering is more than just tractorisation
- Agricultural Engineering is a build-up of other engineering disciplines
- There are numerous objectives that Agricultural engineering aims to achieve
- There are various options under Agricultural Engineering and also emerging options which are due to technologies unfolding.

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1. Define Agricultural Engineering.

2. Is Agricultural Engineering synonymous with tractorisation? Give reasons for your answer.
3. Give four (4) objectives of Agricultural Engineering.
4. Succinctly discuss the various options that are in Agricultural Engineering.

7.0 REFERENCES/FURTHER READING

Onwualu, A.P. (ed) (2001). Agricultural Engineering Practice in Nigeria: *Nigerian Institute of Agricultural Engineers (NIAE) book of achievement. Publ.* NIAE (A division of the Nigerian Society of Engineers).

UNIT 2 AGRICULTURAL ENGINEERING EDUCATION IN NIGERIA

CONTENT

1.0 INTRODUCTION

Prior to the 1960s, engineering problems on Nigerian farms were tackled using the expertise and services of agriculturists and civil engineers, as agricultural engineering was unknown as a discipline in Nigeria. Because of the popularity the agriculturists and civil engineers enjoyed in providing engineering services on the farm, some of them took interest in the profession and sought for opportunities to retrain themselves in what today forms the agricultural engineering curriculum. Some of the pioneer agricultural engineers in Nigeria were therefore also specialists of other disciplines. Because there were no local training opportunities, those who were interested had to train outside Nigeria. Many pioneer agricultural engineers had a part or whole of their professional education outside Nigeria.

2.0 OBJECTIVES

By the end of this unit you should be able to:

- Know how the agricultural engineering profession began in Nigeria
- The foundation on which agricultural engineering started.
- Know the admission and graduation require for agricultural engineering course.
- Know the regulatory body that supervises the running of agricultural engineering course

3.0 MAIN CONTENT

3.1 Admission and Graduation Requirement

Two criteria must be met by candidates, who wish to be admitted to a university degree programme in any discipline in Nigeria, agricultural engineering inclusive. One is obtaining passes at credit levels in a minimum of five subjects at one sitting or six at two sittings in the Senior Secondary School or the General Certificate Examinations. For agricultural engineering, these subjects include English language, mathematics, physics, chemistry and any other science related subject. The second criterion is sitting and passing the universities matriculation examination and obtaining a grade higher than the cut-off mark for the programme during the year the examination is taken.

Graduation requirements have undergone changes all over the years. At present, a number of Nigerian universities operate the cumulative grade point average (CGPA) system. Under this system, all courses taken by a student are used in calculating his class of degree.

3.2 Regulatory body

A professional Regulatory body is a body established by a decree or law whose primary function is to regulate the training of members of the profession and the professional practice while a professional Society is an association formed by members of the profession with the primary objective of providing a forum where members of the profession can interact to share ideas.

For most programmes in Nigeria tertiary institution, there are two regulatory bodies. One is an organ of the Ministry of Education who bears the burden of funding the programme and the second is a professional one concerned mainly with the adherence to the ethics of the profession. The National Universities Commission (NUC) and the National Board for Technical Education (NBTE), are organs of the Ministry of Education that oversee all academic programmes in the universities and the polytechnics/colleges of agriculture respectively. Each programme has its own professional monitoring body.

4.0 CONCLUSION

Early agricultural engineering curricula dwelled mainly on tractor application and repairs such that when the name was changed to farm mechanization and much later agricultural engineering following a better knowledge of the profession, its widening curriculum and role in agricultural development, many did not perceive it beyond the already well known tractor maintenance use.

The wrong notion and the herculain task of disabusing people's mind have seriously affected the development of the profession in many areas. At least in many of the universities, the agricultural engineering programme is based in the faculty/college of engineering where a number of the engineering disciplines are offered.

5.0 SUMMARY

In this unit you have learnt that:

- Prior to the 1960s, engineering problems on Nigerian farms were tackled using the expertise and services of agriculturists and civil engineers, as agricultural engineering was unknown as a discipline in Nigeria.
- Prior to local training opportunities, those who were interested in agricultural engineering had to train outside Nigeria.
- Two criteria must be met by candidates, who wish to be admitted to study agricultural engineering discipline in a Nigerian university.
- Early agricultural engineering curricula dwelled mainly on tractor application and repairs.

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1. Which professions tackled engineering problems on Nigerian farms prior to the existence of Agricultural Engineering?
2. What criteria must be met by candidates, who wish to be admitted to a university degree programme in agricultural engineering in Nigeria?
3. What are the functions of a professional regulatory body?

4. What is the difference between a regulatory body and a professional society?

7.0 REFERENCES/FURTHER READING

Mijinyawa, Y. (2005). Agricultural Engineering Education in Nigeria. *Agricultural Engineering International: the CIGR Ejournal.* Invited Overview Paper No. 10. Vol. VII, August 2005.

UNIT 3 AREAS OF APPLICATION OF AGRICULTURAL ENGINEERING

CONTENT

1.0 INTRODUCTION

The description of Agricultural Engineering plays a pivotal and important role in the development of Nigeria. These are in the areas of food security, reduction of drudgery in agricultural work, rural infrastructural development, soil and water resources management, environmental management, improvement in the quality of life of farmers, sustainable agriculture and industrial development.

Agricultural engineering graduates have in the past found jobs in the following areas of economy; Government, Self-employment, Educational Institutions, Research and development Institution, International Organizations and other areas not usually recognized by employers of labour.

2.0 OBJECTIVES

By the end of this unit you should be able to:

- Know how the Agricultural Engineering profession helps in national development.
- Know areas of job opportunities.

3.0 MAIN BODY

3.1 Agricultural Engineering in National Development.

3.1.1 Food Security

Food security has recently become an important concept in sub-Saharan Africa. For Nigeria, the idea of food security revolves around ensuring that there is readily available food in the right quantity and quality and at an affordable price.

Food security can only be achieved if the food is produced in abundant quantity and in fact at commercial scale. Even when food is abundantly produced, if it is not taken care of, most of it will be lost to deterioration.

The Federal Government and some States in Nigeria have recognized the need to ensure food security and so they established a number of institutions to ensure food security. These include the Federal Strategic Food Reserve under the Federal Ministry pf Agriculture and other parastatals in the Ministry. In all these areas, Agricultural Engineering principles are practiced to ensure that there is adequate supply of food all year round.

3.1.2 Reduction of Drudgery in Agricultural Work

The traditional farming method and system in Nigeria is characterised by the use of primitive tools and technology. These include the hoe, machete, and axe. A visit to any rural farming community will reveal how tedious it is to work with hand tools. For toiling under the sun for hours, most farmers can only cover a few fraction of a hectare. The drudgery involved in Nigerian traditional agricultural system can be seen on the faces and body of farmers.

With the introduction of machines, tedious operations hitherto handled by man are mechanised. Operating machines is less tedious than manual operations. The reduction in drudgery that comes with the introduction of machine makes agricultural work to be more attractive to the younger generation. This has a number of implications including a reduction in rural-urban migration, and improved dignity of the agricultural worker.

3.1.3 Rural Infrastructural Development

Most large-scale agricultural development programmes involve the development of basic rural infrastructure. These infrastructures include water, roads, electricity, schools, markets, energy supply systems, maintenance systems, processing systems and waste management and control systems. When these infrastructures are provided for the farm, the rural population benefits.

Thus, agricultural engineering has been referred to as a catalyst for rural infrastructural development. This is because with the development of the infrastructure listed above, the

standard of living of rural dwellers is improved as they have access to basic necessities of life.

3.1.4 Natural Resources Conservation

The natural resources on which the practice of agriculture is based are soil, water and air. One of the important roles of agricultural engineering is to ensure an optimum management of these resources. This will ensure that these resources are conserved. If soil and water resources are used without conservation, then one day, the resources will deplete to a point where they can no longer support plant and animal life.

Soil and Water Engineering option in Agricultural Engineering ensures that soil and water are conserved and reclaimed where necessary. Agricultural Engineering practices such as conservation tillage, terracing, erosion control, etc, are used for soil and water conservation. These are practised by Agricultural Engineers in many institutions in Nigeria including the River Basin Development Authorities and Agricultural Development Projects.

3.1.5 Environmental Management

A major area of Agricultural Engineering deals with environmental management. The control and hence management of the environment is achieved in different area. First, is the control of the environment (moisture, temperature, humidity, etc) of the environment of animals and crops. Agricultural Engineering provides required environmental conditions for the growth of animals and crops. After harvest, technologies are provided

for managing the environments under storage. The second aspect of environmental control and management involves solid and liquid waste disposal. Agriculture produces waste in different forms – animal dung, crop residue, damaged food etc. the practice of engineering in agriculture provides the techniques for managing these wastes by recycling and converting some of them to useful products. The third area of environmental management includes the control of the use of natural resources, forestry and horticulture where machines and systems are provided for environmental beautification.

3.1.6 Quality of Life of Farmers

With the practice of agricultural engineering the quality of life of farmers is improved. Engineering in agriculture comes with it, mechanization of production. For mechanization to succeed, it has to be practiced on relatively large-scale farms. This results in farmers shifting from subsistent to commercial farming. With the scale of production increased, farmers can make more profits. More profits mean that they can have more disposable income, which they can invest in other areas of economic venture. In addition, they can now buy what they need to live decent lives and improve on their standard of living. This is the main goal of any national development strategy.

3.1.7 Sustainable Agriculture

A sustainable agricultural system is one that operates in such a way that the ability of future generations to operate is not compromised. Sustainable agriculture is therefore practiced in such a way the future generations can practice their own agriculture. In other

words, the resources used for agriculture should be used in such a way that they are not depleted to a point where they cannot support agriculture for future generations. Agricultural Engineering provides technologies for conserving resources (Soil, Water, Energy and Funds) while producing enough food for the present generation. This is achieved through optimization techniques, which Agricultural engineering offers.

3.1.8 Industrial Development

When engineering is applied in agriculture, more food is produced and the variety and type of food increase. It means there will be more food in the economy than what is needed for consumption. This situation fuels the development of industries for processing the excess food into industrial raw materials either for local consumption or foe export. For example, it is now common knowledge that cassava is processed into industrial raw materials of different forms. With industries springing up, more employment opportunities are created and government revenue improves through more tax revenue. Thus, this can lead to a buoyant economy and citizens that are more gainfully employed.

3.2 Career Opportunities in Agricultural Engineering

3.2.1 Government Ministries

Nigeria operates three tiers of government, namely, federal, state, and local government. Each of these tiers of government operates ministries where agricultural engineers are employed. At the federal level these include Ministries of Agriculture, Water Resources, Environment, Science and Technology. Each of the Ministries has departments under which many Agricultural Engineers are contributing their quota towards national

development. At the state and local government levels, similar ministries exist and each of them has an engineering division.

3.2.2 Government Parastatals

There are many government agencies, which are supervised by some ministries or are directly supervised by the Chief Executives of the states or at the federal level by the Presidency. Some of these have been phased out but many of them are still operational and since their services are agricultural based, they employ agricultural engineers. These include Tractor and Equipment Hiring companies, Environmental Protection Agencies in the state and federal level, National Centre for Agricultural Mechanization, River Basin Development Authorities, Erosion and Flood Control Programmes, etc.

3.2.3 Private Companies and Industries

In the private sector, there are many opportunities for Agricultural Engineers in the service and production industry. In this sector, there are companies who provide agricultural services with engineering content. These include companies involved in the marketing and maintenance of agricultural machinery, agrochemicals and provision of agricultural services of different forms. Companies of this category include Tractor and Equipment (Division of UAC), Diezengoff, Leventies Technical, etc, and a host of other smaller indigenous companies. In the production sector, there are food processing companies and equipment manufacturing companies, flour mills, rice mills, tractor assembly plants, beverage manufacturers, confectionaries manufacturers etc.

3.2.4 Educational Institution

Educational institutions in Nigeria include Colleges of Agriculture, Education, and Technology. There are also Polytechnics and Universities. Some of these Institutions have Department of Agricultural Engineering as well as Farm Operation Centre where Agricultural Engineers are employed. \

3.2.5 Research and Development Institution

There are many Research and Development (R&D) institutions in Nigeria. Under the Federal Ministry of Agriculture, there are over 18 Agricultural research Institutes. Each of the institute has an Agricultural Engineering Department as well as a field demonstration farm and industrial development units where the Agricultural Engineer works.

3.2.6 International Organizations

There are a number of international organizations resident in Nigeria who are involved in agricultural and rural development and so employ Agricultural Engineers. These include the United Nations Development Programme (UNDP), Food and Agriculture Organization (FAO), World Bank, International Labour Organization (ILO), United Nations Educational and Scientific Organization (UNESCO), American Agency for International Development (USAID). In addition there are some Non-Governmental Organization (NGOs) who are involved in Agriculture and Rural Development. These include Ford Foundation etc.

3.2.7 Self Employment

Self employment is an area that has not been fully explored or exploited by Agricultural Engineers. Opportunities exist in consultancy field in almost all government parastatals and the NGOs, as well as companies in the private sector. These include all areas of project feasibility, implementation, monitoring and evaluation. Many food processing industries need agricultural raw materials, which can be supplied by Agricultural Engineers, especially those interested in post harvest systems. There are also wide ranges of opportunities in storage.

3.2.8 Other areas

There are other areas of employment, which are usually not recognized by employers of labour. Usually, the tendency by Human Resources Personnel in companies is to exclude agricultural engineering discipline when they are looking for staff, even in areas where agricultural engineers by their training will do better than other engineers. For example, in a recent advertisement for jobs by Niger Delta Development Commission, Agricultural Engineering was not listed. Yet the Commission's business is to develop an area where 95% of the inhabitants are farmers.

4.0 CONCLUSION

Agricultural Engineering, which is the grass root profession has hardly been involved in the conceptualization and implementation of programmes aimed at improving the well being of the people at the grass root in Nigeria. This unit has enabled you understood

how agricultural engineering helps in National Development. You are also aware of the several career opportunities offered by agricultural engineering.

5.0 SUMMARY

This unit has acquainted you with:

- The fact that agricultural engineering is a grass root profession which if given its rightful place in Nigeria will greatly contribute to national development.
- Areas where agricultural engineering is relevant in National development
- Career opportunities in agricultural engineering
- The arrears of relevance of agricultural engineering in International Organizations

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1. Discuss six (6) areas where agricultural engineering plays a pivotal and important role in the national development of Nigeria.
2. What reasons can you adduce behind the lack of impact of agricultural engineering in National Development?
3. Discuss six (6) areas of career opportunities that is offered by agricultural engineering.

7.0 REFERENCES/FURTHER READING

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MODULE 2

WORKSHOP TOOLS AND MATERIALS OF CONSTRUCTION

Unit 1 Worksop

Unit 2 Workshop Tools

Unit 3 Materials of Construction

UNIT 1 WORKSHOP

CONTENT

1.0 INTRODUCTION

The workshop is a room or building in which manual work or manufacture etc is carried out. In any society, rules and regulations must be devised for the guidance and benefit of

all concerned; the workshop is no exception. These rules are necessary to make the workshop a safe, efficient and healthy place in which to work.

2.0 OBJECTIVES

By the end of this unit you should be able to:

- Know what a workshop is.
- Know what is required of a workshop environment.
- Know the care and order required in the workshop.
- Know about workshop safety.

3.0 MAIN BODY

3.1 Workshop Environment

There are many different sets of conditions and circumstances affecting the safe layouts of workshops. There are, however, certain general points that will be considered here, and are as follows,

3.1.1 Gang ways

Those parts of a workshop floor which are allocated for personnel to walk on their necessary business requirements should:

1. be clearly marked with broad lines and clearly labelled, preferably by using a light-coloured luminous paint;
2. be wide enough to ensure that people using them are well clear of machines and their operators;

3. allow clear access, by the shortest practicable route, to all exits;
4. be kept clean and free from obstruction;

3.1.2 Emergency Lighting

When there is a possibility, however remote, of the main lightning system failing during the hours of darkness, it is essential that an alternative system be provided. Ideally, this should consist of an adequate number of battery-operated lamps, which are switched on automatically whenever the mains power fails. These lamps should be positioned so that they illuminate gangways, corridors, exists and all places where projecting objects can be hazardous. The operation of emergency lighting equipment should, of course, be tested regularly, especially when emergencies are few and far between.

3.1.3 Suspended Weights

If heavy weights must be suspended for any length of time,

1. Get them down again as soon as possible;
2. Make sure that all lifting equipment is in first class condition;
3. Do not stand underneath.

3.1.4 Dangerous Substances

Many workshops contain certain materials which are dangerous if incorrectly stored or carelessly handled. There are deadly poisons such as cyanide, highly inflammable liquids such as petrol and paraffin, explosive gases, extremely

corrosive acids and many others, all of which are perfectly safe if a few common sense rules are observed;

1. Obey implicitly all handling and storage instructions issued by manufacturers and other competent authorities, especially with regard to one's own personal cleanliness.
2. Never dispose of unwanted substance or waste by burning them or pouring them into drains.
3. Never allow dangerous or unstable substances to come into contact with one another, e.g. oil and oxygen are liable too explode when mixed.
4. Always wear the correct protective clothing and equipment.
5. make sure that there is adequate ventilation
6. Never investigate mysterious packages which seem to have lost their labels.
7. "No Smoking" means **NO SMOKING.**

3.1.5 Bars of Metals

Bars of metal incorrectly stored can be very dangerous. They should be kept horizontally in strongly built racks with the shorter pieces on top so that they are supported by, and parallel with, the longer bars.

All tools, materials, etc., not immediately required for the job in hand should be put away or returned to the stores. Benches should be brushed, floors should be swept, machines should be cleaned and swarf trays emptied, all at regular

intervals, in order to prevent the accumulation of dirt and metal cuttings. Proper receptacles for the disposal of swarf and rubbish should be provided.

3.1.6 Injuries

All cuts and scratches, however slight, must be treated as quickly as possible in a first-aid centre. Particles of foreign matter must be removed from the eyes as soon as they are felt. Delay in getting these things done can lead to infection, loss of limbs and blindness.

It may be impractical to expect everybody to be skilled in first aid, but it is essential for all workshop personnel to be aware of certain fundamental obligations to their fellows. They are;

a. To read all the notices, prominently displayed in every properly run workshop, dealing with the saving of life and the prevention of accidents;

b. To know the location of first aid boxes, fire blankets and fire extinguishers;

c. To know the names of the people who are skilled in first aid and where they can be found;

d. To know the procedure for calling an ambulance. (This information should be prominently displayed together with the location of the nearest telephone).

3.2 Care and Order in the Workshop

It is necessary to offer a few words of advice on matters of tangible nature and do so in the hope that they may help to form the right type of habits to commence with. If good habits can be formed early in one's career, they are never left behind and their value cannot be estimated.

3.2.1 Tidiness – Habits of tidiness are no less important in the workshop than in any other aspect of life, and one may form a very reliable judgement regarding the capabilities of a workman by the tidiness and order or otherwise of his method of working. When we say tidiness we mean more than the obvious habits of tidiness exhibited by keeping one's tools in their proper place, replacing a tool as soon as it is finished with, and so on. Tidiness implies such order, cleanliness and method in one's working that the job seems to proceed smoothly without any obvious effort.

A first-class mechanic should regard soil, dirt or superfluous articles about his machine, tools, or work with as much concern as if they were on his own person. If he has developed orderly habits it will not be necessary for him to fritter his energy looking for tools, or clearing unwanted article, he will have his mind clear for attending to the jobs, and at the end of the day he will be fresher than another of untidy habits who probably has not done nearly as much useful work.

3.2.2 The Care of Tools and Machines – from the very start of his career the reader will need the help of tools and machines in his work, and as he advances these will get more numerous and costly. Some of the tools will belong to the employer; others will be the reader's property. To the employer, the equipment he provides represents so much capital being used in the business for obtaining output, and earning profits, whilst to the worker, the equipment represents the means of earning his living, and a better living may be earned if the equipment is kept in good condition. The accuracy and life of a machine tool is helped exceedingly if it is kept clean.

Spanners, files and other heavy objects should not be dropped on the machined surfaces of tables and slides. If we must store spanners and tools on a machine bed a piece of board placed under them will look tidier, and leave the machine undamaged.

Often, it is necessary to use a hammer to loosen, tighten or withdraw some part of a machine. If possible a lead or copper hammer should be used to avoid bruising the part being hit. Failing that, a block of hard wood or soft metal interposed between the hammer and the part being hit will save damage. It is a shame to see in some workshops, parts of machines mutilated by constant hammering; the handles of vises and jigs are particularly unfortunate in this respect; actually these are hammered up far more than they need be to hold the work securely.

3.2.3 Grinding Tools – In every machine shop a considerable amount of capital is locked up in cutters, cutting tools, drills and various other cutting equipment, and when we consider that these are made from steel which is vary costly, we realise that the annual cost of them must be heavy. Because they do not have the appearance of being worth much, and because they are the general property of everyone, they are not always treated with the respect due to them. As a tool is used its edge gradually becomes dulled and needs re-sharpening. If this is delayed the tool rapidly deteriorates and might in a short time be ruined. The reader should learn as soon as possible the proper methods of grinding tools, as a tool may be as easily spoiled by faulty grinding as by being left unground.

When a tool is ground, a large amount of heat is generated, and if plenty water is flowing it carries the heat away, thus preventing the tool from over heating. If the tool is ground gently without water the heat is not generated as rapidly, and has time to be conducted away to the body before the edge becomes burned. If the supply of water is sparse and intermittent the outside of the tool becomes heated, and when a splash of water falls on to it a sudden local quenching takes place leading to minute cracks which sooner or later will lead to the failure of the tool. Grinding a tool dry, and plunging it into cold water from time to time will lead to similar effects, and is equally as bad as using an insufficient supply of water.

3.2.4 Tool failure in cutting – A frequent cause of tool failure is running the machine fast. This causes rapid overheating and deterioration of the cutting edge, and if the

tool seems to be making hard work of its job the speed should be reduced and plenty of cutting lubricant applied to the tool. Cast iron should not be cut with a lubricant, but can generally be machined if the first cut gets well beneath the hard outer scale. If the tool is allowed to ride over the hard scale its nose will be rubbed away.

Some of the special steels which must be machined have the property of hardening up under the action of the tool. This is accentuated if the tool is allowed to "loiter" on its job, and if the tool is kept well up to its work on a low speed, it will bite into the material and cut efficiently.

The reader in matters of safety and care, not only to develop good habits himself, but also to take initiative in persuading others of the importance of doing the same. If everyone who reads these notes and acts on the advice contained can claim a convert to their principles, he will have achieved a creditable piece of work.

3.3 Workshop Safety

All work in the shop must be done with everyone's safety in mind. The most important safety tool in class is a good attitude. The right attitude simply means a good worker. When doing something, consider the other people in the shop.

There are five (5) important areas of safety:

(i) Personal Safety

(ii) Eye Protection

(iii) Tools

(iv) Housekeeping

(v) Materials Storage and Handling

3.3.1 Personal Safety – includes clothes. Loose fitting clothing like sweaters, jackets, ties, and jewellery should be taken off. Shirt tails and long hair must be tucked in. Sleeves should be buttoned or rolled above the elbow. Wear shop aprons. Report all injuries, even the slightest scratch, sliver, or cut.

3.3.2 Eye Protection – is required for power tool work or where there is flying dust or particles.

3.3.3 Tool Safety – means not touching or handling a tool until your instructor demonstrates the safe and correct way to use it, and gives you the "okay". Use the right tool for the right job. Carry sharp tools carefully. Always cut away from your hands and body. Clamp your work in a vise whenever possible. Close vises when they are not in use. Return tools to their proper place. Do not use tools with cracked or loose handles. Do not cut with dull tools.

3.3.4 **Housekeeping –** means cleaning up and caring for the shop. Sweep up scraps that someone might slip on. Avoid spilling glues, oils, or finishes. Close lockers, doors, and drawers, and keep aisles clear.

3.3.5 Good **Material Storage –** and handling prevents fires. Shavings, dust, solvents and dirty rags must be stored in the proper containers.

4.0 CONCLUSION

In this unit you have attempted to learn about the workshop. You have also learnt that there are rules necessary to make the workshop a safe, efficient and healthy place in which to work.

5.0 SUMMARY

In this unit you have learnt that:

- The workshop is a room or building in which manual work or manufacture etc. is carried out
- There are many different sets of conditions and circumstances affecting the safe layouts of workshops which form the workshop environment.
- Care and order are necessary in the workshop.
- All work in the shop must be done with everyone's safety in mind.

6.0 TUTORED-MARKED ASSIGNMENTS (TMA)

1. What is a workshop?
2. Why do you need rules and regulations in the workshop?

3. Write on six (6) factors that affect the workshop environment.
4. Write on the care and order that must be maintained in the workshop.
5. List five (5) areas of safety in the shop.
6. What is the first tool safety rule?
7. Why is loose clothing a safety hazard?
8. What safety precautions should be taken to protect your eyes?

7.0 REFERENCES/FURTHER READING

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UNIT 2 WORKSHOP TOOLS

CONTENT

1.0 INTRODUCTION

Workshop tools are mechanical devices used in the workshop. Tools should be used properly at all times so that they will be available for use when needed.

2.0 OBJECTIVES

By the end of this unit you should be able to:

- Know some workshop tools
- The uses of the workshop tools mentioned

3.0 MAIN CONTENT

3.1 Types of Workshop Tools

3.1.1 Files

The file is used for smoothing and shaping metals. Shaping includes three types of file use: Sharpening of tools, Smoothing metal surfaces, and cutting metal to the desired form and dimension.

There are two major kinds of file teeth. The single-cut file has chisel-like teeth running at an angle across the body of the file. Double-cut files have two sets of teeth or chisel cuts that cross each other, the double-cut file cuts faster, but it tears a rough surface.

Figure 1.Files

3.1.2 Nail hammer

Nail hammers are used for driving, pulling or setting nails on wood or metals. There are different types of hammer e.g. ball pene hammer, cross pene hammer, and claw hammer. Points to bear in mind when using a hammer are:

1) The handle should be clean, dry and free from oil or grease.
2) It should be remembered that the hammer face is hardened and it may chip if used on hard materials.
3) A hammer with loose head should not be used.

Figure 2. Nail hammers

3.1.3 Spanner

Spanners are used to screw or unscrew bolts and nuts. Many types of spanner are available but the open-ended, ring, socket and box types are the more commonly used for the maintenance and repair of agricultural machinery.

Figure 3. Open-ended spanner

3.1.4 Hand plane

The hand plane is used for paring (remove thin strip of wood etc) wood. Planning can be done to smoothen surface, straighten or correct the size of an object.

3.1.5 Allen keys

Allen keys are tools in the form of an L-shaped rod, hexagonal in cross section, made in different sizes to turn corresponding sizes of Allen screws.

3.1.6 Hand saw

Hand saws are used to saw (cut) wood. They are cutting tools with zigzag edge. There are various kinds of hand saws; used either for straight sawing or cut curves and circles. Saws commonly used for straight sawing are Crosscut saw and Rip saw, while those for curves and circles are compass and key hole saws. The hand saw may be preferred over the power saws for reasons like: power availability, work can be completed faster on some jobs, some jobs are easier to handle etc.

Figure 4. Allen keys

Figure 5. Hand saw.

3.1.7 Screwdrivers

The screwdriver is used to screw or unscrew a bolt or screws. Several types of screwdrivers exist. The major parts of a screwdriver are: Head, Handle, Ferrute, Blade and Tip.

Figure 6. A Screwdriver

3.1.8 Hand drills

The hand drill is used to bore or drill holes either in wood or metal. A bit which normally does the drilling is inserted in the tip of the drill. The twist drill is commonly used for making holes in the course of repairs to farm machinery and the construction of fittings for farm builds.

4.0 CONCLUSION

In this unit you have attempted to learn about some workshop tools.

5.0 SUMMARY

In this unit you have learnt that:

- There are different types of workshop tools.
- Each workshop tool has a specific function to carry out.

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1. What are workshop tools?

2. Write on any six (6) workshop tools.

7.0 REFERENCE/FURTHER READINGS

Shippen, J.M., C.R. Ellin and C.H. Chover (1980). Basic Farm Machinery. Pergamon Press, Great Britain.

UNIT 3 MATERIALS OF CONSTRUCTION

CONTENT

1.0 INTRODUCTION

The strength, durability, and service of a workshop tool, farm implement etc depends largely upon the kind of material used in building it. The materials of which workshop tools, farm implements and equipment are made can be grouped into two main classes, namely *metals* and *non-metals*. The metals are further divided into *ferrous* and *non-ferrous* materials.

2.0 OBJECTIVES

By the end of this unit you should be able to:

- Know the different kind of engineering materials used for tools, implements etc.
- Know the difference between a metallic and non-metallic material.

- Know the difference between ferrous and non-ferrous materials.

3.0 MAIN CONTENT

3.1 Metals

Metals may be used in various ways,

1. As pure metals.
2. As substances containing non-metals, of which carbon is the most common.
3. As substances containing two or more metals, these are called alloys.

Metals are known as ferrous when they are composed largely of iron and non-ferrous when they do not contain iron.

3.1.1 Ferrous Metals

The ferrous metals include cast iron, wrought iron, and steel. These metals are all produced by the reduction of iron ore into pig iron and subsequent treatments of the pig iron by various manufacturing processes. The term “cast” refers to the process that is used to obtain the final form or shape of the metal. The hot molten metal is poured into a mold and allowed to cool and harden into the shape dictated by the pattern of the mold. The method is used to form many intricate and irregular-shaped parts on tools, farm implement and machinery. The basic differences between iron and steel include the manufacturing processes, the amount of carbon, and impurities, which in turn affect the physical properties.

1. **Cast Iron –** there are five (5) general types of casting that are made of iron. These include gray, white, chilled, malleable, and ductile.
2. **Wrought Iron –** wrought iron is almost pure iron. It is relatively weak. It is not used much in the construction of tools and farm implement. However, pieces of wrought iron can be joined easily by heating them white hot and hammering them together, a process known as forge or fire welding. For this reason, it is very suitable for making chain links and ornamental gates and fences.
3. **Mild Steel –** mild steel is a mixture of iron and about 0.5% (1 part in 200) of carbon. It is stronger than wrought iron. Mild steel can be formed into round or rectangular bar, angle iron and steel metal by rolling it, when red hot, between suitably shaped rollers. Much of the framework and sheet metal work of farm machines is made of mild steel.
4. **Carbon Steel –** when the amount of carbon mixed with iron is greater than about 0.5%, the material is usually called carbon steel. The carbon content varies slightly in different types of carbon steel: and steels containing up to about 1% (1 part in 100) are in common use. Carbon steel is stronger than mild steel, also carbon steel can be hardened and tempered (made softer and tougher) to give the material the properties it needs for particular uses. Carbon steel, sometimes just called steel, is used to make the framework of cultivation machinery, hoe blades, the disc coulters on ploughs, and other parts where strength is essential.
5. **Steel Alloys –** a steel alloy is a mixture of two or more metals. The mixture is composed largely of steel with small amounts of one or more alloy metals. The

more common alloy elements used in steel are baron, manganese, nickel, vanadium, tungsten, and chromium.

3.1.2 Non-Ferrous Metals

1. **Aluminium** – Aluminium is used either pure, as sheet aluminium, or mixed with silicon to make castings. The aluminium sheet is weather resistant and some grain storage bins are made of this material. Aluminium silicon alloys are easy to cast and this is one of the reasons why this substance is used for tractor engine pistons, and parts such as injection pump casings. Some tractor sumps are also made of aluminium silicon alloys.
2. **Brass** – Brass is an alloy of copper and zinc. It is a good bearing material and is often used for the brass bushes which are found on nearly all farm implements. Water pump parts are also sometimes made of brass, due to its resistance to rusting.
3. **Bronze** – Bronze is an alloy of copper and tin; like brass it is a good bearing material. Sometimes phosphorous is added to improve its properties; the substance is then called phosphor bronze.
4. **Copper** – Copper is generally used, alloyed with zinc or tin to give brass or bronze; although copper water pipes are often found in farm buildings. Also due to the fact that it conducts efficiently both heat and an electric current, copper is used for making tractor radiators and for windings in electrical apparatus such as starters and dynamos.
5. **Lead** – Lead is used for making the plates in tractor batteries. Some water pipes are also made of lead; but the material is much dearer than it used to be and iron

or copper pipes are now more commonly fitted. Lead is alloyed with tin to make solder, which is used for the construction and repair of electrical apparatus and plumbing installation.

6. **Tin** – Tin, which is not usually used in the pure state now, owing to its very high cost, is a constituent of solder.
7. **Zinc** – Zinc is also used as a coating for the mild steel plates known as galvanized iron. The clean steel plates are dipped in a bath of molten zinc which coats the surfaces. The zinc is resistant to corrosion by the weather and these sheets are used for the roofs of farm buildings and to make buckets, feeding troughs and other pieces of farm equipment.

3.2 Non-Metals

1. **Wood** – Various types of wood are used in the construction of farm tools, implements and equipment. Four common home-grown timbers, their properties and uses are listed below:

   Ash: a light strong resilient wood particularly suitable for fork and hoe handles.

   Elm: a heavy tough wood durable in water, often used for trailer bottoms.

   Larch: a light resinous soft wood with some degree of resistance to decay used for fencing stakes and for some parts of huts for livestock.

   Oak: a heavy hard wood used for gate posts and for those parts of construction work where strength is essential.

The cost of painting prevents its wide use for the protection of farm woodwork. Lead-based paints should never be used on equipment for stock as they tend to lick it and the intake of even a small amount of paint may cause death. Manufacturers can supply various types of paint which can be applied with safety to woodwork with which stock will come in contact.

2. **Rubber** – Rubber is used for making tractor tyres, driving belts (particularly those of the V type) and hose pipes. It is unaffected by damp but perishes in strong sunlight and it is attacked by fuel and lubricating oils. Rubber tyres can become permanently deformed if the vehicle, tool or implement is left standing for a long time with the tyres under-inflated. To obtain the maximum life for tyres, the pressure should be kept at the correct figure; and if the vehicle or implement is to be stored it should be jacked up and left standing on blocks, the tyres being covered with sacks. Any fuel or lubricating oil which is spilt on a tyre or other rubber parts should be wiped off at once.

3. **Plastics –** The plastics most commonly found on the farm are those of the polythene type which are used for hose pipes, buckets, and various water installation parts such as ball valve floats. These plastics are commonly resistant to cold water, but they become soft and will be distorted by hot water.

Fibreglass, which is made of glass fibres bonded together by special adhesives, is often used for belt and chain guards. The material is not affected by the weather but cracks

may develop if the fixing bolts are not kept tight. If guards made of fibreglass are damaged they can be repaired easily by building up the broken areas with fresh glass fibre and adhesive. Sometimes it may be necessary to cut away the damaged parts; but full instructions are always given with the repair kits, which are readily available.

4.0 CONCLUSION

In this unit you have attempted to learn the workshop and some type of tools that can be found in the workshop. You have also learnt about types of materials used for construction.

5.0 SUMMARY

In this unit you have learnt that;

- The strength, durability, and service of a workshop tool, farm implement etc depends largely upon the kind of material used in building it
- The materials of which workshop tools, farm implements and equipment are made can be grouped into two main classes, namely *metals* and *non-metals*.
- The metals are further divided into *ferrous* and *non-ferrous* materials.
- Metals are known as ferrous when they are composed largely of iron and non-ferrous when they do not contain iron.

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1. Write on any four (4) ferrous metals.
2. Write on any four (4) non-ferrous metals.

3. Write on any two (2) non-metals.

7.0 REFERENCE/FURTHER READINGS

Shippen, J.M., C.R. Ellin and C.H. Chover (1980). Basic Farm Machinery. Pergamon Press, Great Britain.

MODULE 3

INTERNAL COMBUSTION ENGINES AND THEIR OPERATION

Unit 1 Internal Combustion (IC) Engines

Unit 2 Components of an Internal Combustion Engine

Unit 3 Engine Operation

UNIT 1 INTERNAL COMBUSTION (IC) ENGINES

CONTENT

1.0 INTRODUCTION

The internal combustion (IC) engine is a device to release the energy available in some form of fuel like petrol, kerosene, diesel and similar petroleum products. Therefore, it

may also be called an energy converter, in that it liberates the heat energy in the fuel and converts it into usable mechanical energy. Petrol fuel is used for spark ignition (SI) engines while diesel fuel is used for compression ignition (CI) engines.

2.0 OBJECTIVES

By the end of this unit you should be able to:

- Know what an internal combustion engine is
- Know types of tractor
- Know the distinguishing features of different types of tractors
- Appreciate the different power outlets available in a tractor

3.0 MAIN BODY

3.1 The Agricultural Tractor an IC Engine as a Power Source

When an internal combustion engine is equipped to make it self-propelled, it forms a machine commonly known as a tractor. The agricultural tractor is one of the mobile machines that involve the “traction” process. The word “traction” and name “tractor” come from the word to “draw” or “pull” so a tractor is basically a machine for pulling; other mobile machines such as locomotives are in the same class.

The tractor is also in the class of machines that involves operation under what are known as “off-road” conditions. Others in this class include machines used in earth moving, mining and military work, also four-wheel drive motor vehicles for cross-country operations.

3.2 Tractor Types

The different types of tractor are classified in a number of ways, depending on their conformation and general use. One major method of classification is based on the manner in which traction is achieved. Three types of tractor may be identified under this classification:

- Wheel type: A tractor that generally has rubber-tyre wheels at the front and rear.
- Crawler type: A tractor that has a crawler chain or track running practically the full length of the vehicle on both sides.
- Half-track type: A tractor that is a combination of both the above types. That is, the front part has wheels and the rear part has tracks.

The track or crawler-type of tractor is preferred where heavier powered machines are required. They usually used for:

- Land clearing and land forming;
- Soil conservation operations such as pond building, irrigation ditches, and so on;
- Deep tillage operations;
- Work in soft and swampy ground

The large area of contact between the tracks and the ground reduces slip, provides better traction and allows the tractor to be used even on soft ground. However, crawler tractors do not usually have adjustable tread of adequate clearance for row crop operation.

The wheel type of tractor, on the other hand, is more of a general-purpose machine, especially for row crop use. There are four wheels mounted in pairs on front and rear axles and generally the spacing between the wheels is adjustable to suit row crop spacing. In four-wheel-drive tractors the propelling power is delivered to both the front and the rear wheels.

There are also differences in the basic configuration of the tractor chassis, including overall dimensions, and several terms are used to define a particular type, and this is described in table 1.

Table 1: Distinguishing Features of Different Types of Tractors

Tractor Type	**Major or Distinguishing Features**
Row Crop	The implement can become an integral part of the tractor, and can be mounted front or rear. High clearance and adjustable wheel tread (spacing) to suit different crops. Attachments may be easily fixed.
Standard	Ideal for general work but not for row crop cultivation. Less vertical clearance.
Utility	A type between a row crop and a standard wheel tractor. A general purpose-machine.
Orchard	Possesses narrow tread and short wheelbase. Operator seat low. All projecting parts covered to prevent damage by tree branches.
Garden	Small wheel, compact machine with low centre of gravity.
Industrial	Suitable for heavy-duty loading and other industrial operations.
Tool carrier	Provide versatility, simplicity and ease of attaching tools.
Two-wheel	For small operations. Steered by a walking operator.

The classification given in the table is not very definitive but it does provide a rough guideline. However, as can be seen, the basic tractor concept is common to most of the different types of machine.

3.3 Tractor Power Outlets

Today's tractor has been referred to as a "central power station" in that it provides power for many activities, both mobile and stationary. The functions of some of the power outlets from a tractor are as follows:

1. To provide a pull from the rear of the tractor for drawbar machines such as ploughs, trailers, and so on;
2. To provide a push at the front of the tractor for equipment such as bulldozer blades;
3. to provide a rotary drive to the power take-off (PTO) for machines such as balers, mowers, and so on;
4. to provide hydraulic power to a three-point linkage or remote cylinder;
5. to provide power to a belt pulley for machines such as threshers, pumps, and so on;
6. to provide a means of transport, in conjunction with a trolley or any other device.

It is true that not all the power outlets on a tractor are always fully utilized but a good manager will ensure that he gets as many hours of use as possible in a year (thus ultimately reducing the unit cost of operation). The tractor can be kept busy doing different operations at different times of the year, using several of the power outlets listed above.

4.0 CONCLUSION

In this unit you have attempted to learn that a tractor an internal combustion engine is an energy converter. Different types of tractors are available to perform various farm works. You have been educated that a tractor can be kept buy all year round by reason of its various power outlets.

5.0 SUMMARY

In this unit you have learnt that;

- The internal combustion (IC) engine is a device to release the energy available in some form of fuel like petrol, kerosene, diesel and similar petroleum products.
- Petrol fuel is used for spark ignition (SI) engines while diesel fuel is used for compression ignition (CI) engines.
- When an internal combustion engine is equipped to make it self-propelled, it forms a machine commonly known as a tractor.
- The different types of tractor are classified in a number of ways, depending on their conformation and general use.
- There are also differences in the basic configuration of the tractor chassis, including overall dimensions, and several terms are used to define a particular type.
- The functions of some of the power outlets from a tractor.

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1. What is the function of an internal combustion engine?
2. Classify tractor types based on their conformation and general use.
3. Classify tractor types based on the differences in the basic configuration of the tractor chassis.
4. Give five (5) functions of some of the power outlets from a tractor.

7.0 REFERENCES/FURTHER READINGS

Kaul, R.N. and C.O. Egbo. (1985). *Introduction to Agricultural Mechanisation.* General Ed. Onazi, C.O. MacMillan Education Ltd. London and Basingstoke.

UNIT 2 COMPONENTS OF AN INTERNAL COMBUSTION (IC) ENGINE

CONTENT

1.0 INTRODUCTION

The internal combustion engine, when geared to a self-propelling system, comprises what is popularly known as a tractor. In this unit the basic terminology and functioning of an internal combustion engine is examined, with particular reference to its use on a tractor.

2.0 OBJECTIVES

It is expected that at the end of the unit you would be able to:

- Know the significant terms used to describe the operation of an internal combustion engine.

- Know that the IC engine comprises several important components used to liberate the heat energy in fuel into usable mechanical energy.

3.0 MAIN BODY

3.1 Engine Terminology

There are some significant terms to describe the operation of an internal combustion engine and are:

a) Bore - The diameter of the cylinder

b) Stroke - The maximum length of travel of the piston from one extreme position to the other in one direction.

c) Top Dead Centre (TDC) - The position of the piston at the end of its travel when moving towards the cylinder head.

d) Bottom Dead centre (BDC) - The position of the piston at the end of its travel when moving towards the crankcase.

e) Piston Displacement (PD) - The volume displaced or covered by the piston when it moves from TDC to BDC.

f) Clearance volume (CV) - The space or volume at the top of the piston and the engine cylinder head when the piston is at TDC. This is also sometimes referred to as the combustion chamber.

g) Total cylinder volume (TCV) - The volume designated by the sum of the piston displacement and the clearance volume (CD + CV)

h) Compression Ratio (CR) - The ratio of total cylinder volume (TCV) to clearance volume (CV).

i) Engine size - This is given by the bore and stroke of the engine. For instance, a 100 mm x 124 mm engine has a bore of 100 mm and a 124mm stroke.

Given the above engine size, it is possible to compute:

i) The piston displacement

ii) The total cylinder volume; and

iii) The compression ratio (given that CV = PD/6)

Solution:

i) Piston displacement (PD) = Volume swept in one stroke

$$PD = \frac{\Pi}{4} D^2 \, X \, L$$

Where , D = diameter or bore; and L = stroke

Therefore: $PD = \frac{\Pi}{4}(100)^2 \, X \, 124 = 973\,400 mm^3$

ii) Total cylinder volume (TCV) = PD + CV

Where $CV = PD/6 = \frac{973400}{6} = 162\,233.3 mm^3$

Therefore: TCV = 974 400 + 162 233.3

= 1135633.3mm³

iii) Compression ration $CR = \frac{TCV}{CV}$

$$= \frac{1135633.3}{162233.3}$$

$$= 7.0$$

3.2 Essential Components of an Internal Combustion (IC) Engine

Several important components are in the IC engine which helps to achieve the conversion of fuel into usable form. Some of these components are listed below with their functions.

a) A cylinder – The nucleus of all activity, but principally for receiving and burning the fuel.

b) A piston - which moves up and down within the cylinder and receives power generated in the cylinder.

c) A cylinder head – covers the top of the cylinder(s) and house other components, such as valve.

d) A crankshaft - this is rotated by the piston on the power stroke and receives from the piston through the connecting rod.

e) A Connecting rod - which connects the piston to the crankshaft. These two components convert reciprocating motion of the piston into rotary motion of the crankshaft to form a useable means of power.

f) A gudgeon pin - connects the connecting rod to the piston.

g) An inlet value - allows the fresh charge of fuel/air mixture into the combustion chamber.

h) An exhaust valve - allows the spent gases to escape to the atmosphere via the exhaust system.

i) A camshaft - opens and closes the valves.

j) Valve springs - operates the valves.

k) A flywheel - fitted to the crankshaft and absorbs power on the power stroke and gives off energy on the three non-power strokes to maintain smooth operation of the engine.

l) Engine block - it is the foundation block to which all the above components are directly or indirectly attached.

A cross section of a typical diesel engine is shown in Figure 7.

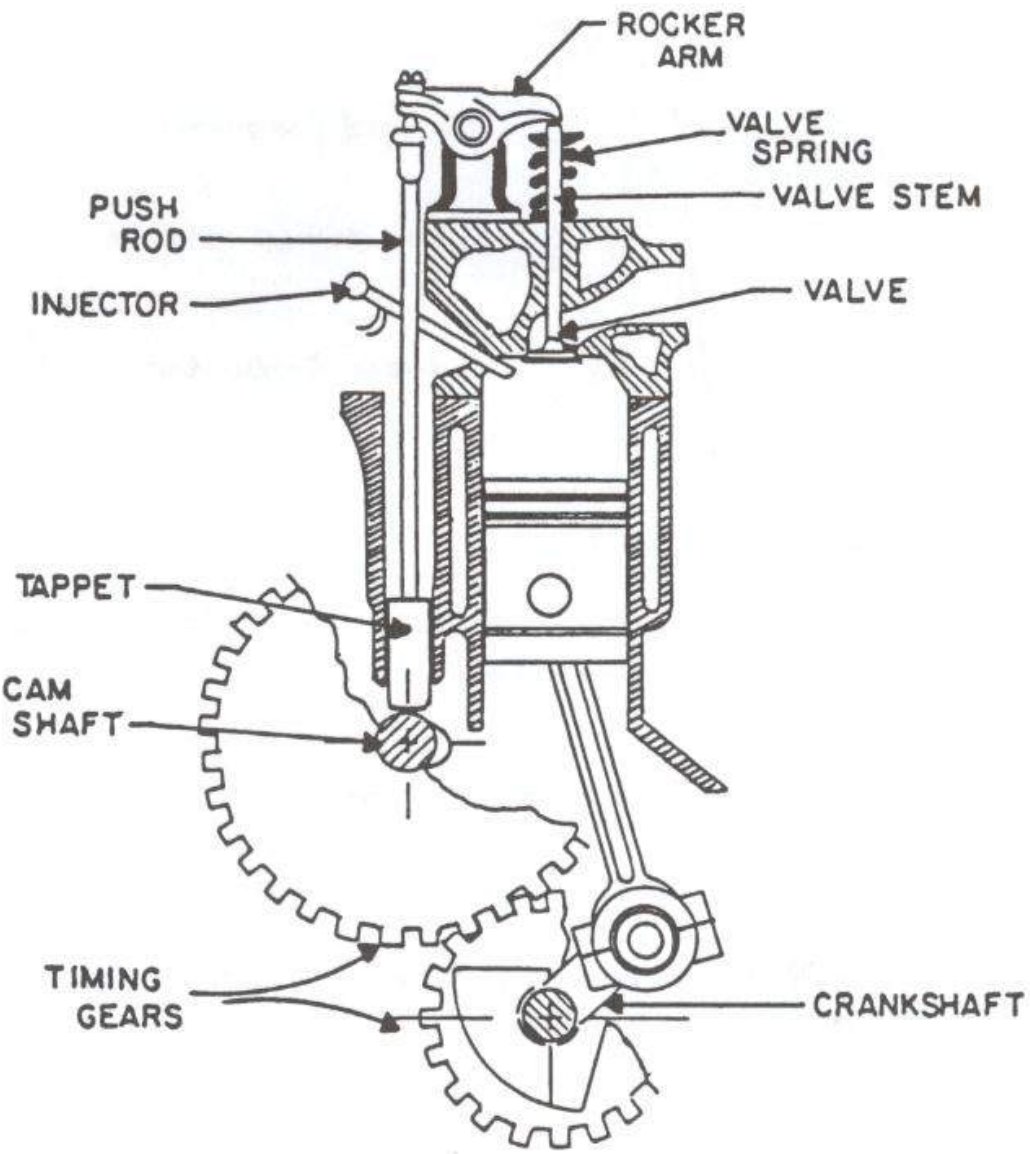

Figure 7 – Cross section of a typical diesel engine.

3.3 Engine Systems

The IC engine is provided with a system to govern each function. Some of the systems and their intended functions are given in table 2 below. If the engine is also equipped to be self- propelled, namely to be a “tractor”, it will also have a transmission and hydraulic

system to provide locomotion and, using principles of hydraulics, to provide a means of delivering power .

Table 2. Engine Systems and their Function

Engine System	**Function**
Valve System	To govern operation of intake and exhaust valves
Fuel System	To supply regulated amounts of fuel and air, in accordance with operational needs
Cooling System	To keep the engine operating at an optimum temperature
Lubricating System	To lubricate all moving and other parts
Ignition and Electrical system	To create a spark in the engine (for ignition), and provide lights and a starting mechanism

There are openings in the cylinder of an engine (**inlet** and **exhaust**) to provide for the entry of fuel or fuel-and-air mixture and for the exhaust of the burnt gases respectively. These openings are controlled by valves and the various components that assist in operating the valves broadly constitute the valve system.

The valves are located either in the cylinder head (overhead valves in an I-head arrangement) or in the engine block (side valves in an L-head arrangement). They are driven by a special shaft called **camshaft** and special rods called **pushrods** operate the valves off hardened cams located on this shaft.

The camshaft is driven by the **crankshaft** at half its own speed. This is because in one cycle (of a four-stroke engine) the crankshaft makes two revolutions (720^o) but the valves have to open only during the intake and exhaust strokes (occurring at 360^o and 720^o). The camshaft therefore runs at half the speed of the crankshaft.

The valve is opened by a push from the pushrod against the rocker arm and valve spring. The valve is then returned to its seat by the pressure of the valve spring once it is no longer being pushed open by the pushrod.

Figure 1 includes the valve system arrangement. The valve timing has to be synchronised correctly and the operating manual should be consulted to determine the recommended timing and clearances at various points.

4.0 CONCLUSION

This unit has enabled you understand some engine terminologies. You have been educated on the working of some essential components of an internal combustion engine. You are aware of the essential systems that make up an engine.

5.0 SUMMARY

This unit has equipped you with:

- Basic terminology used in defining an IC engine.
- Simple calculations on how to compute an engine size.
- Knowledge of essential components of an IC engine.

- A cross-section of a typical diesel engine.
- What makes up a typical engine system.
- How the various component parts are connected and function.

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1. Define the following terminology:

a) Bore

b) Stroke

c) Top Dead Centre

d) Bottom Dead centre

e) Piston Displacemen

f) Clearance volume

g) Total cylinder volume

h) Compression Ratio

i) Engine size

2. Give the functions of any ten (10) essential components of an IC engine.

3. Succinctly give the functions of any Four (4) engine systems.

7.0 REFERENCES/FURTHER READINGS

Kaul, R.N. and C.O. Egbo. (1985). *Introduction to Agricultural Mechanisation.* General Ed. Onazi, C.O. MacMillan Education Ltd. London and Basingstoke.

Srivastava, A.K., C.E. Goering and R.P. Rohrbach. (1993). *Engineering Principles of Agricultural Machines.* Revised Printing. ASAE Textbook No. 6. Published by the American Society of Agricultural Engineers, USA.

UNIT 3 ENGINE OPERATION

CONTENT

1.0 INTRODUCTION

There are three broad classification systems for engines. Engines are classified as two cycle or four-cycle, depending on whether the combustion cycle is carried out in two or four piston strokes. Also, engines are classified as spark ignited (SI) if the air/fuel mixture is ignited by a spark or compression-ignited (CI if ignition occurs by compression of the air/fuel mixture. Because of its higher compression ratios and leaner combustion, a CI engine can deliver up to 40 percent better fuel economy than a similarly loaded SI engine. Finally, engines are classified as air or water cooled. Small, single-

cylinder SI engines are air cooled. With only a few exceptions, large, multi-cylinder engines are water cooled.

2.0 OBJECTIVES

It is expected that at the end of the unit you would be able to:

- Know the operations of a four-stroke engine.
- Know the difference in operation between the spark ignition (SI) engine and the compression ignition (CI) engine.
- Know the operation of a two-stroke engine.

3.0 MAIN BODY

3.1 Four-Stroke Engine

This type of engine completes one cycle in four-stroke of the piston. Four events are associated with the travel of the piston for one cycle. There is a slight difference in operation between the spark ignition and compression ignition engine as discussed below:

3.1.1 Spark Ignition (SI) Engine

This type of engine uses petrol and fuel-air mixture is carried out by a carburettor in the correct proportion. The carburettor also atomizes the mixture and sprays it into the cylinder ready for combustion. Below are the operations that take place in the cylinder to release the energy stored in the fuel.

a) **Intake/Induction stroke:** The piston moves from TDC to BDC. The inlet valve is opened to allow the fuel-air mixture to enter and fill the partial vacuum created by the movement of the piston. The exhaust valve remains closed.

b) **Compression stroke:** The intake valve is closed, the exhaust valve remains closed and the piston moves from BDC to TDC compressing the fuel-air mixture into the clearance volume, thereby raising its temperature.

c) **Power stroke:** When the piston approaches TDC during the compression stroke above, a spark ignites the fuel mixture and the expanding gases drive the piston from TDC to BDC.

d) **Exhaust stroke:** The piston returns from BDC to TDC sweeping out burnt fuel through the exhaust valve which has been opened, while the intake valve remains closed.

3.1.2 Compression Ignition (CI) Engine

This type of engine uses diesel fuel to achieve combustion in the cylinder. The diesel is atomize and injected into the cylinder by the aid of an injector. Below are the operations that take place in the cylinder to release the energy stored in the fuel.

a) **Intake induction stroke:** The piston moves from TDC to BDC. Only air is drawn into the cylinder, inlet valve opens while exhaust valve is closed.

b) **Compression stroke:** The air is compressed in the cylinder which raises its temperature very high. Intake and exhaust valves are closed. Piston moves from BDC to TDC.

c) **Power stroke:** Just at the end of the compression stroke, a fine spray of diesel is injected into the hot compressed air which ignites the fuel instantly. The expanding gas drives the piston from the TDC to BDC for the power stroke.

d) **Exhaust stroke:** The piston returns from BDC to TDC sweeping out burnt fuel through the exhaust valve which has been opened, while the intake valve remains closed.

3.2 Two-Stroke Engine

This type of engine completes one cycle in only two strokes of the piston. There are no definite intake and exhausted valves, but instead there are openings or ports located in the cylinder well which get covered or uncovered as the piston moves up and down the cylinder.

When the piston moves from TDC to BDC, a fresh fuel mixture enters through the intake port. At the same time the burnt fuel escapes through the exhaust port which is also uncovered. The compression and power strokes are similar to those of the four-stroke engine. The piston makes only two strokes which is one revolution of the crankshaft to complete one cycle.

The spark ignition engine like the compression ignition engine may be either two – stroke or four – stroke.

4.0 CONCLUSION

This unit has enabled you understand the Internal Combustion (IC) engines, the different types and their working principles. You are now aware that the IC engines have two-stroke cycle and four-stroke cycle of both the spark ignition and compression ignition engines.

5.0 SUMMARY

In this unit you have learnt that:

- The Internal Combustion (IC) engine can either be a Spark Ignition (SI) engine or Compression Ignition (CI) engine.
- Engines, be it SI or CI can be classified as two-stroke cycle or four-stroke cycle.
- The working principles of the SI and CI engines of the four-stroke cycle engine and also the two-stroke cycle engine.

6.0 TUTOR-MARKED ASSIGNMENT

1. What is the difference between the two-stroke cycle and four-stroke cyvle of an IC engine?
2. What is the sequence of operation of a Spark Ignition engine starting from the intake stroke?

3. What is the sequence of operation of a Compression Ignition engine starting from the intake stroke?

7.0 RESEARCH/FURTHER READINGS

Kaul, R.N. and C.O. Egbo. (1985). *Introduction to Agricultural Mechanisation.* General Ed. Onazi, C.O. MacMillan Education Ltd. London and Basingstoke.

MODULE 4

TILLAGE SYSTEMS AND EQUIPMENT USED

Unit 1 Tillage

Unit 2 Primary Tillage Implement

Unit 3 Secondary Tillage Implement

UNIT 1 TILLAGE

CONTENT

1.0 INTRODUCTION

Tillage is the preparation of the soil to create optimum environmental conditions for plant growth. Tillage also means the preparation of the growth zone in the soil (about 10 to 90

cm of the top layer of soil) for plant development. This is achieved by providing a good seedbed, which involves breaking, stirring, turning or conditioning the soil surface to a certain depth.

Tillage is classified as either primary or secondary. As large areas of the surface of the earth are subject to tillage, man has tried to ease the cumbersome and time-critical work of tillage and developed machines which allow in most places of the world to perform this task with ease and efficiency.

2.0 Objectives

By the end of this unit you should be able to:

- Know what tillage is.
- Know the general importance of tillage operations
- Know the objectives of Primary tillage
- Know the objectives of Secondary tillage
- Know the different types of tillage systems practiced

3.0 MAIN BODY

3.1 General Importance of Tillage Operations

The task of tillage is to prepare soils for productive use. Usually tillage is limited to the arable layer of soil, which contains organic matter and where plant life actually can occur. Tillage has to be performed to clear virgin soils of plants and animals for agricultural use. Furthermore, it must be performed to bring the seedlings into the soil and procure for them a good environment for further development.

Another objective of tillage is to control weeds and animals living in the soil, such as mice or slugs. This is, compared to the use of chemical means, an energy and time consuming way to control pests. Another important point is surface leveling because most operations in mechanized agriculture depend on level surfaces. Irregularities in the soil niveau may be caused by traffic on the soil, harvesting or climatic effects. Together with this goes the need to distribute clods and porosity according to plant need (Fig. 8).

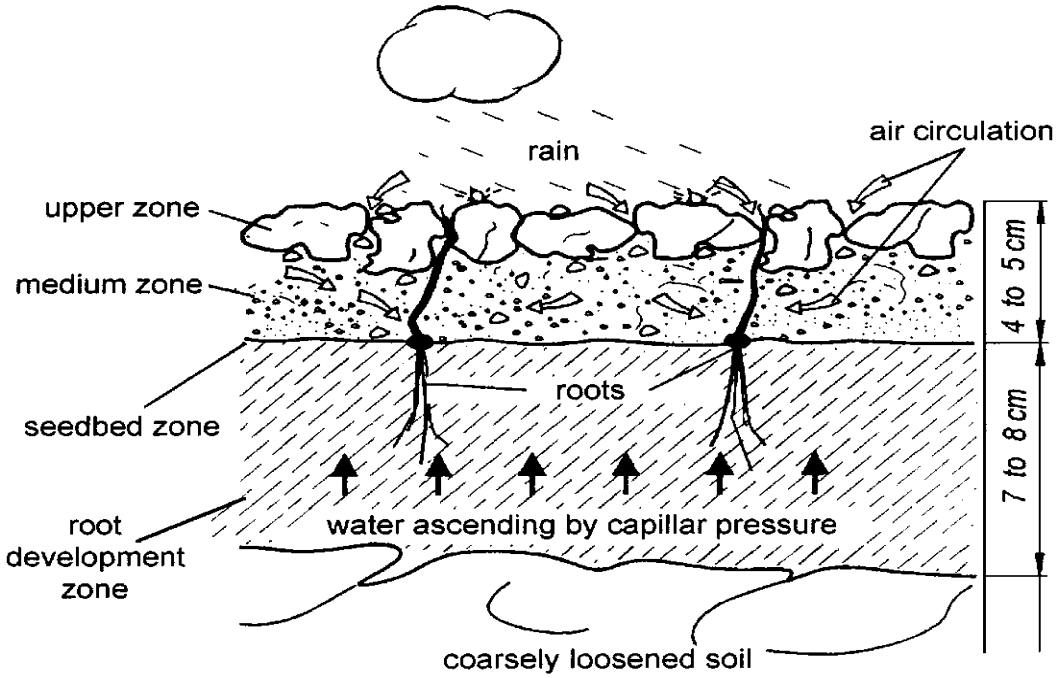

Figure 8. Stratified Seedbed

The seeds should be covered by small clods for protection while around the seeds, fine soil should prevail. Under the seeds, porosity must not be too high, while smaller and larger clods should give structure to the soil. Producing this distribution of smaller and larger clods (stratified seedbed) is one of the main objectives of primary tillage. Producing fine soils for the environment of the seedling and the structure of the seedbed is the main objective of secondary tillage and seedbed preparation. Warming up the soil and bringing air to deeper layers stimulates life in the soil. At the same time, loosening

makes it easier for plant roots to penetrate into deeper soil layers. An optimum porosity will also facilitate the infiltration of air and water for the plant roots, and the ascension of water from deeper soil layers during dry periods. Loosening the subsoil may be necessary to break up a hardpan, which can be created by trafficking and smearing the bottom of the tillage zone as it happens with plowing or which may develop naturally as in sodopol soils. Finally, it can be necessary to undertake soil improvements such as bringing down organic matter into the sterile subsoil or bringing up sand/clay subsoil into arable layers containing too much sand/clay in their texture.

3.2 Primary Tillage

Primary tillage is the main tillage operation that is done in the beginning of the growing season. A primary tillage operation constitutes the initial, major soil-working operation; it is normally designed to reduce soil strength, cover plant materials and rearrange aggregates.

3.3 Secondary Tillage

Secondary tillage implies the preparation of a seedbed after the first coarse primary tillage. Normally an implement that is used for primary tillage will not be used again for secondary tillage. The general objectives of secondary tillage are stated as follows:

1. To improve the seedbed by greater pulverization of the soil.
2. To conserve moisture by summer-fallow operations to kill weeds and reduce evaporation.

3. To cut up crop residues and cover crops and mix vegetable matter with the top soil.
4. To break up clods, firm the topsoil, and put it in better tilth for seeding and germination of seeds.
5. To destroy weeds on fallow lands.

3.4 Tillage Systems

The terms below are used to define various tillage systems in agriculture;

3.4.1 Conventional tillage: Tillage operations traditionally performed in preparing a seedbed for a given crop and grown in a given geographical area.

3.4.2 Minimum tillage: The least soil manipulation necessary for crop production or for meeting tillage requirements under existing conditions.

3.4.3 Mulch tillage: Tillage of the total soil surface in such a way that plant residue is specifically left on or near the soil surface.

3.4.4 No-till: Seeding directly into previously undisturbed soil.

3.4.5 Optimum tillage: An idealized system which permits a maximized net return for a given crop under given conditions.

3.4.6 Conservation tillage: Any tillage or seeding system that maintains a minimum of 30% residue cover on the soil surface after planting or maintains at least 1,100 kg/ha of flat small grain residue equivalent on the soil surface during critical erosion period.

3.4.7 Reduced tillage: A system which consists of fewer or less energy intensive operations compared to conventional tillage.

3.4.8 Strip tillage: A system in which 30% or less of the soil surface (bands in the row) is tilled.

3.4.9 Ridge tillage: A system in which the ridges on which the crop is planted are formed during cultivation or after harvest and maintained from year to year in the same location. Seeding is done on the ridge top.

3.4.10 Reservoir tillage: A system in which a large number of depressions or small reservoirs are formed to hold rain or sprinkler applied water.

4.0 CONCLUSION

In this unit you have been taught what tillage is and the different types. You have also been exposed to the general importance of tillage operations and tillage systems.

5.0 SUMMARY

In this unit you have learnt that:

- Tillage is the preparation of the soil to create optimum environmental conditions for plant growth.
- Tillage is classified as either primary or secondary.
- Another objective of tillage is to control weeds and animals living in the soil, such as mice or slugs. This is, compared to the use of chemical means, an energy and time consuming way to control pests.
- There are specific objectives for carrying out primary and secondary tillage operations.
- There are different tillage systems.

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1. Define tillage.
2. How can you classify tillage? Outline their respective objectives.
3. Discuss the general importance of tillage operations.
4. Write on any eight (8) tillage systems you know.

7.0 REFERENCE/FURTHER READING

ASAE (American Society of Agricultural Engineers) Standards (1998). 45th Edition. Standards Engineering Practices Data. http://asae.org/

UNIT 2 PRIMARY TILLAGE IMPLEMENTS

CONTENT

1.0 INTRODUCTION

The initial breaking up of the soil is generally called primary tillage. Implements used for primary tillage comprise mainly ploughs of various types.

2.0 OBJECTIVES

By the end of this unit you should be able to:

- Know the main types of primary tillage implements;
- Know how these implements work;
- Know the basic components that make up each tillage implement to be discussed;
- Know the maintenance and care of the primary tillage Implement.

3.0 MAIN BODY

3.1 Primary Tillage Implement

Ploughs – the four man types used for primary tillage:

a) Mouldboard;

b) Disc;

c) Subsoiler;

d) Chisel.

3.1.1 Mouldboard plough

This is one of the oldest of all the tillage tools and is primarily intended for use in situations where it is desired to invert the soil in order to cover crop residue. A mouldboard plough consists of the following parts

(i) Share – this is the first part of the plough to enter the soil and cut a furrow slice.

(ii) Mouldboard – the cut soil is lifted upwards to the mouldboard where it is inverted by the curvature of this component.

(iii) Landside – this assists in making a neat furrow. It presses against the furrow wall, absorbing the side – ways thrust of the plough.

(iv) Frog – is the component that joins the share, mouldboard and land side.

(v) Beam – provides the connection between the plough and the source of power (tractor).

3.1.2 Disc plough

The basic component of this type of plough is a disc of a certain diameter and curvature. The disc is mounted on a frame. A plough may have several individually- mounted discs and the number depend on the power available to pull the plough.

Disc ploughs are preferred in dry soils or in sticky soils where the mouldboard plough will not work satisfactorily, Disc ploughs are built more heavily and occasionally, additional weights are put on it to aid penetration.

3.1.3 Subsoiler

A subsoiler is an implement that is used to break up the hard soil pan (or compacted soil) that can develop as a result of the continuous use of ploughs. The legs of the subsoiler shatter the hard pan, thus improving drainage and aeration, but it requires a highly powered tractor, usually of the crawler type, to pull it through the soil.

3.1.4 Chisel plough

This type of plough comprises deep tines which operate at a considerable depth to break open the subsoil and thus assist in drainage and pulling out deep – rooted weeds. Because of the depths to which they plough (deeper than subsoiler), chisel ploughs are sturdy in construction and require considerable power to be pulled through the soil.

3.2 Maintenance and Care of the Primary Tillage Implement

a) Check plough for proper alignment of bottoms

b) Check the hitch arrangement of the mouldboard plough for proper performance

c) Keep the shares on mouldboard ploughs sharp.

d) Check the automatic trip for mouldboard bottom.

e) On disc ploughs, check hitch arrangement for proper performance of the plough.

f) Store in off-season in a shed, on concrete slab, planks, or blocks.

g) Remove wheels with rubber tires and store in shed.

h) Tag wheels for plough and location on plough

i) Apply rust – resistant grease or heavy oil to bottoms

j) Make list of repairs needed if any, and place order for replacements.

k) Cover hydraulic hose ends with plastic, tied securely.

l) Cover with plastic or canvas sheet, tied securely

4.0 CONCLUSION

In this unit you have attempted to learn about implements used for primary tillage. You have also learnt the various maintenance and care required to keep the implements for long before replacement and to also achieve the desired result while in use.

5.0 SUMMARY

In this unit you have learnt that:

- Implement used for the initial breaking up of the soil is generally called primary tillage.
- Implements used for primary tillage comprise mainly ploughs of various types.
- The various primary tillage implements are of different configuration and are specific in their work output.
- There are various maintenance and care that need to be carried out on these implements to make them last and to also get the require working output.

6.0 TUTOR-MARKED ASSIGNMENT

1. What are primary tillage implements?
2. Discuss the various primary tillage implement you know.
3. Outline the maintenance and care that need to be carried out on these primary tillage implements.

7.0 REFERENCES/FURTHER READING

Kaul, R.N. and C.O. Egbo. (1985). *Introduction to Agricultural Mechanization.* Ed. Ochapa, C.O. Publ. MacMillan Education Ltd, London and Basingstoke.

Shippen, J.M., C.R. Ellin and C.H. Chover (1980). *Basic Farm Machinery.* Pergamon Press, Great Britain.

Smith, H.P. and L.H. Wilkes (1976). *Farm Machinery and Equipment.* Publ. Tata Mc Craw Hill, Ltd. New Delhi.

UNIT 3 SECONDARY TILLAGE IMPLEMENTS

CONTENT

1.0 INTRODUCTION

Secondary tillage implements can be used either before or after the crop is planted. It may be either to prepare the seedbed, to mix fertilizer, to break the soil crust, or to break clods left by a primary tillage implement. Secondary tillage implements are used, after a crop is planted, for weeding and for minor earthening–up operations.

2.0 OBJECTIVES

By the end of this unit you should be able to:

- Know the main types of secondary tillage implements;
- Know how these implements work;
- Know the basic components that make up each tillage implement to be discussed;

- Know the maintenance and care of the secondary tillage Implement.

3.0 MAIN BODY

3.1 Secondary Tillage Implement

The equipment used for secondary tillage are generally called *harrows*. Some secondary tillage implements are:

a) Cultivators

b) Harrows

c) Rotary cultivators

d) Rotary hoe

e) Rollers

f) Ridgers

3.1.1 Cultivators

These implements comprise basically a set of soil working tines or a share, mounted on a robust frame. Depending on the types of tines used, the cultivator can be classified as

(i) a rigid – tine cultivator

(ii) a spring – tine

Cultivators can often be adopted for row crop hoeing, special hoe blades are fitted which cut away the weeds and small concave discs can also be attached. The cultivator frame is drilled so that the position of the tines can be altered to suit the row widths of the crop being hoed.

3.1.2 Harrow

A harrow is an implement used to tend the ground and crush clods, to stir the soil, to prevent and destroy weeds. Under some conditions, harrows can be used to cover seeds. The main types of harrows are:

(i) disc harrow;

(ii) spike – tooth harrow;

(iii) chain harrow;

(iv) spring – tooth harrow

3.1.3 Rotary hoe

Basically a rotary hoe consists of a revolving shovel that breaks down and pulverizes the soil by impact. The pulverizing action can be controlled by the forward speed of the tractor.

Several of the revolving shovels may be mounted on an axle which is then powered by the tractor PTO shaft. In dry soil conditions such implements have limited use because of lack of penetration and a high degree of wind, in addition, the amount of dust generated may be uncomfortable for the operator.

3.1.4 Rollers

This implement is useful for breaking down soil clods that may not have been broken down by the cultivator or harrow.

It is designed to be drawn quite quickly behind the tractor so that the clods are broken by impact rather than being buried or pushed down into the soil. A roller is sometimes used for conserving moisture. It has also been found to be useful for breaking down soil clods after groundnut digging has seen carried out, to ease the separation of pods from the soil.

3.1.5 Ridger

This is what may be termed a double mouldboard plough and is used to form ridges. The ridger bodies, mounted on a frame can be staggered to give the required spacing. Each ridger body carries a narrow share and two mouldboards. The mould board spacing is usually adjustable.

3.2 Maintenance and Care of the Secondary Tillage Implement

a) Check equipment for proper hitching

b) Check hydraulic units for proper operation

c) On disc harrows, check gang angling system

d) Store in off-season in shed on concrete slab, planks or blocks.

e) Remove wheels with rubber tires and store in shed

f) Tag wheels, listing implement and location on implement

g) Apply anti- rust grease or oil to discs and soil wearing parts.

h) Make list of needed repairs

i) Cover hydraulic hose ends with plastic tied securely

j) If stored in yard, cover with plastic or canvas sheet, tied securely.

4.0 CONCLUSION

In this unit you have attempted to learn about implements used for secondary tillage. You have also learnt the various maintenance and care required to keep the implements for long before replacement and to also achieve the desired result while in use.

5.0 SUMMARY

In this unit you have learnt that:

- Secondary tillage implements can be used either before or after the crop is planted.
- The equipment used for secondary tillage are generally called harrows and are of various types.
- The various secondary tillage implements are of different configuration and are specific in their work output.
- There are various maintenance and care that need to be carried out on these implements to make them last and to also get the require working output.

6.0 TUTOR-MARKED ASSIGNMENT

1. When do you use secondary tillage implements?
2. Discuss the various secondary tillage implement you know.
3. Outline the maintenance and care that need to be carried out on these secondary tillage implements.

7.0 REFERENCES/FURTHER READING

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