**EXERCISE:**

- Describe the steps involved in clearing land?

- List the implements used in clearing land?

## UNIT 4.6.3

## PLOUGH LAND

**Description**

The information in this unit describes the process involved in loosening and turning the soil, which helps in mixing the soil in preparation for planting; this can be done mechanically with a tractor or manually with a hoe. Land ploughing for Rice production can be done in the following ways.

1. Manually
2. Use of work bulls
3. Use of tractor

**Unit Objectives**

At the end of this unit students should be able to:

- Describe the steps involved in ploughing land.
- State the implement used in ploughing land.

**Steps**

1. **Manually**
   - Plough entire area to be cultivated.
   - Use a hoe to scoop the top soil and turn it back into the soil to mix it.
   - Continue till you have covered the entire area to be cultivated.

**Figure 10: Manual Land Preparation**

**2. Traction Animals**

- Get two strong bulls, a wooden frame and a plough.
- Attach the wooden frame to the plough then attach it to the bulls.
- Walk the animals round the farm in an orderly manner.

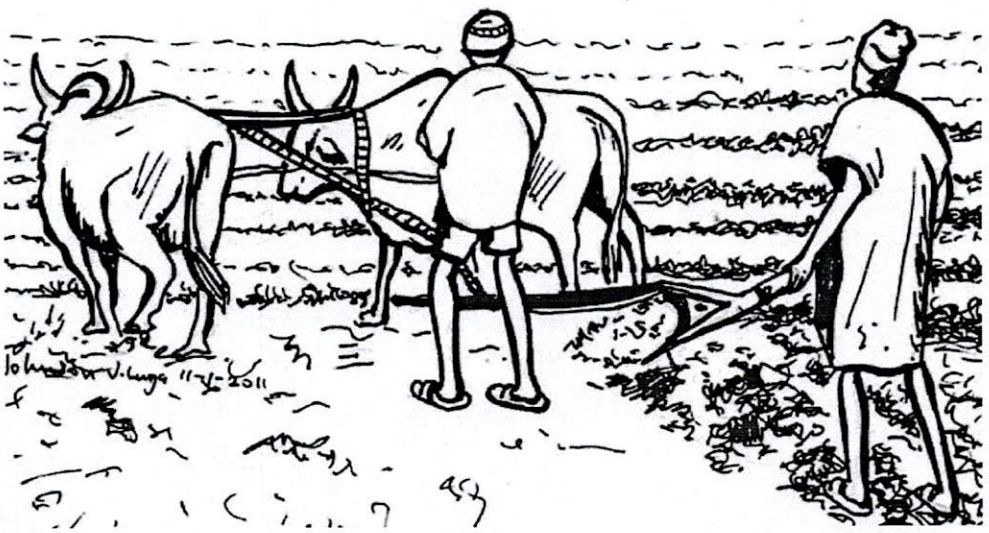


**Figure 11: Use of traction animals in land cultivation**

**3. Machinery**

- Hire a tractor to plough the farm.

**Figure 12: Use of tractor in land cultivation**

**EXERCISE:**

- Describe the steps involved in ploughing land?

- List the implements used in ploughing land?

## UNITS 4.6.4

## HARROW LAND

**Description**

The information in this unit describes the process involved in breaking soil lumps in to smaller particles, ridges should be made at 70cm apart, this can be done manually by the use of a hoe, traction animals or mechanically. Ridges across the slope in erosion prone areas can be used to prevent erosion.

**Unit Objectives**

At the end of the unit students should be able to:

- Describe the concept of land harrowing.
- List the implements and cost of hiring labour.

**1. Manually**

Use a hoe to break down lumps formed as a result of ploughing. Use the hoe to heap soil on some portions of the land to make ridges. Ensure that there is a 25cm space between each ridge.

**Figure 13: Manual Seed bed preparation**

2. **Traction animal**

Get two strong bulls, a wooden frame and harrow disc. Attach the wooden frame to the harrow disc then attach it to the bulls. Walk the animal round the farm in an orderly manner.

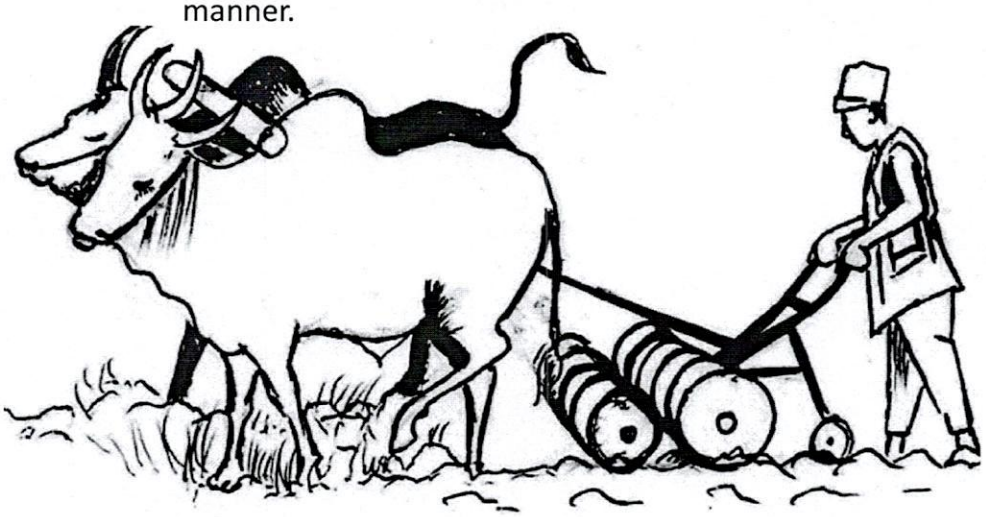


**Figure 14: Gathering of debris in the farm**

3. **Machinery**

Hire a tractor to harrow the farm.

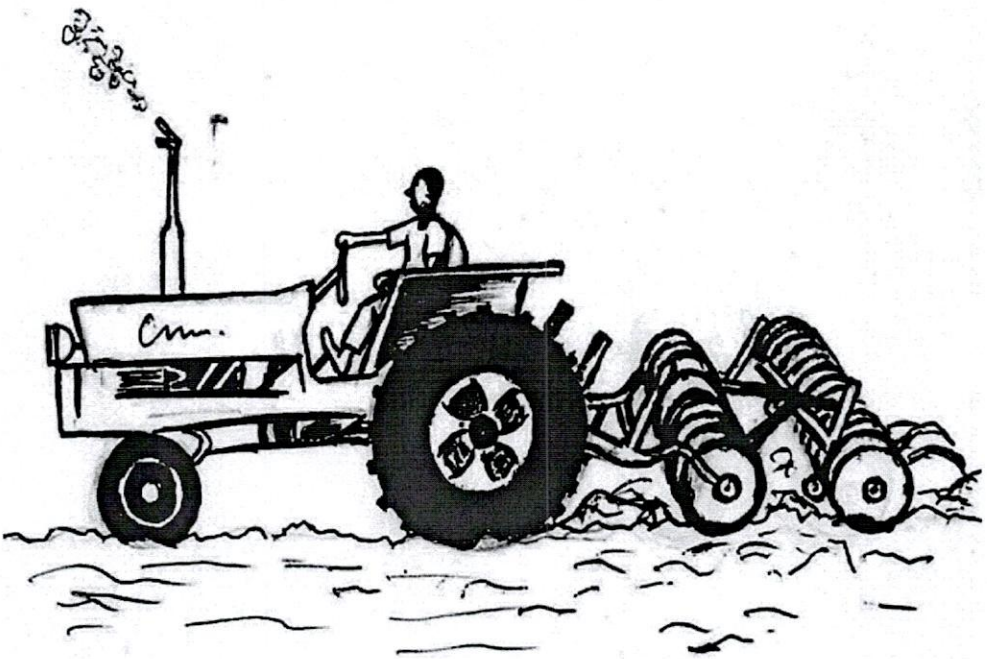


**Figure 15: Gathering of debris in the farm**

**EXERCISE:**

- Describe the concept of land harrowing.?

- List the implements and cost of hiring labour?

## UNIT 4.6.5

## CONSTRUCT IRRIGATION CHANNELS

**Description**

This unit describes the steps involved in providing water artificially to the farm by constructing irrigation channels within the rice plot from the water source which could be a stream, river etc.

The following steps are involved in construction of irrigation channels for Rice crop production:

1. Map out the plot for Rice production
2. Make ridges around the beds
3. Pump water into plots

**Unit Objectives**

At the end of the unit students should be able to:

- Describe the steps involved in constructing irrigation channels
- State the importance of constructing irrigation channels in rice production.

**Steps**

The following steps are involved in purchase of irrigation facilities

1. **Map out the plot for rice production**

   The first step is to map out the plot in which rice is to be grown as this will enable the farmer decide on the places where the channels will be constructed. The channels should be constructed round each plot with small inlet and outlet into each plot. Care should be taken to avoid over flooding of the plot.

**Figure 16: Gathering of debris in the farm**

**2. Build ridges around the plot**

Heap soil around the rice plot to control the flow of water in and out the plot especially in areas that are prone to flooding. The ridges can be built manually by Using hoe to clear the soil around the channels and heaping it round the rice plot.

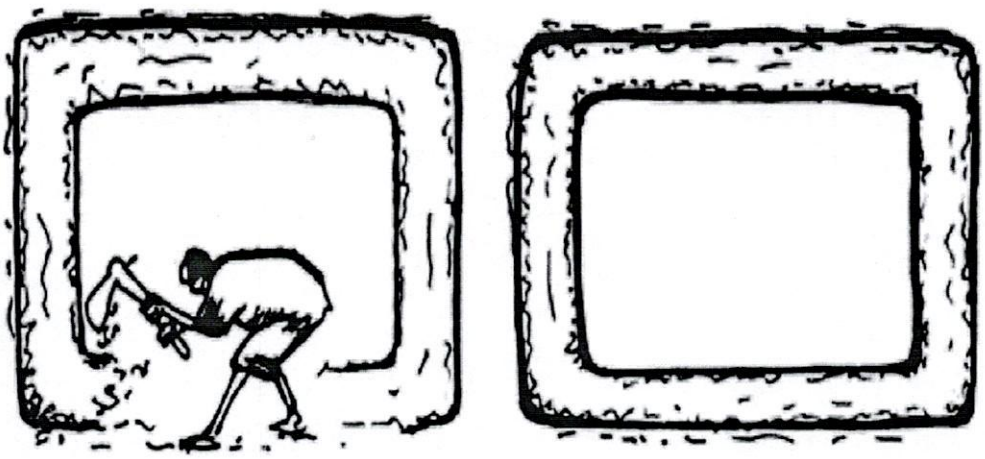


**Figure 17: Gathering of debris in the farm**

Figure 18: Gathering of debris in the farm

**EXERCISE:**

- Describe the steps involved in purchasing irrigation system?

## UNIT 4.6.6

## ACQUIRE INPUTS

**Description**

This unit describes how the farmer should go about acquiring the correct inputs for rice production. The following are steps involved in acquiring agricultural inputs:

1. Identify the various sources of agricultural inputs
2. Check seed quality for viability
3. Plant some sample seeds to ascertain viability

**Unit Objectives**

At the end of this unit students should be able to:

- Identify the sources of inputs such as improved seed varieties, fertilizer, herbicides and pesticides from reliable sources.

**Steps**

The following are steps involved in acquisition of inputs for rice production.

1. **Identify the various sources of agricultural inputs**

   The farmer first identifies the various sources of inputs within his locality. The essence of identification is to ensure that the right inputs are got from reliable sources. The success of vegetable crops production is dependent on the source of input. Inputs such as improved seeds varieties can be got from reliable sources like:

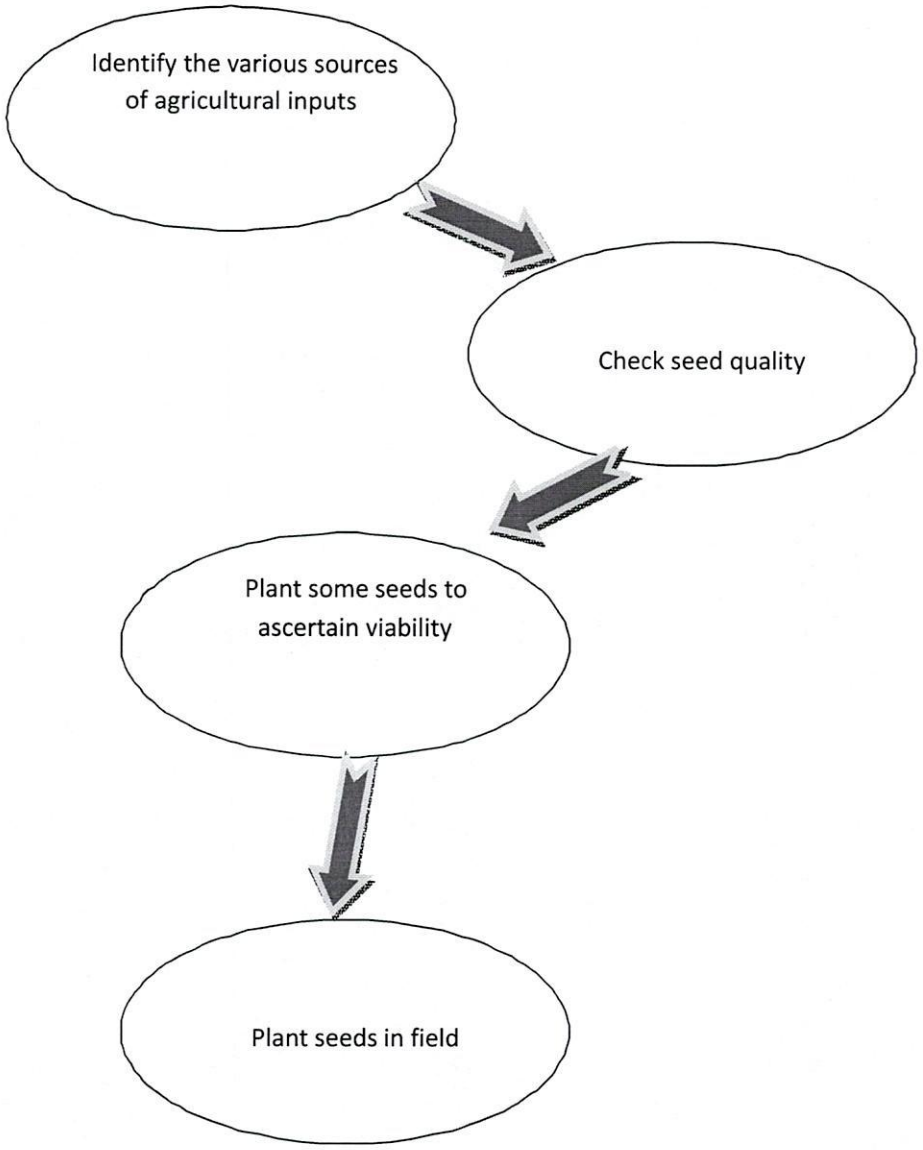
   - Adamawa State Ministry of Agriculture
   - **AADP-** Adamawa Agricultural Development Program
   - **AADIL-** Adamawa Agricultural Development Investment LTD
   - **FSAC-** Farming Skills Acquisition Centre
   - **TAC-** Tropical Agro-farms Clinic LTD

The seeds got from these centers are improved and unadulterated varieties which can be sown by farmers for increased yield. The improved seed varieties are usually disease resistant and high yielding compared to the local seed varieties. Another relevance of these inputs distribution Agencies is the timely provision of other inputs like fertilizer, herbicides and pesticides to farmers when they are needed most.


**Figure 19: Purchase Inputs from Reliable Source**

2. **Check Seed Quality**
   Ensure that seeds that contain the seeds of weeds are not sold to you. For optimum yield vegetable seeds should be free from the seeds of weeds as this can affect the plant survival in the nursery. Weeds have the characteristics to grow fast and compete with crops for available nutrients in the soil and as such can distort the growth of seedling in the nursery.
3. **Plant some sample seeds to ascertain viability**
   When the seeds are bought some of the seeds should be planted in a small nursery and monitored to ensure that the seeds being bought are viable. In case of non-viability, the seeds should be returned to the source where they were purchased for change.

## UNIT SUMMARY



**EXERCISE:**

- Describe the steps necessary involved in acquiring inputs?

## UNIT 4.6.7

## TRANSPORT INPUTS

**Description**

This unit describes the various ways inputs can be transported to the farm from the point of acquisition. The following are processes involved in transporting inputs from area of purchase to where they are needed:

1. Get an affordable vehicle or wheelbarrow depending on the quantity of inputs
2. Negotiate price with the transporter
3. Load the inputs into the carriage
4. Make payment when the goods have been delivered

**Unit Objectives**

At the end of the unit students should be able to:

- Describe the process of transporting inputs.

**Steps**

The following three (3) steps are involved in transportation of inputs:

1. **Get an affordable vehicle.**
   In transporting of inputs the farmer should decide on the cheapest means of transportation. The transportation means is dependent on the quantity of inputs purchased.
2. **Negotiate price**
   Upon agreement give the driver the deposit. While negotiating on price, you have to tell the driver the type of oods and determine the weight; this will determine the price then give some part of money as deposit.
3. **Load the inputs in to the vehicle**
   Negotiate the price of loading the inputs with the laborers pay them after loading.

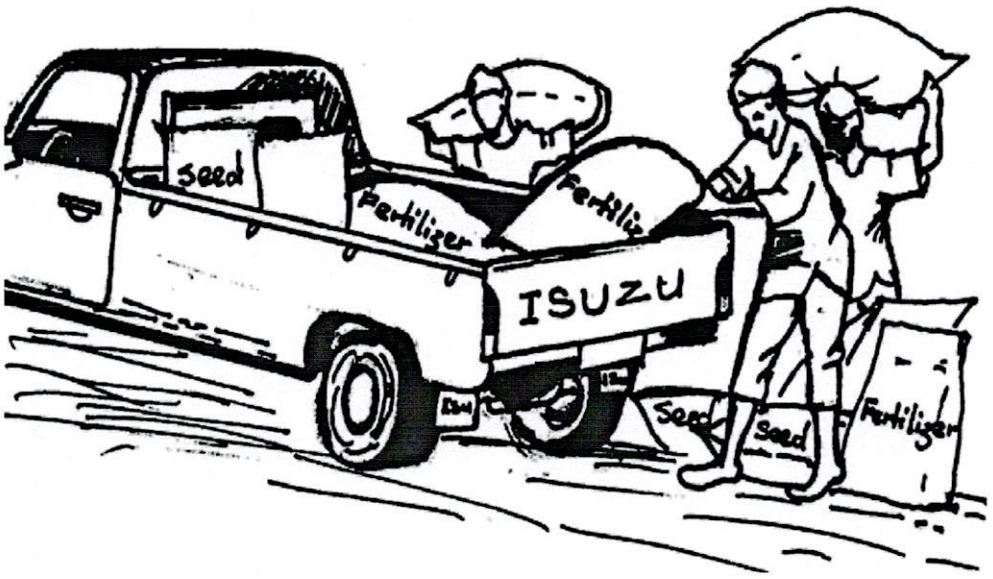
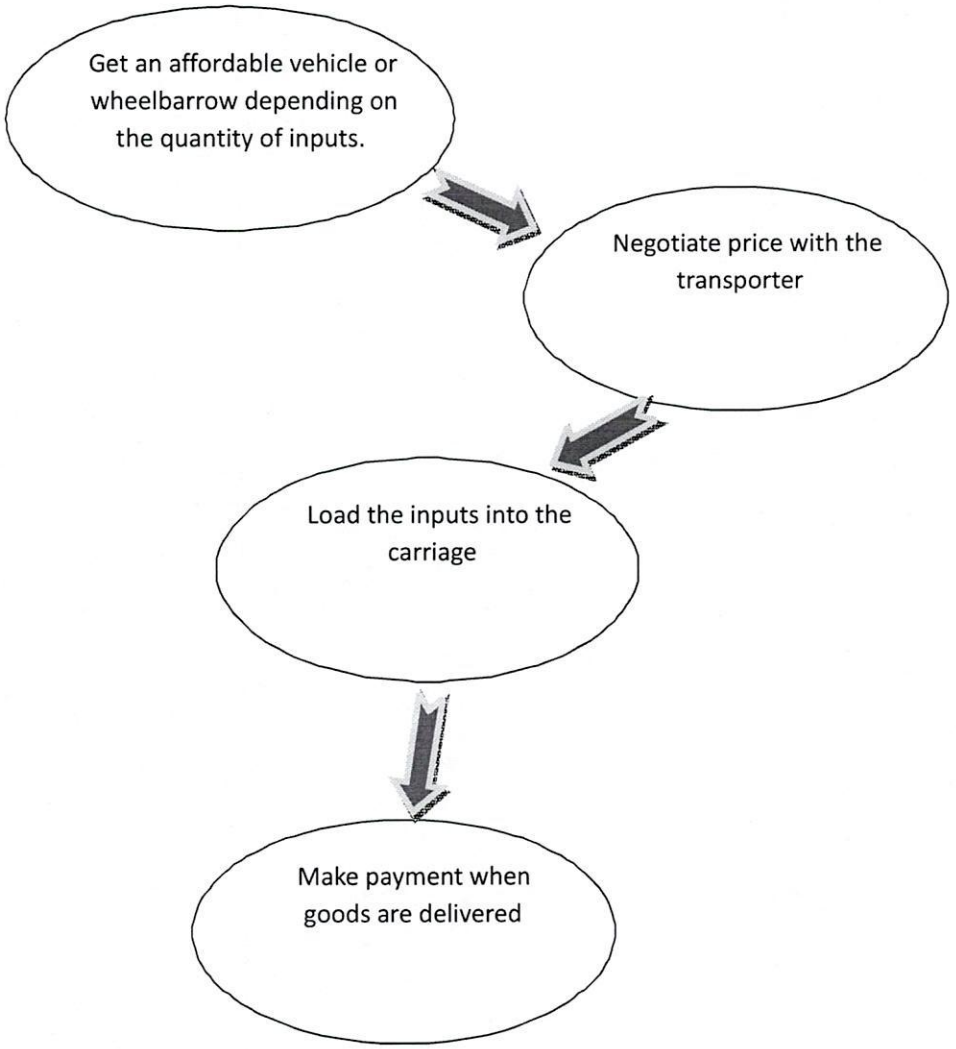



**Figure 20: Loading of Inputs into Vehicle**

## UNIT SUMMARY



**EXERCISE:**

- Describe the process of transporting inputs?

## UNIT 4.6.8

## PLANT SEED

### Description

The information in this unit describes the processes involved in planting seeds in the soil by drilling at 100kg per hectare. Seed planting can be done in the using the following steps:

1. Pour seeds into a container
2. Add seed treatment chemical
3. Make drills by placing rope across the plots
4. Plant seeds on the drill
5. Maintain the crops

### Unit Objectives

At the end of the lesson students should be able to:

- State the steps involved in planting rice using drilling method

### Steps

There are (4) steps involved in planting of rice:

1. **Pour rice into a container**

   The required quantity of rice should be poured into a container possibly a bow or whatever the farmer deems fit.

**Figure 21: Farmer treating Seed with Chemical**

3. **Add seed treatment chemical (Apron Star) to the rice**
   After adding the chemical, mix with the hand properly to ensure that every grain is rubbed with the chemical.The essence is to prevent the seeds from infection by soil borne micro-organisms which are capable of destroying seeds and preventing them from germinating.

**Figure 22: Farmer Mixing Seed in Chemical**

4. **Make drills by placing rope across the farm land**
   The drills are made by running a long rope across the farmland and pegging it at both ends. The holes should be made on a straight path following the rope with either hoe or stick depending on how loose the soil is. Drills should not be deep and should be done on a straight line. Drills should be made at 25cm apart.

**Figure 23: Farmers Placing rope Across the farmland**

5. **Plant seeds on the drill**

Treated seeds should be broadcast on the drill following the straight path after which they should be covered lightly with top soil. Germination takes place within 5-7 days and the percentage germination is dependent on seed variety and viability.

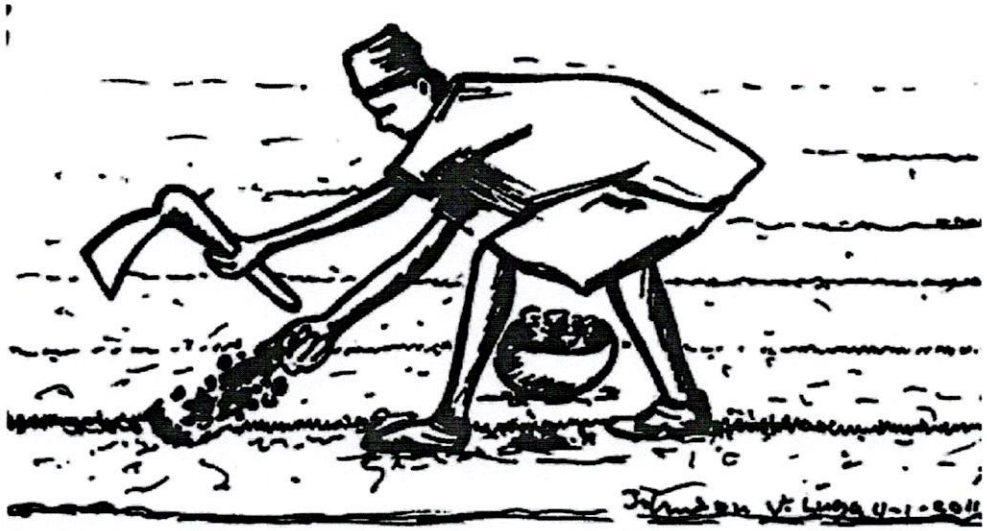
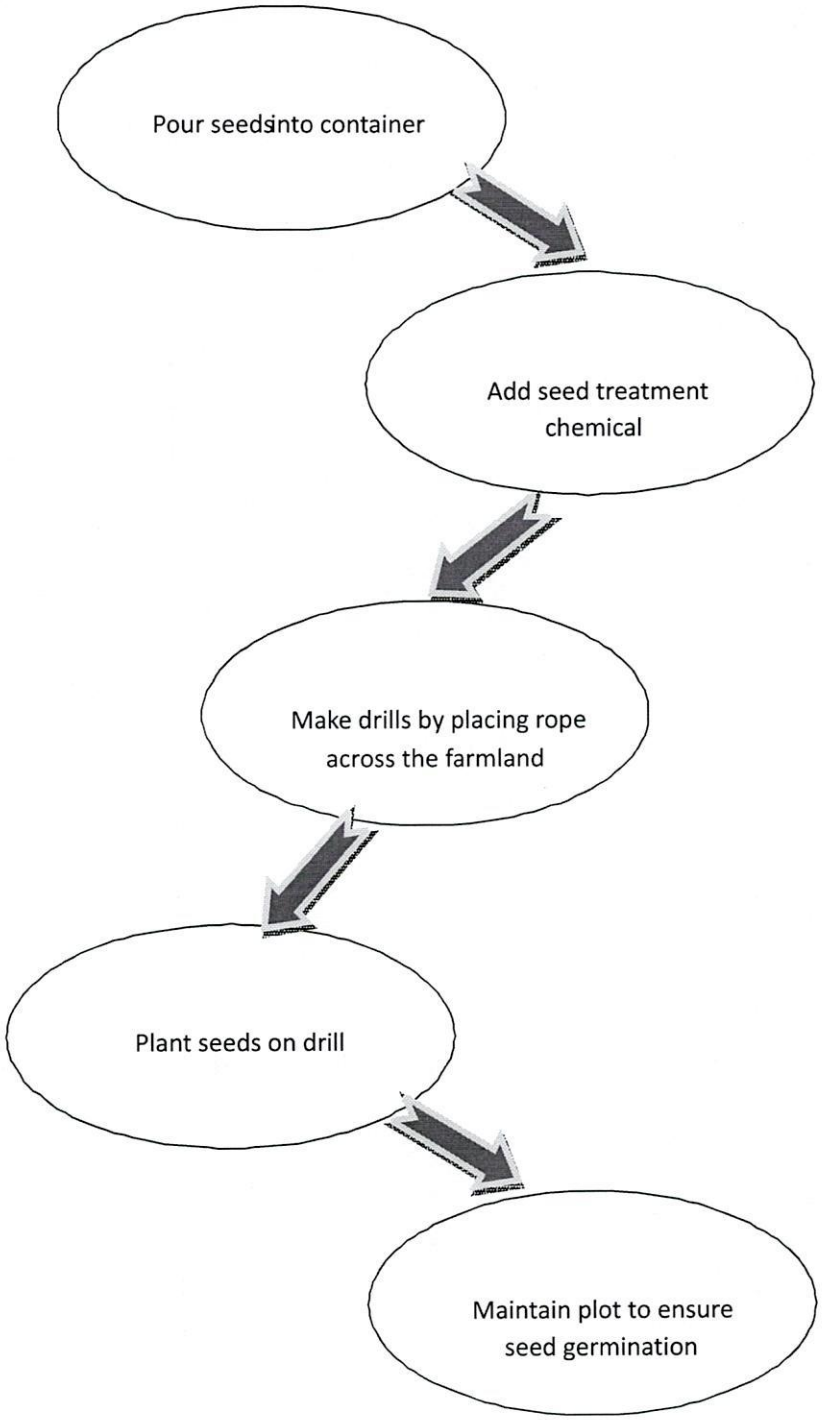


**Figure 24: Farmer Planting Seeds Manually**

## UNIT SUMMARY



**EXERCISE:**

- Describe the steps involved in planting rice seed?

## UNIT 4.6.9

## APPLY HERBICIDE

**Description**

This unit describes the process involved in the application of chemical to prevent the growth of weed which is done one day after planting.

**Unit Objectives**

At the end of this lesson students should be able to

- Identify the steps involved in applying herbicide.

Two-hand weeding, at 2-3 and 5-6 weeks after sowing or transplanting is adequate; however, weeds are also controlled by the use of herbicides.

| Compound | Active Ingredient | Rate |
|---|---|---|
| STOMP F 34 | PROPANIL | 6L/ha |
| ORIZOPLUS | PROPANIL | 6/ha |
| BUTACHLOR | 4 | 5L/ha |
| PENDIMETHELIN | 40EC | 5L/ha |
| | | |
| 2,4D | 24D | 5l/ha |

The following are steps used in controlling weeds in the farm using chemicals (pendelline)

1. **Wash the knapsack sprayer with a detergent.** Wash the sprayer with detergent after every use and before use to avoid complication of chemical reaction on the crops.

**Figure 25: Farmer Washing Knapsack Container**

2. Mix 200ml of pendelline and 300ml of roundup in a 15 litre knapsack sprayer. The knapsack sprayer should be feel hour with water before putting the chemical mixture.

**Figure 26: Farmer Mixing the required Quantity of Chemicals**

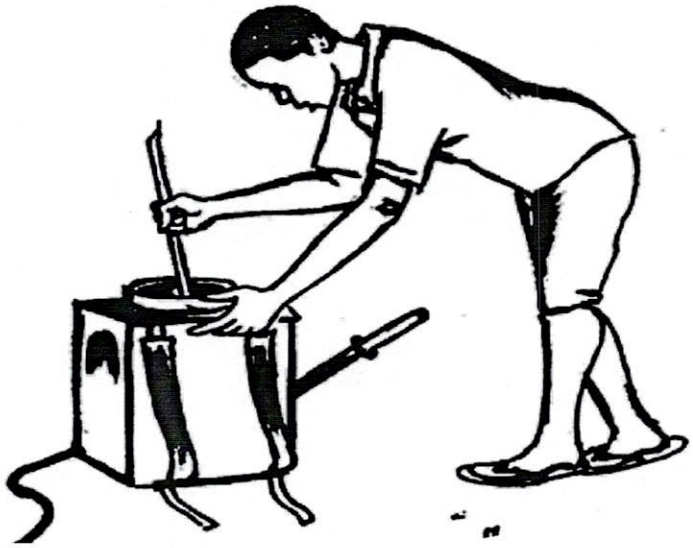


**Figure 27: Farmer Ensuring Proper Mixture Using a Stick**

3. **Mix it thoroughly and cover it with the injector**. The knapsack sprayer should be feel half with water before putting the chemical mixture then mix thoroughly and cover

**Figure 28: Farmer Strapping Knapsack Sprayer**

4. Allow the mixture to dissolve for an hour
5. **Cover your mouth and nose mask.** Herbicides are dangerous to man therefore care should be taken while handling it.

6. Strap the knapsack sprayer to your back.
7. Direct the nozzle towards the ground and spray round the area that has been planted.
8. While spraying, they should not be directed upward; it should be a bit downward and not be too fast or too slow to achieve a desired result.

**Figure 29: Farmer Applying Herbicide to Crops**

**EXERCISE :**

- List the steps involved in applying herbicide?

## UNIT 4.6.10

## APPLY FERTILIZER 1

### Description

This unit describes the processes involved in the application of fertilizer (NPK 15:15:15) to increase the nutrient content of the soil, this takes place 4-5 days after germination. The following are steps involved in fertilizer application:

1. Prepare the soil carefully
2. Remove weeds from farm
3. Apply the appropriate dose at the right time
4. Choose a time when there is no rain.

### Unit Objectives

At the end of the unit students should be able to:

- Explain the concept of applying fertilizer.

### Steps

In fertilizer application the following steps are involved:

1. **Prepare your soil carefully**

   Before applying fertilizer the soil should be worked on adequately to ensure that nutrient can easily made available for plants use. The essence is to loosen the soil so that the fertilizer can easily decompose into the soil.

**Figure 30: Manual Weeding Using Hoe**

2. **The modern varieties which respond well to fertilizer**
   The varieties that respond well to inorganic fertilizer should be sown as this will maximize nutrient use and increase crop yield.
3. **Apply the appropriate dose at the right time**
   Apply the appropriate dose of fertilizer to crops and at the right time. Failure to apply fertilizer at the right time may distort plant performance in terms of yield.8bags of NPK 15:15:15 should be applied per hectare for first application.

**Figure 31: Fertilizer Application by Broadcasting**

4. **Choose a time when there is no rain**
   Fertilizer should be applied at the time when there is less rain so that it will not be washed off from the soil by erosion or leaching.
5. **Do not let weed benefit from the fertilizer**
   Fertilizer should be applied on soil free of weeds so that the intended purpose of applying fertilizer can be achieved which is to increase crop production or yield.

**Figure 32: Hand pulling of Weeds**

Fertilizer applications in rice production are in two ways:

i. **Manual Spreading** which can be done by broadcasting or by distributing the fertilizer along the rows according to how the sowing was undertaken and the stage at which the fertilizer is applied.

**Figure 33: Manual Application of Fertilizer by Broadcasting**

ii. **Mechanical spreading** this is done with the aid of centrifugal distributor.

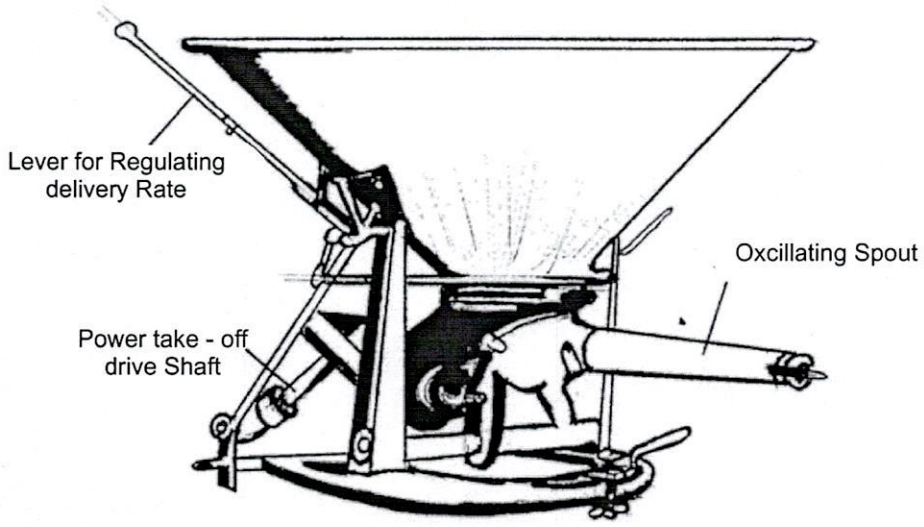



**Figure 34: Centrifugal Fertilizer Distributor**

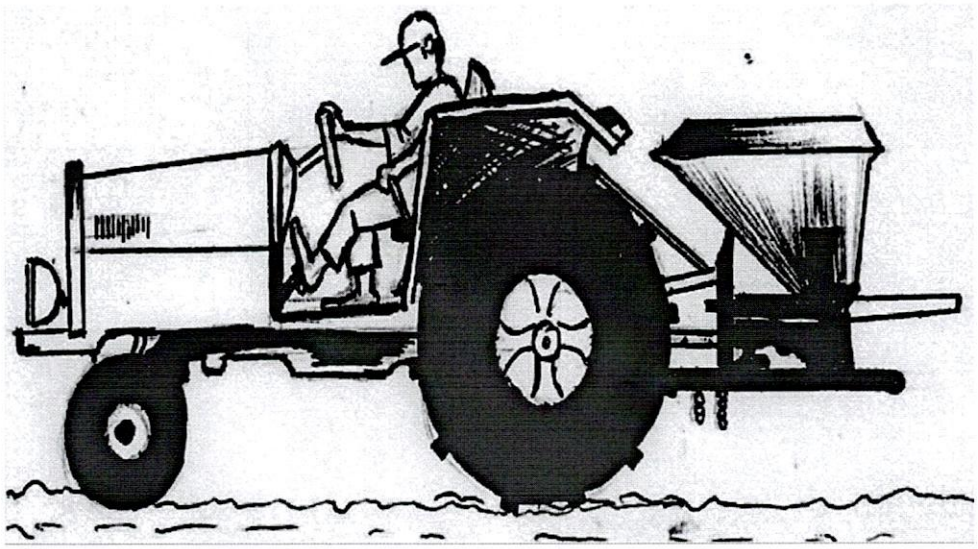
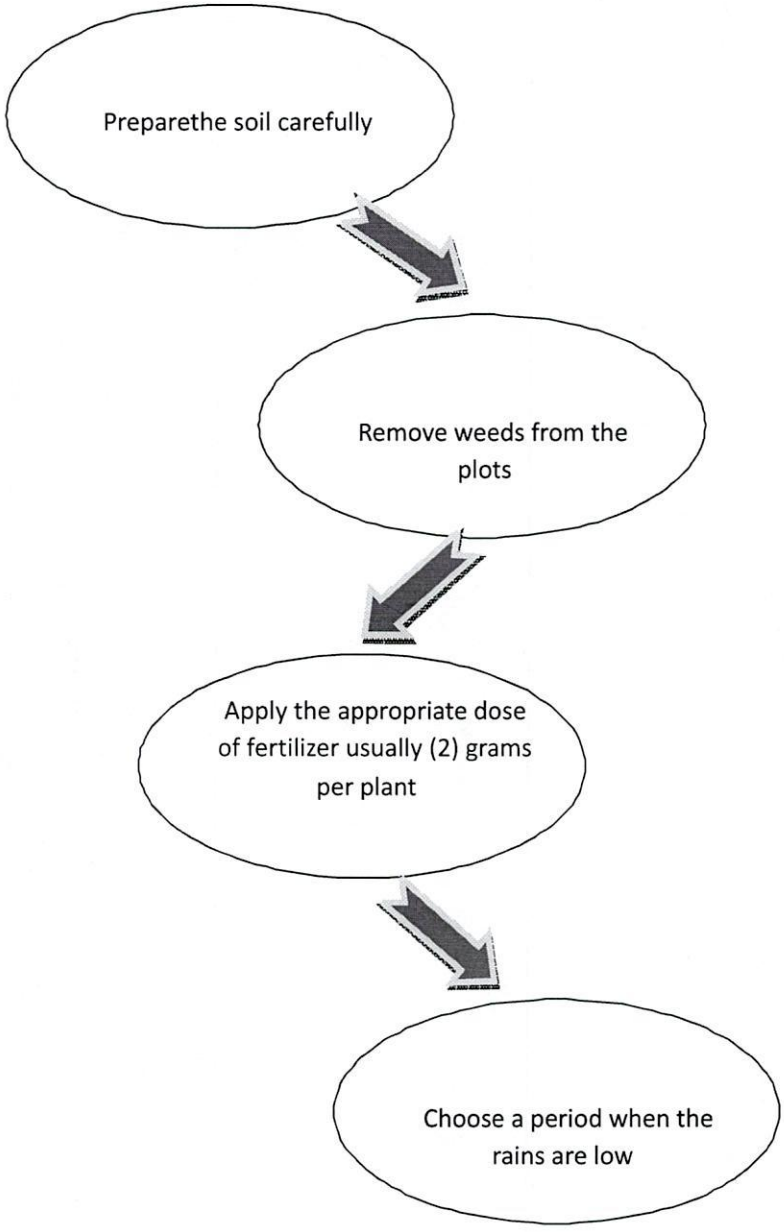


**Figure 35: Farmer Applying Fertilizer Using Centrifugal Distributor**

## UNIT SUMMARY



**EXERCISE:**

- Describe the process involved in applying fertilizer?

## UNIT 4.6.11

## WEED PLANT

### Description

This unit describes the process involved in the removal of unwanted plants from the farm which takes place 3-4 weeks after planting. Weeding can be done using the following steps:

1. Identify the weeds
2. Hand pull the overgrown weeds
3. Use a hoe to manually remove the weeds from their roots
4. Gather weeds and remove them from the plots

### Unit Objectives

At the end of the unit students should be able to:

- Explain the concept of weeding

### Steps

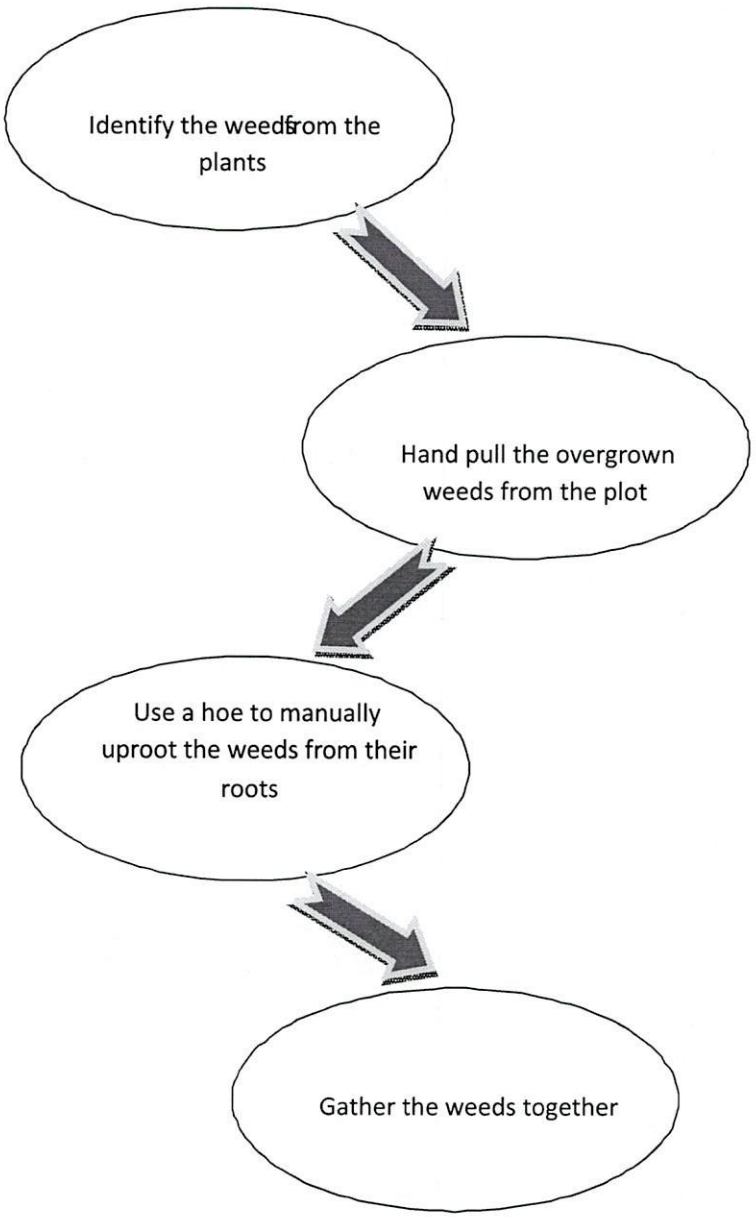
1. **Identify the weeds from the plants**
   Before weeding operation the farmer has to first of all identify the weeds from the plants because some weeds may appear to look like the plants and if care is not taken the plants may either be weeded alongside the weeds or the weeds may be mistaken for the plants and left not weeded.
2. **Hand pull the overgrown weeds**
   Overgrown weeds should be hand pulled carefully from the plot ensuring that the roots of crops are not affected in the process.
3. **Use a hoe to manually remove the weeds from their roots**
   During weeding operation ensure that the roots of the weeds are completely removed from the farm. This is the only way the farmer can ensure that they do not germinate again after weeding.

**Figure 35: Manual Weeding of Rice Plot.**

4. **Gather the weeds together.**
   After weeding the debris should be gathered together and removed from the plot.

**Figure 36: Gathering of debris in the farm**

## UNIT SUMMARY



**EXERCISE:**

- Describe the process involved in weeding?

## UNIT 4.6.12

## APPLY FERTILIZER II

**Description**

The information in this unit describes the process involved in the second application of fertilizer (urea) to increase the nutrient content of the soil, this take place 4-5 weeks after planting, 2-4 bags is applied per hectare for the second application.

**Unit Objectives**

At the end of the unit students should be able to:

- Explain the concept of applying fertilizer.
  **Apply fertilizer using the procedure in Unit 4.6.10**

**EXERCISE:**

- Describe the process involved in applying fertilizer?

**UNIT 4.6.13**

**APPLY PESTICIDE**

**Description**

This unit describes the process involved in the application of chemical to control pests and diseases infestation on farm which is done at flowering stage three times before harvest.

**Unit Objectives**

At the end of the unit students should be able to:

- Identify the steps involved in applying pesticide.

**Steps**

Pesticide application can be done using the following steps:

1. Measure 50ml of Karate into 15litres of water

**Figure 37: Pouring of Pesticide into Knapsack Container**

2. Mix properly to ensure adequate dilution

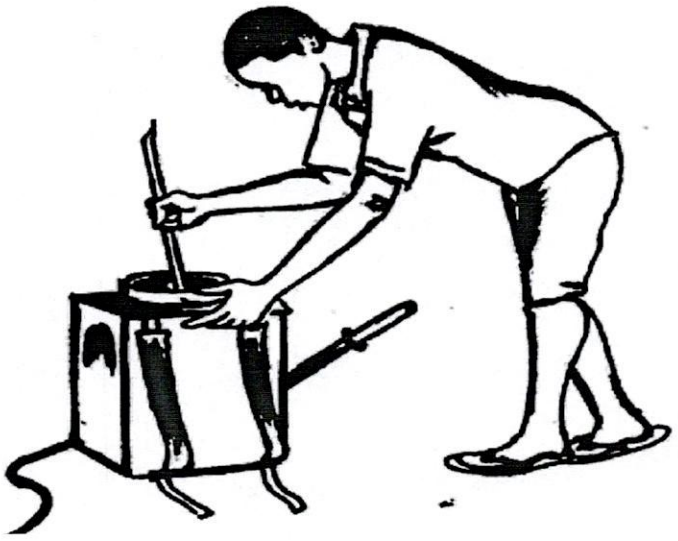


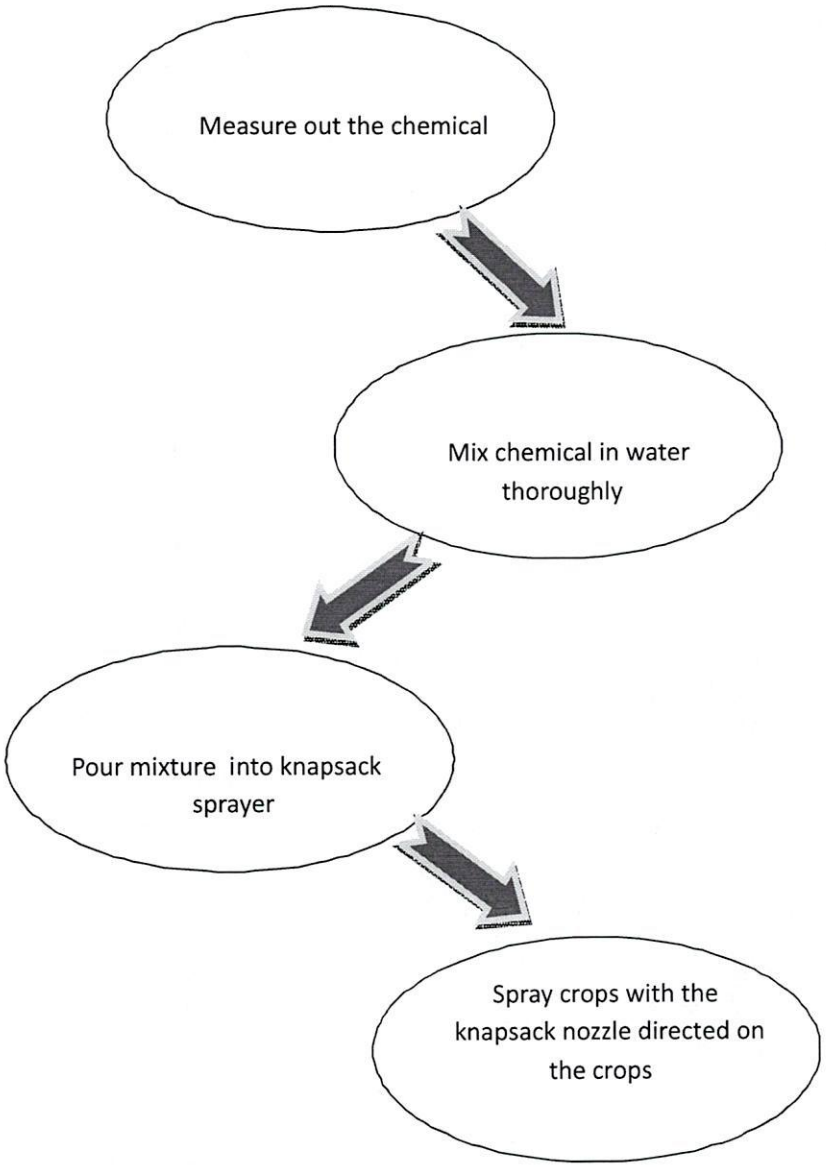
**Figure 38: Mixing of Pesticide in Knapsack Container**

3. Allow the mixture for about an hour to dissolve .
4. Strap the Knapsack sprayer on your back.

**Figure 39: Pesticide Application**

5. Direct the nozzle towards the ground and spray round the area that has been planted.

## UNIT SUMMARY



**EXERCISE:**

- List the steps involved in applying pesticides?

## UNIT 4.6.14

## HARVEST PRODUCE

**Description**

This unit describes the process involved in cutting rice straw from the parent plant at maturity

**Unit Objectives**

At the end of this unit students should be able to:

- Describe the processes involved in harvesting rice.

**Steps**

Harvesting of rice is done in the following ways

1. Harvest the rice when the head turns brown

**Figure 40: Manual Harvesting of Rice Using Sickle**

2. Cut the stem with a sickle or hire a combined harvester.
3. Gather the rice straws in bunches and beat it against a drum to separate the paddy rice from the straw.
4. Beat the rice straw

**Figure 41: Manual Processing of Rice**

**5.** Winnow to remove the dirts

**Figure 42: Manual Winnowing of Rice**

1. Spread it to dry.

**Figure 43: Sun drying of Harvested Rice Grain**

2. Bag the paddy rice

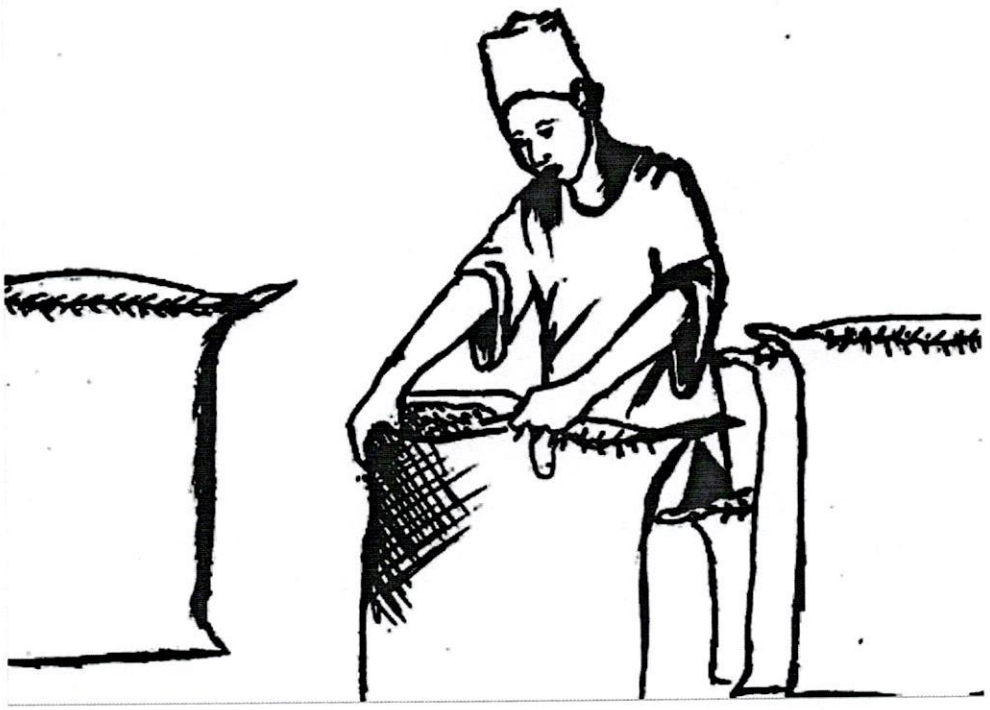


**Figure 44: Bagging of Process Rice**

**EXERCISE:**

- Identify the steps involved in harvesting produce?

## UNIT 4.6.15

## STORE PRODUCE

**Description**

This unit describes the process involved in keeping the produce for future use or sale in a dry and well ventilated room.

**Unit Objectives**

At the end of the unit students should be able to:

- Describe the process of storing produce

In storing harvested rice the following precautions must be strictly adhered to:

1. Ensure that the store is clean, dry and well ventilated.
2. Use a wooden plank or stake as the base to avoid placing the bags directly on the floor.
3. Stack the bags carefully on each other in the store.

**Figure 45: Grain Storage in a ware hause**

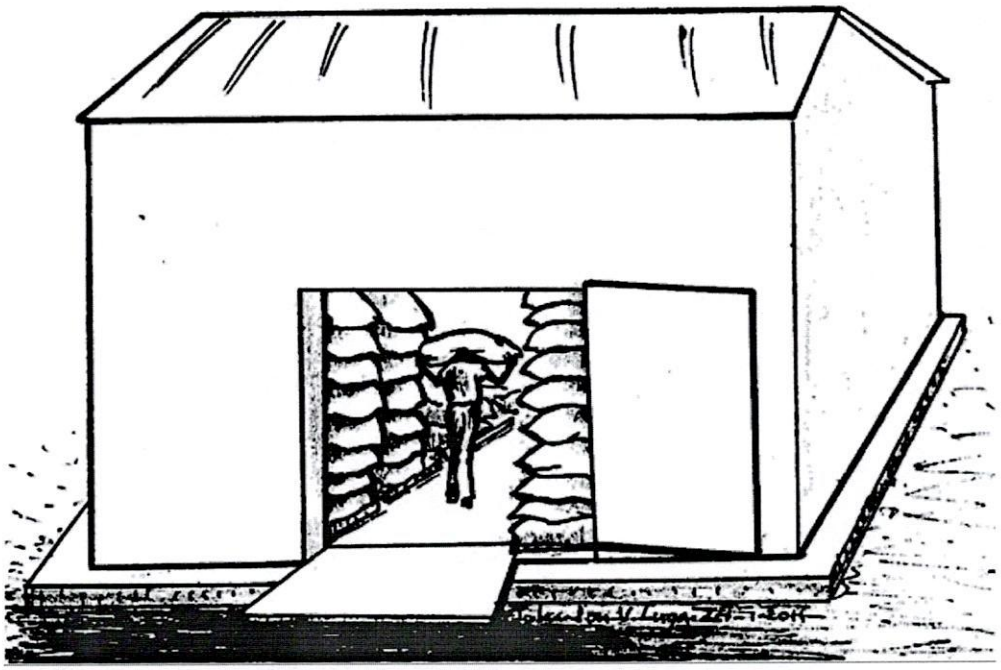


**Figure 46: Ware house**

**EXERCISE:**

- What should be considered in selling of Rice to maximize profit?

## UNIT 4.6.16

## TRANSPORT PRODUCE

**Description**

This unit describes the process involved in movement of produce from the farm to the market for sale.

**Unit Objectives**

At the end of the unit students should be able to:

- Negotiate on the best way to transport produce.

The processes involved in transporting produce should be repeated as in Unit 4.6.7

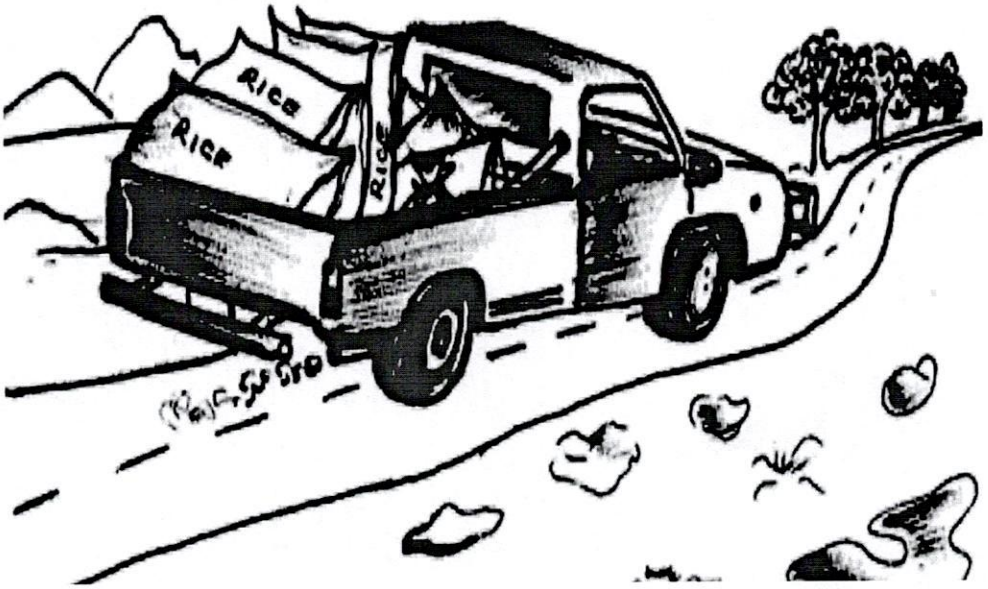



**Figure 47: Vehicle Transporting Produce**

**EXERCISE:**

- List the steps involved transporting produce?

## UNIT 4.6.17

## SELL PRODUCE

**Description**

This unit describes the process involved in exchange of produce for money

**Unit Objectives**

At the end of the unit students should be able to:

- Identify the right time to sell produce.

Sale of farm produce should be done in the following ways

1. Sell produce at the farm gate if customers are available
2. Look for customers around the farm after harvesting and sell but at relatively lower price, farmers are advice to store their produce for some times till it reaches off season when the price rise.


**Figure 48: Sale of Produce at the Market**

**EXERCISE:**

- Identify the steps involved in selling produce?

## DOCUMENT OVERVIEW

This manual is intended to be a guide to the crops extension personnel, literate farmers as well as agricultural institutions in their endeavour to improve productivity in the agricultural sub-sector.

This manual contains up-to-date information on the recommended practices and it is designed to provide guidelines on seedling production and management, plant spacing, cropping programme, soil fertility, crop protection as well as marketing aspects. The manual is divided into two segments; Lessons and Units, The Lesson explains the "WHAT IS" and the Unit explains the "HOW TO" i.e. step-by-step processes involved in achieving the desired increase in crop production.

The language used in this manual is simple and explanations are made with appropriate illustrative diagrams to buttress relevant points. We hope, therefore, that this manual will contribute modestly to the goal of improving crop production with resultant incremental effect on disposable income of farming families in the state.

Researchers from the department of Agriculture were involved in the reviewing, editing, and production of this manual. Their valuable contributions are hereby gratefully acknowledged. We welcome suggestions for further improvement of this training manual.

## LESSON 1

## INTRODUCTION TO RICE PRODUCTION

### 1.1 Overview

Rice is a member of the grass family. It is one of the most mportant food crops in the world. It is the main staple food for people in developing countries like Nigeria. As a major food rice is consumed in all parts of Nigeria Rice production in Adamawa is dominated by small holder farmers using traditional manual methods that are with drudgery and a lot of problems. Individual farmers cultivate between 0.5- 1.5 hectares on the average depending on labour availability and access to inputs. In low land areas farmers depend mainly on flooding that is very difficult to control and does not allow for efficient fertilizer and agro-chemical application.

The cereal research institutes in Nigeria have developed over 52 rice varieties with potential yield of 2-8 tonnes paddy per hectare and maturity periods ranging from 95-140 days. Planting dates for rice must be worked out according to the water requirements. The period when the water requirements is greatest must coincide with the maximum rainfall is expected. Planting of rice can be done by drilling, dibbling, transplanting and broadcasting.

### 1.2 Lesson Objectives

At the end of the lesson students should be able to:

- Understand the various rice sowing techniques
- State the correct seed rate and spacing for rice production
- Understand the developmental stages of rice

### 1.3 Key Concepts

- **Cultivate-** Tilling of soil and planting
- **Tonne-** 1000Kg
- **Photo-sensitive**- Light sensitive

# LESSON 2

# SITE SELECTION

## 2.1 Overview

Rice is a temperate and tropical crop that requires a good site for optimum yield. There are different rice varieties that are adapted to certain climatic and soil requirements. The various soil and climatic requirements are explained in this lesson to guide the farmer or student on the right choice to make while selecting site for rice production if optimum yield is to be achieved.

## 2.2 Lesson Objectives:

At the end of the lesson students should be able to:

- State the factors considered in site selection for rice production
- State the climatic requirements for rice production
- Identify the type of soil needed for rice production.

## 2.3 Key Concept:

- **Fadama:** Area that has high water retention capacity.
- **Tillering:** This is branch formation in rice

## 2.4 Climatic and Soil Requirement

Rice can be grown in different conditions under a variety of soil and climatic conditions.

There are various parameters that influence rice production, they include:

### i. Temperature

Extreme temperatures are destructive to crop growth. Temperature influences the crops by influencing various phenomenon like tillering, spikelet formation, ripening etc. Temperature has a linear effect on rice crop. The low, high and optimum temperature needed for rice production is as follows:

| Growth Stage | Temperature $^0$C | | |
|---|---|---|---|
| | Low | High | Optimum |
| Germination | 10 | 45 | 20-35 |
| Seedling and Emergence | 12-13 | 35 | 25-30 |
| Rooting | 16 | 35 | 25-28 |
| Leaf Elongation | 7-12 | 35 | 31 |
| Tillering | 9-16 | 33 | 25-31 |
| Panicle Initiation | 15 | - | - |
| Anthesis | 22 | 35 | 30-33 |
| Ripening | 12-18 | 30 | 20-25 |

**ii. Soil Type**

Clay loam soils are desirable for some upland rice varieties because of its good water-holding capacity, while clay loam soils of river valleys and flood plains(Fadama) are best for low land rice. Area should be flat for uniform flow of water gradient, this is important to reduce cost and improve grains; it also enhances weed control and tillering.

**iii. Rainfall**

Rice crop is highly sensitive to water stress conditions as well as water stagnation conditions. Upland rice varieties require moderate rainfall for optimum yield and lowland varieties require high rainfall due to its high moisture requirement for optimum yield.

## LESSON 3

## LAND PREPARATION

### 3.1 Overview

Land preparation for rice production goes through a process that involves clearing of the land, stumping, clearing of debris and the tillage operations. Tillage is done to a depth of 15-20cm for sufficient, quick and deep root development. Agood land reparation is recommended by applying farm yard manure at about 2-3 tones/ha after ploughing, then harrow. Use a machine or manual labour to incorporate farm yard manure. Farm yard manure improves soil texture.

### 3.2 Lesson objectives:

At the end of the lesson students should be able to:

- Explain the reasons for land preparation before lanting
- State the techniques used in land preparation for rice production.
- Be able to prepare land for cultivation.

### 3.3 Key Concepts:

- **Farm yard manure**: This is organic manure that Contains certain number of elements.

### 3.4 Land Preparation Activities

- **Land clearing:** This is the removal of the existing vegetation on the land intended to be used for cropping to make it clean

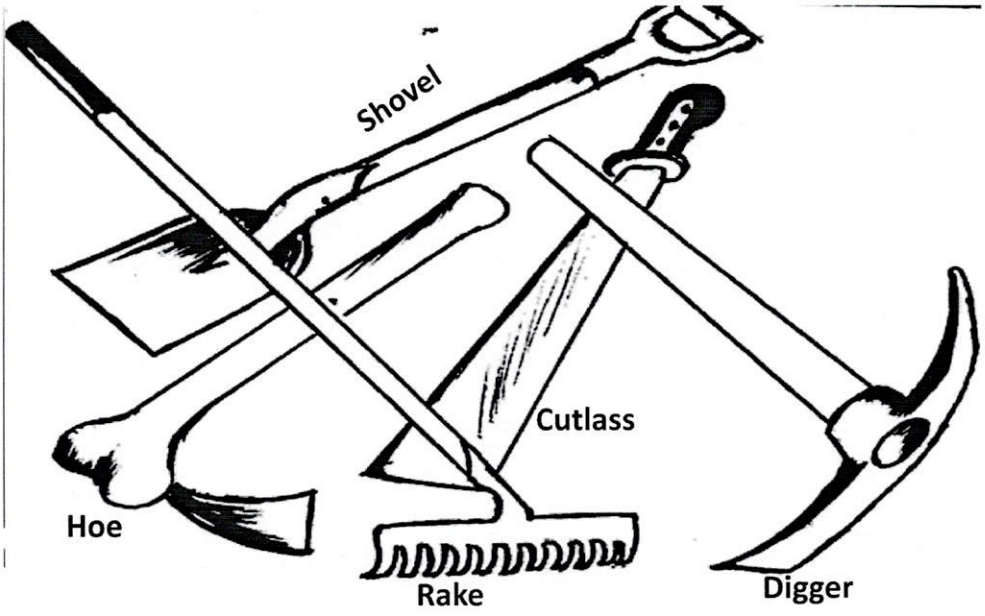



**Figure 1: Simple Farm Implements**

**Advantages**

- Clearing of land gets rid of weeds from the land
- It leaves the land free from all obstacles that may hinder tillage and planting operations.

**Disadvantages**

- It results in the disturbance or removal of top soil
- It exposes the soil to direct sunshine hence, it affects evaporation of water
- It increases the temperature of the soil
- It exposes the soil to erosion
- It leads to destruction of soil structure or soil composition.
- It leads to reduction in soil organisms

**Figure 2: Manual bush Clearing using Cutlass**

2. **Bush Burning:** This involves the setting of fire on the bush to clear out the vegetation.

**Figure 3: Bush Burning**

**Advantages of Burning**

- The remains of burnt plant materials provide ash which is a good source of potash
- Burning has some sterilizing effects on the soil by killing some harmful soil borne micro-organisms.

**Disadvantages**

- Nitrogen is lost in the process
- Soil macro and micro organisms are destroyed in the process
- Reduction of soil organic status

1. **Tillage Operations:** This refers to the working, digging or breaking up of the soil in preparation for planting of crops. There are three types of tillage operation namely:
   i. **Zero Tillage:** This refers to the situation where there is no tilling of the soil at all.

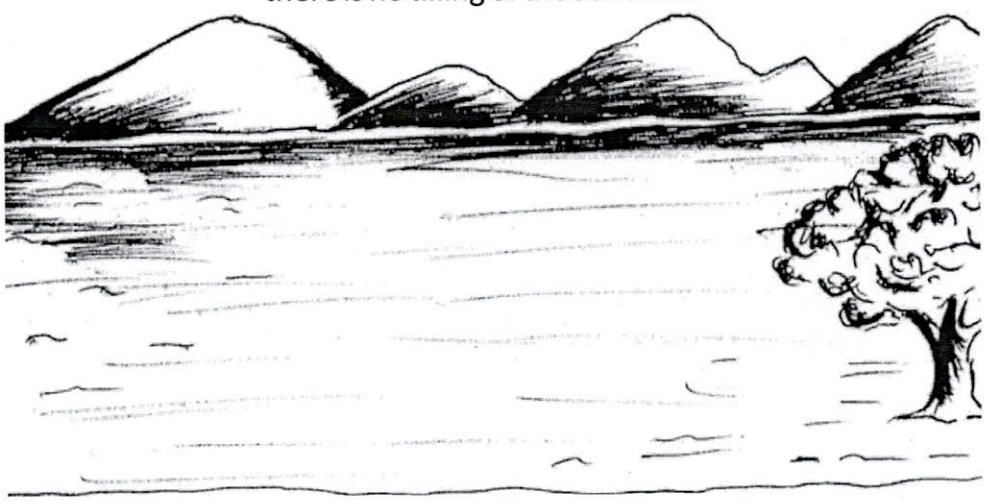


**Figure 4: Zero tillage in rice production**

ii. **Minimum Tillage**: This refers to a situation where the soil is tilled at minimal level just to break the top soil to ease planting operation especially in hard soils.

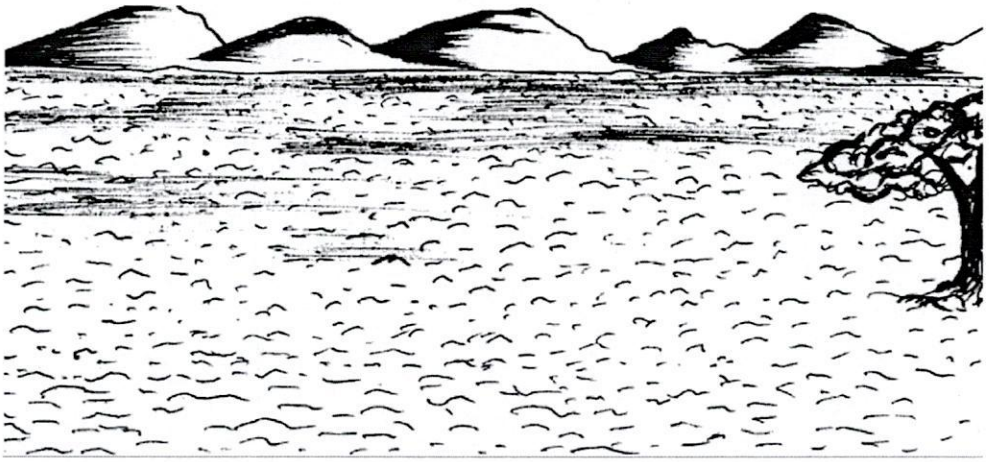


**Figure 5: Minimum tillage operation in rice production**

iii. **Total Tillage:** This involves the use of heavy implements like plough, harrows, ridgers to till the soil and prepare seed beds for planting

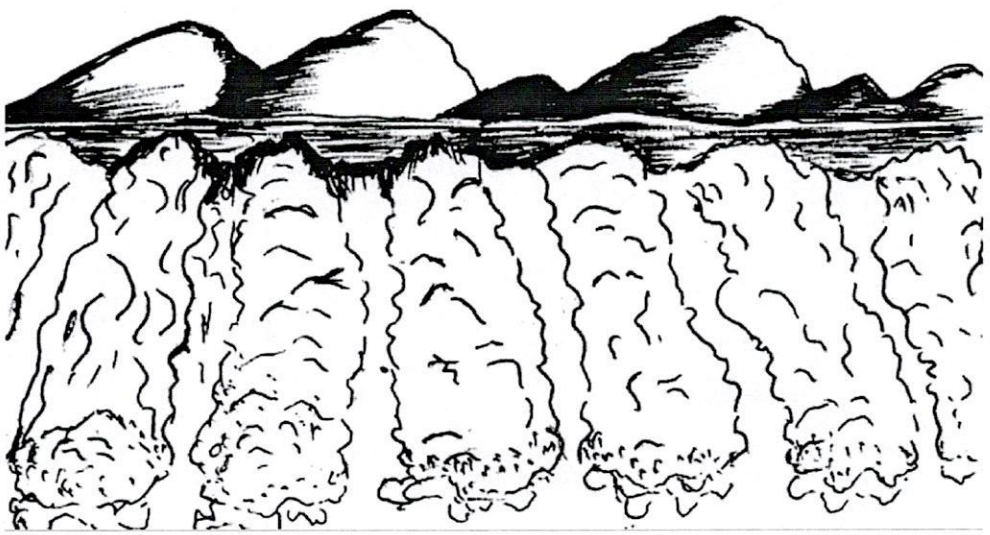


**Figure 6: Total tillage operation in rice production**

**Effects of Tillage Operations on the soil**

1. It exposes useful soil organisms to hostile external environment
2. It leads to destruction of soil structure
3. It exposes soil grains to wind and water erosion
4. It encourages the development of hard pan layer which leads to water logging.

Land preparation in rice production can be done in the following ways:

1. **Manual land preparation**
   This involves the use of simple farm implements like hoes, cutlasses, rakes, axes to prepare the farmland for planting. Cutlasses and axes are used to remove grasses and stumps that will hinder cultivation from the soil while hoes are used to till the soil for planting.

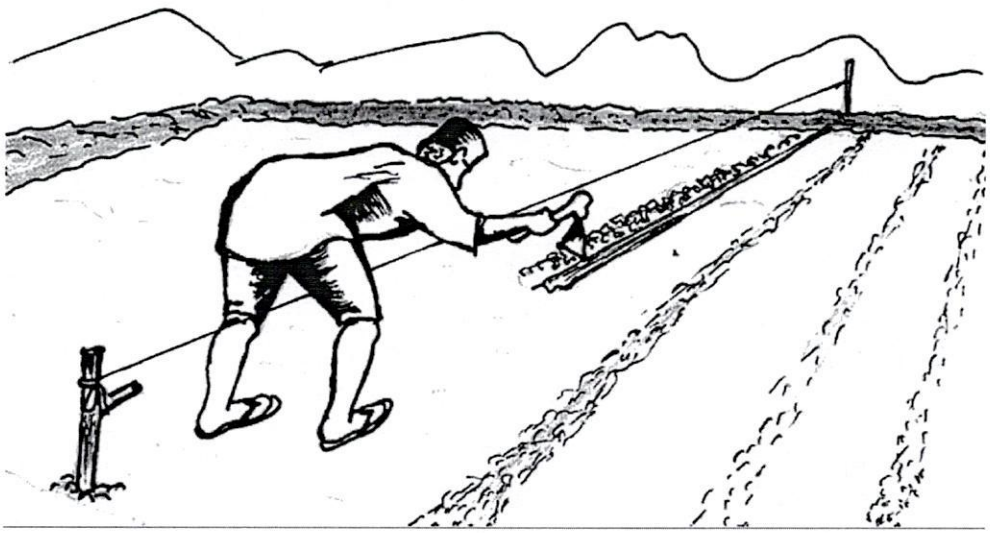


**Figure 7: Manual Land Preparation.**

2. **Use of Traction Animals**
   This is the use of trained bulls to prepare the land for cultivation. A simple farm implement is attached to the bulls that pull the implements to perform its function and the bulls are being directed by the farmer. The diagram below gives you an idea of traction animals.

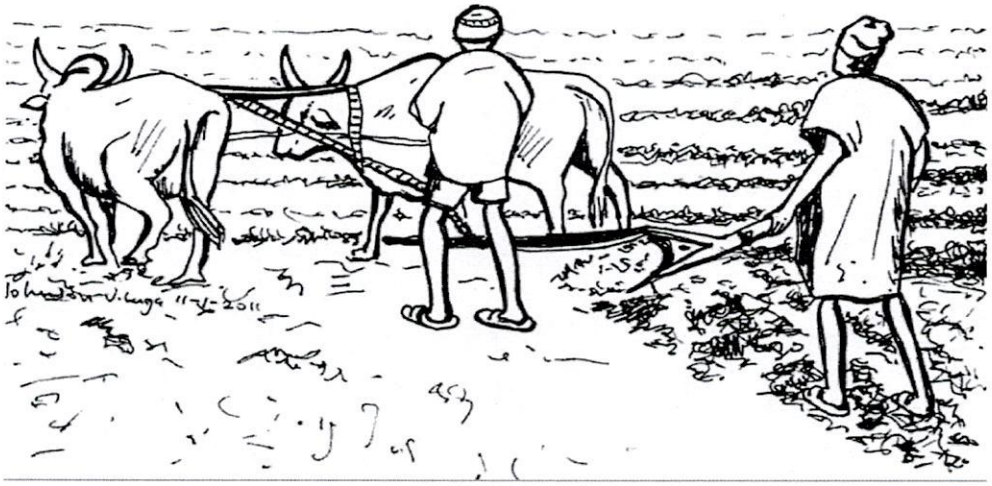


**Figure 8: Use of Traction Animals in Land Preparation**

3. **Mechanical land Preparation.**

This involves the use of tractors to prepare the soil for planting. Soil preparation can be in three stages:

- **Land Clearing:** This is the removal of trees, shrubs and stumps which can be done manually or mechanically.

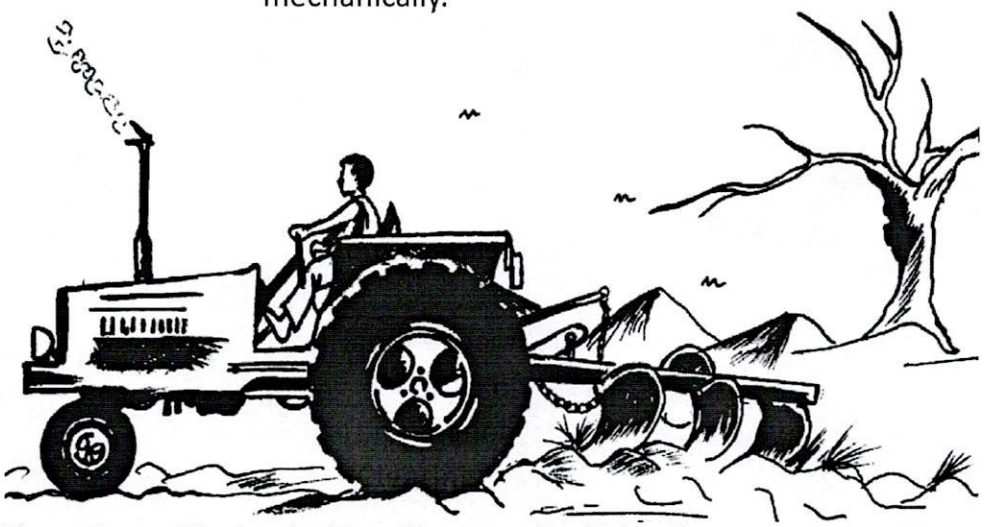


**Figure 9: Mechanical Land Preparation Using Tractor**

- **Land Harrowing:** This involves breaking soil lumps into smaller particles and leveling the soil, it can also be done manually by use of hoe, traction animals and machinery.

## LESSON 4

## PLANTING

### 4.1 Overview

Rice is propagated by seed. Yield of rice is determinant on the method of sowing. Rice can be sown in two major ways; direct seeding and planting in nursery which can be done by dibbling, drilling or broadcasting.

### 4.2 Lesson Objectives

At the end of the lesson students should be able to:

- Explain the different rice sowing techniques
- State the different rice varieties
- Plant rice using the different planting methods

### 4.3 Key Concepts:

- **Dibbling:** This is the planting of rice seed in a hole.
- **Drilling:** This involves the planting of rice on a straight line on the field.
- **Broadcasting:** It involves spreading of rice seeds on the field.
- **Transplanting:** It involves replanting of seedling in to the permanent site.

### 4.4 Recommended Varieties

- **Early Maturing**
  Faro 38 (IRAT 133), FARO 39 (IRAT 144), FARO 45 (ITA 257), FARO 46 (ITA 150).
- **Medium Maturing**
  FARO 11(OS 6), FARO 43 (ita 128), FARO 47 (ITA 117), FARO 48 (ITA 301), FARO 49 (ITA 315)
- **National Accelerated Food Production Program Tested**
  ITA 321, ITA 331, IDSAID, WAB 35-2-FX, TDX 1012-12-28
  In Africa the large, traditional, varieties of Oryza sativa, both

traditional and improved can be divided into two major groups

(i) Varieties generally grown under upland conditions- Upland rice

(ii) Varieties grown under lowland conditions- lowland rice

Rice is planted by dibbling, broadcasting, transplanting and drilling. Drilling gives higher yield. Drilling requires planting on a straight line while transplanting, requires a nursery. Varieties are selected based on the total number of days of maturity, associated with raining days e.g. varieties maturing between 80-90 days will be good for upland, while those that mature in 120-140 days will be good for lowland. Seed tolerant to pest, diseases and drought are to be considered during selection. Some upland and lowland varieties of rice include:

**Table 1: Showing Rice Varieties**

| Varieties of upland | Varieties of lowland |
|---|---|
| EX. China, faro38, 39, 45, 46 | FARROW44 (SIPPI) |
| WAB450B-B-P38-HB (NERICA) | WITA 1 and 4 |
| WAB189-6-B-B-B | TOX3661-2-3-2 |
| WAB450-B-B-P31-HB | |
| FARROW43, 47, 48, AND 49 | |
| WAB340-B-B-1-HB | |
| WAB337-B-B-HB | |

Rice is generally planted by dibbling, broadcasting and transplanting by farmers. Few practice drilling & transplanting, which gives higher yields. Below are spacing, seed rates and planting depth for each of the planting methods.

**Table 2: Showing Methods of Rice Propagation**

| METHOD | SPACING | SEED RATE KG/HA |
|---|---|---|
| Dibbling | 10x10cm | 60 |
| Drilling | 15-12cm | 100-120 |
| Broadcasting | Evenly distributed | 100-120 |
| Transplanting (seedlings) | 13X10 | 30 |

Before planting, seeds should be treated. Seed dressing helps to ensure the prevention of seed decay before germination and disease after germination. It ensures even stands at the recommended population density and higher yield. The recommended seed dressing chemical is Apron star 3-4kg of rice can be treated with a sachet Rice cultivation involves (4) four techniques. They include

## 4.5 Planting

### a. Direct Seeding

This is possible in hydromorphic areas by broadcasting or dibbling. Divide the field into plots of 50 m2 or 100 m2, and construct small bunds. Weeds are the major problem. Apply herbicides to control them. in dibbling, the spacing should be 20–25 cm between rows and 15–20 cm betweenplants. Direct seeding can be done with pre germinated seeds in wet soils.

### b. Nursery Raising

Soak the seeds in water for 24 hours. Spread them on the floor and incubate them by covering them with polyethylene bags for 48 hours for the seeds to sprout. To provide seedlings for 1 ha of land, raise the nursery in 500 m2 (1/20 acre). Spread the sprouted seeds uniformly on a puddled nursery field. Drain excess water from the field for a week. Ensure that seed beds are raised in high rainfall areas. Avoid bird damage during germination by scaring birds. In gall midge affected areas, apply FuradanTM(Carbofuran) at 1 kg/ha in nursery beds a week before uprooting.

## 4.6 Transplanting

Transplant seedlings from nursery after 21 days. This is done by uprooting the seedlings. Transplant 2–3 seedlings per hill. Spacing should be 20 cm between rows and 15–20cm between plants.

Transplant early maturing varieties 15 cm apart and transplant medium and late maturing varieties 20 cm apart.

## 4.7 Gap Filling

Gap fill the areas where seeds have not germinated 7–10 days after transplanting. Use remaining seedlings.

1. **Manual Cultivation**

   This is done using human labour. It is usually time consuming and it does not require a high level of technical expertise it is well known to small holders by whom it is mastered perfectly.

**Figure 10: Manual Land Cultivation**

2. **Draught animals-** Traction is provided by a pair of animals (Zebra or N'Dama cattle in Africa). An important feature of using draught.

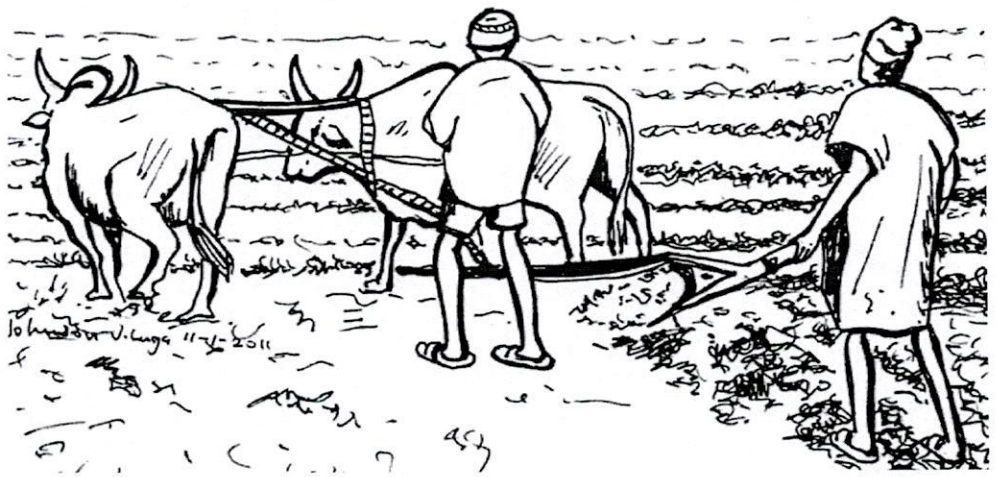


**Figure 11: Use of Traction Animals**

animals is the possibility of additional fertilization from the animal excreta

- ***Cultivation with small tractors or machinery-*** This category covers equipment with a low output

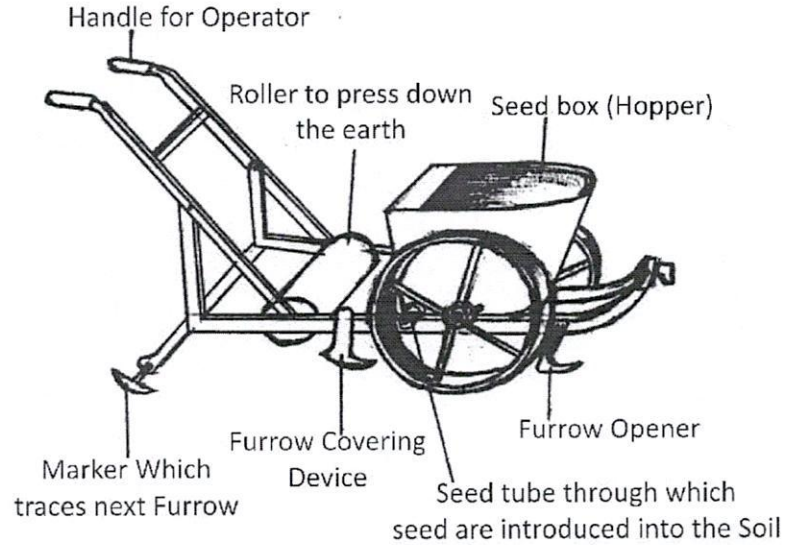



**Figure 12: Mini Cultivation Machine**

- **Conventional mechanized cultivation** which has to do with the use of large machineries like tractors. Seed are dressed with 3-4 kg/sachet of Apron start or dress force.

**Figure 13: Conventional mechanized cultivation**

Seed rate for drilling is 100-120kg per hectare with a spacing 10x10cm while transplanting (seedling), 30kg per hectare with spacing 10x13cm.

## 4.8 Stages of Rice Development

A basic understanding of the physical characteristics of the rice plant will facilitate understanding of rice growth cycle and will also prove useful in many aspects of cultivation. Rice belongs to a family of cereal grass along with wheat, corn, millet, oats, barley etc. The grass family provides the world with 60% of its caloric intake and over 75% of protein intakes for developing countries.

The rice plant is an annual grass with round hollow ,jointed stem, flat leaves and a terminal panicle. It is the only cereal that is adapted to growing in both flooded and non-flooded soils. Grown under a wide range of climatic and geographic conditions on all the continents of the world. The parts of rice plant may be divided as follows:

***Roots-*** As the underground of the plant the roots serve as support, draw food and water from the soil and store food

***Stem-*** The role of the stem is to support the leaves and reproductive structures and to transfer essential nutrients between the roots, the leaves and the reproductive structures.

***Leaves-*** The leaves function as the principal organs of photosynthesis and respiration. They contain chlorophyll containing cells which convert sunlight to chemical energy and synthesize organic fuel compounds to inorganic compounds.

***Panicle-*** The panicle or flower cluster, contain the reproductive organs of the rice plant.

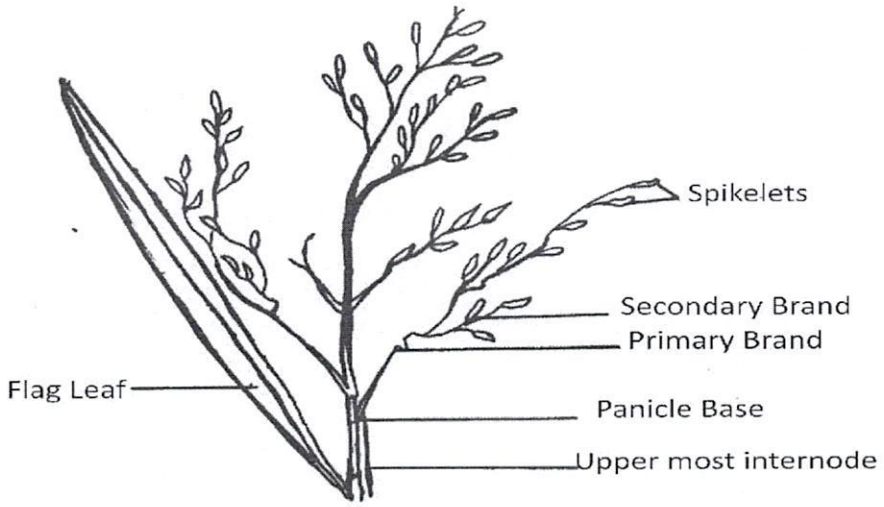



**Figure 14: Rice Panicle**

The Panicle is divided into the primary and secondary branches bearing the spikelets. The panicle stands erect at blooming and drops as the spikelets fill, mature and develop into grains. Varieties differ greatly in length, shape and weight of the overall panicle.

***Spikelet-*** Each individual spikelet contains a set of floral parts flanked by the lemma and palea. The flower consists of six stamens and a pistil. The stamens which contain pollen or sperm are composed of two celled anthers borne on slender filaments. The pistil consists of the ovary containing the ovule or egg. During reproduction the stigma catches pollen from the stamens and conducts it down to the ovary where it comes into contact with the ovule and fertilization occurs

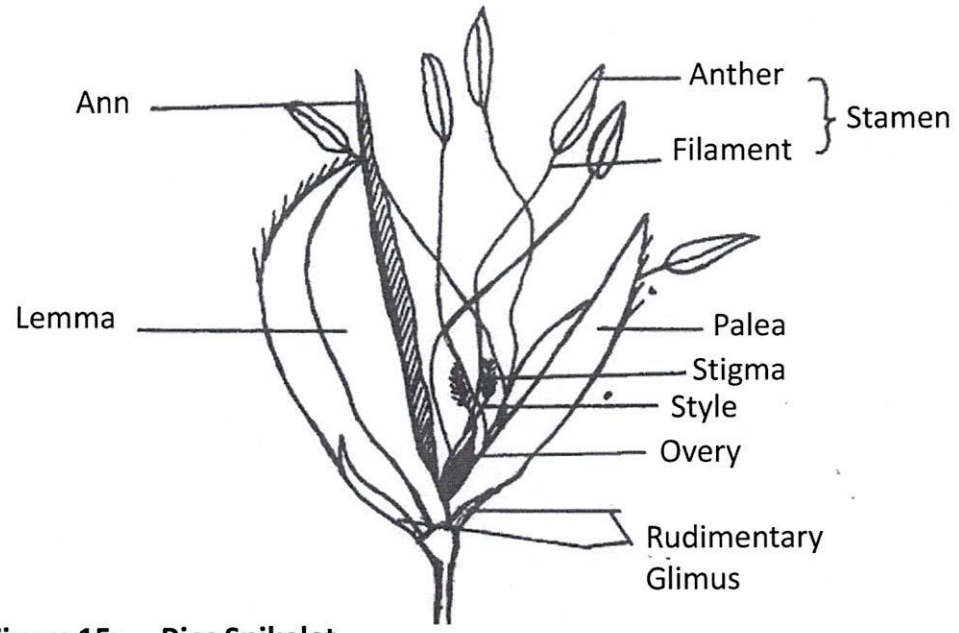



**Figure 15: Rice Spikelet**

***Grain-*** The grain is the seed of the rice plant, a fertilized and ripened ovule containing a live embryo capable of germinating to produce a new plant

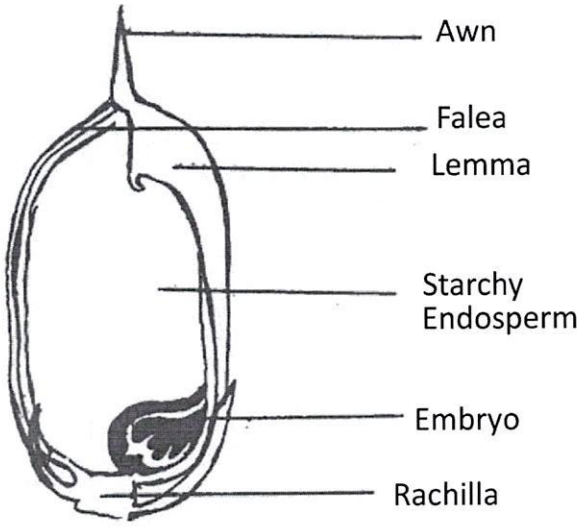



**Figure 16: Rice Grain**

The growth cycle of rice has (3) three stages

1. **Vegetative Phase**
   a. **Seedling stage-**Approximately five days after sowing emergence takes place i.e the plantlets emerge from the soil.

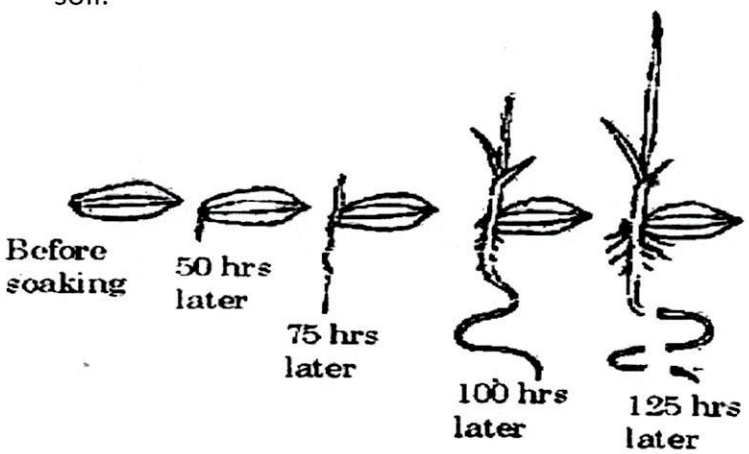



**Figure 17: Rice Seedlings Stages**

   b. **Transplanting stage-** Transplanting of seedling is done by either manual planting, machine planting-transplanter etc. This stage covers uprooting of seedling to full recovery following transplanting.

   c. **Tillering stage-** This follows the seedling stage. It starts with the appearance of the first tiller or shoots. This takes place twenty days after sowing.

2. **Reproductive Phase**
   a. **Panicle initiation stage-** The reproductive stage begins before the maximum tiller number is reached. It could be 60-70 days after seeding depending on the variety.
   b. **Booting stage-** During the booting stage the internodes undergoes a rapid growth spurt and quickly lengthens. During this period of rapid growth the plants demand for nutrient is high making the early booting stage a crucial time for fertilization.

**Figure 18: Booting Stage of Rice**

c. **Heading stage-** The booting stage is followed by the emergence of panicle tip (heading) out of the panicle flag leaf sheat. Emergence continues until 90% of the panicles are out of the sheaths.

d. **Flowering stage-** The flowering stage begins with the emergence of the first anthers from the uppermost spikelet on each panicle. Each individual spikelet flowers for several hours during the day on two or three successive days. During the flowering pollens from the anther is transported by wind and insects to the stigma which carry it into the ovaries where fertilization of the ovules occur. During the period of flowering fertilizer or pesticide should not be applied as the pollination period is very sensitive and can easily be disrupted by the presence of agro-chemicals.

**3. Ripening Phase**

The ripening phase occupies a period of 25-35 regardless o varieties. The rice grain develops after pollination and fertilization. Grain development is a continuous process and the grain undergoes distinct changes before it fully matures.

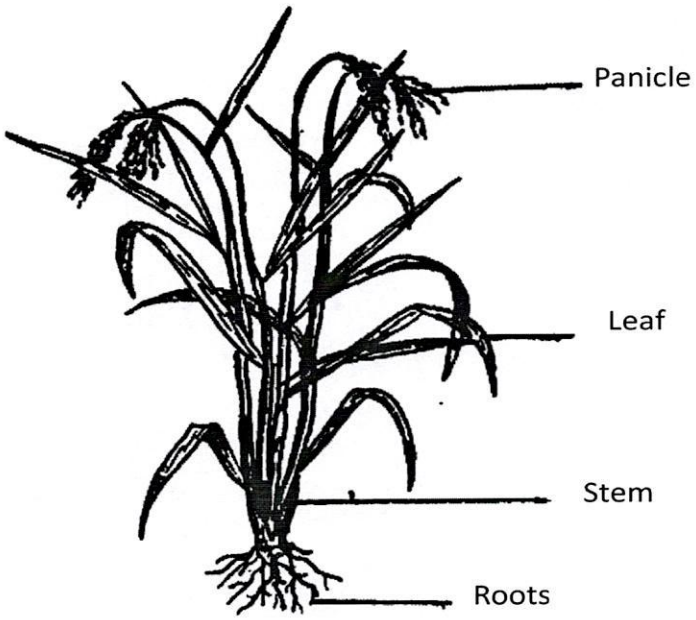



**Figure 19: Ripening Phase of Rice**

a. **Milky stage-** The content of the caryopsis i.e the starchy portion of the grain are first watery but later turns milky in consistency
b. **Dough stage-** The milky caryopsis turns into soft dough and later turns into hard dough.
c. **Maturation stage-** This is the stage when the grains ripen. This happen thirty to thirty five days after heading the grains reach maturity and are ready for harvesting.

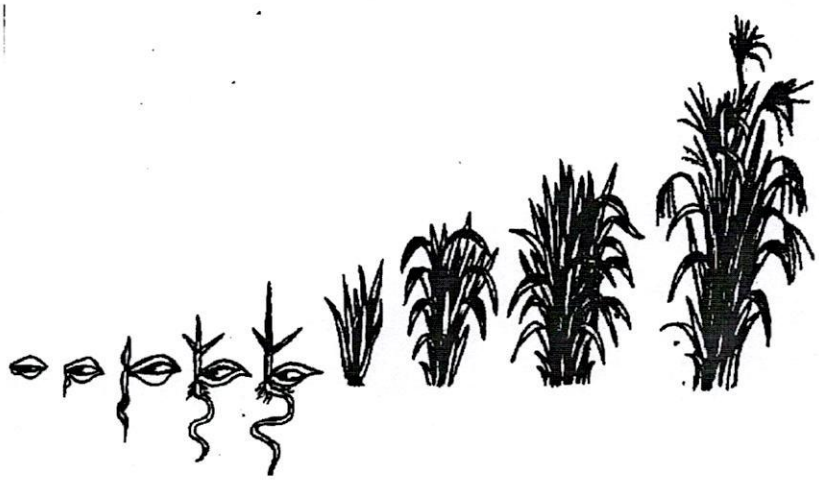


**Figure 20: Stages of rice development**

## 4.9 Seed Selection

The adoption of a variety is determined primarily by two criteria:

1. Varieties must be adapted to the natural environment
2. Varieties must be adapted to cropping system

**Adaptation to natural environment is evaluated in terms of**

- The length of the cycle which must depend on the length of the rainy season.
- Resistance to pest and disease.
- Resistance to foreseeable periods of drought.
- High and stable yield of 3-4t/ha.
- Early maturity.
- Tolerance to adverse soil conditions.

**Adaptation to cropping system can be assessed at two levels:**

- **The degree of intensification-** If the yield target is 2.0-3.5t/ha in areas where rainfall is abundant and regular it is necessary to select a strain which gives a good response to fertilizer and offers a high resistance to logging.

- **Type of mechanization-** For manual harvesting, fairly tall varieties are sort with just a few panicles so as to reduce harvesting time and make the task easier. For mechanical harvesting it is important that ripening is concentrated over a short period of time and the variety offers good resistance to shattering.

# LESSON 5

# FERTILIZER APPLICATION

## 5.1 Overview

Inorganic fertilizer application in rice production is usually done by broadcasting. The broadcast method of fertilizer application can be done either manually or by the use of centrifugal broadcasting machine which is usually attached to a tractor in commercial farms. Application of fertilizer at the correct time can increase yield of rice.

## 5.2 Lesson Objectives:

At the end of the lesson students should be able to:

- Explain the methods of fertilizer application
- Determine the quantity of fertilizer to be applied
- State the different fertilizer rates

## 5.3 Key Concepts:

- **NPK:** This is a fertilizer that contains Nitrogen (N), Phosphorus (P) and Potassium (K) at equal or different ratios.
- **Urea:** It is a fertilizer that contain only one element i.e. Nitrogen

  As with most crops the major nutrients needed by rice are nitrogen, phosphorus and potassium.

## 5.4 Fertilizer Application

**Nitrogen:** It encourages tillering and plant growth. Absence of sufficient nitrogen in the soil makes plants remain small with only a few tillers.

**Phosphorus:** It encourages root development in rice plants and its absence in the soil makes plant leaves become dark green and purplish green in color.

**Potassium:** The presence of potassium enables water to be saved up in the tissues confers some resistance to lodging and increases

resistance to diseases; it also increases the size and weight of the grain

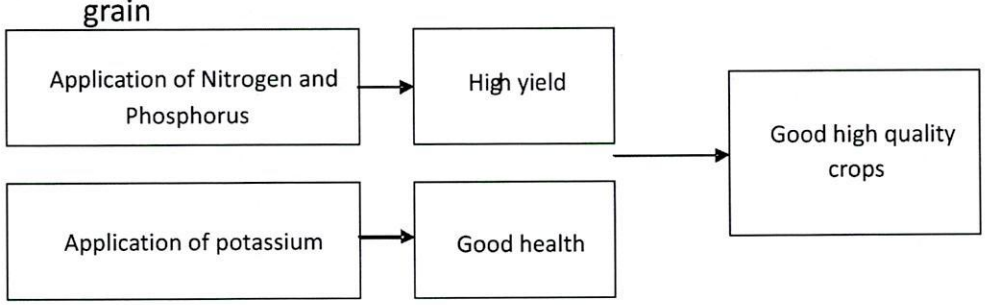



**Figure 21: Importance of Soil Nutrients**

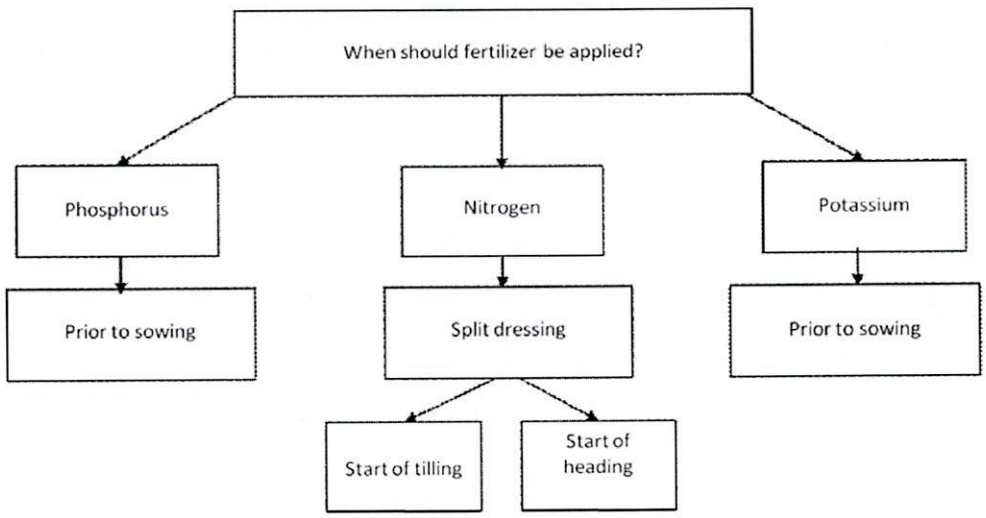



**Figure 22: Time of Applying Fertilizer**

The quantity of fertilizer to be applied depends on the following factors

1. **The specific requirements of the plant in terms of nutrients.** Some plants require high amount of Nitrogen, phosphorus or potassium. An understanding of the level of nutrient requirement of rice plant enables the farmer to apply the right quantity of fertilizer.
2. **The level of intensification aimed:** If the farmer has a target of increasing crop yield by 80% then the soil nutrient has to be improved on artificially by applying the right quantity of fertilizer.
3. The nutrient status of the soil compared to what is required for maximum yield and productivity of crops.

4. The losses caused by leaching of these elements by drainage water and run-off or by evaporation into the atmosphere.


**Figure 23: Bags of Inorganic Fertilizer**

Apply 9 bags of NPK fertilizer 20:10:10 and 2 bags of urea in upland rice per hectare, while 9 bags of NPK 20:10:10 and 2 bags of urea for lowland rice per hectare.

Apply NPK during planting or transplanting and urea at tillering. However, in light soils, 2-3 split application of NPK may be necessary at planting or transplanting while urea is applied at rice tillering stage.

## 5.5 Fertilizer Application Techniques

Fertilizer application in rice production is of two techniques

i. **Manual Spreading:** which can be done by broadcasting or by distributing the fertilizer along the rows according to how the sowing was undertaken and the stage at which the fertilizer is applied.

**Figure 24: Fertilizer Application by Broadcasting**

ii. Mechanical spreading this is done with the aid of centrifugal distributors

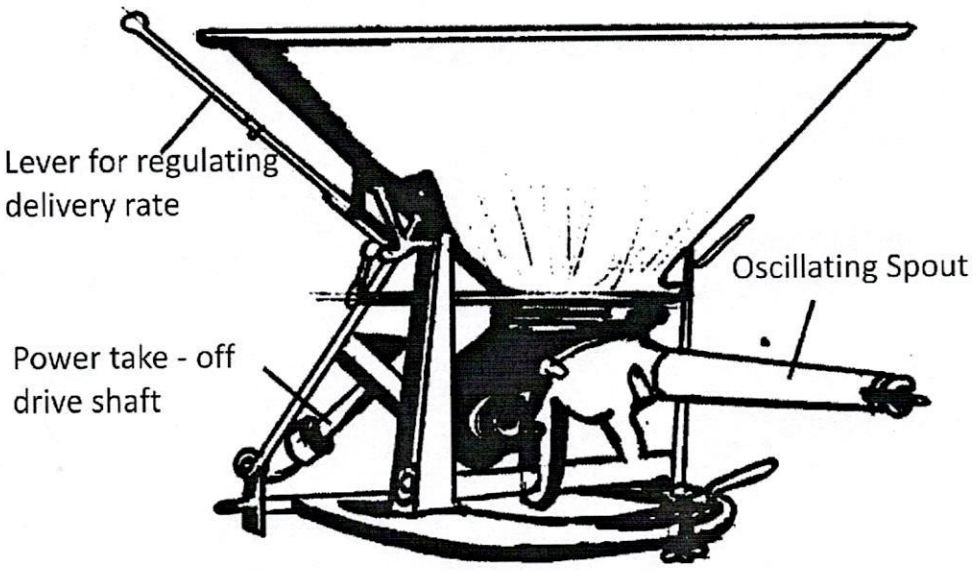



**Figure 25: Centrifugal Fertilizer Distribtor**

**Fertilizer Rate and Time of Application**

Undertake soil test before any fertilizer application. Do not apply any fertilizer on newly cleared land in the first year.

**Fertilizer Rate**

i. **Basal Fertilizer or First Application:** Where Basal fertilizer is applied, use phosphate and potash

fertilizer in deficient soils at final harrowing before seedling. After bush burning, no phosphate and potash fertilizer are needed. Apply 100kg of 15-15-15 per hectare (2 bags/ha) as basal fertilizer or just at the time of first weeding (2–3 weeks after emergence) to facilitate incorporation of fertilizer into the soil.

ii. **Second Application or Top Dressing:** Apply 50 kg (one bag) of Urea per hectare—5 weeks after sowing. In areas where acidity is high, do NOT use Sulphate of Ammonia but use other sources of nitrogen e.g. urea.

**Method Of Application**

By drilling or broadcasting, ensuring incorporation into the soil. Apply fertilizer at 10 cm from base of plant (hill application) immediately after a sufficient rain.

i. **Iron Deficiency:** When the soil is deficient in organic matter and iron, the seedlings turn yellow then white a week after germination. They later die.

- Spray 1% ferrous sulphate with 0.2% citric acid or lemon at 500 liters/ha once or twice depending on the recovery of plants.
- Apply iron chelates and urea in between rows at 25 kg/ha.

ii. **Zinc Deficiency**

- Apply 25 kg/ha zinc sulphate (20% zinc) or
  Spray 1% zinc sulphate with 0.5% lime at 500 ltr/ha to the base as symptoms are seen.

## LESSON 6

## WEED CONTROL

### 6.1 Overview

Weeds are plants growing in places where they are not wanted. Weed control is an important component of plant protection improving the production potential of crops. They compete favorably with economic crops for water, soil, nutrients, light and space and reduce yield of crops.

### 6.2 Lesson objectives:

At the end of this lesson students should be able to:

- Define weeds
- Explain the effects of weed to crops
- State the weed control measures

### 6.3 Weed Control

Weeds are one of the major limiting factors in rice production so far as yield is concerned in that they compete directly with the rice for water light and nutrients. Weed emergence control can be achieved culturally in the following ways:

- **Land preparation-** The more carefully this is done the fewer the weeds that appear. Ploughing is important because of the cleaning effect. If a number of cultivation practices are carried out ranging from ploughing to harrowing ensures that all the weeds are destroyed.
- **Sowing density:** Rapid and dense coverage of the soils gives the rice an advantage in its competition with weeds. It is therefore better not to sow the seeds too far apart where weed control is regarded as a priority objective.

### 6.4 Harmful Effects of Weeds

1. Weeds compete with crops for soil moisture, soil applied nutrient, space, sunlight etc
2. Weeds reduce the yield of crops and affect the quality of

produce.

3. Weeds are alternate hosts for insects and pathogens
4. Weeds reduce harvesting and processing efficiency

Weeding of rice plot can be done in the following ways:

i. **Manual hoeing:** This a a traditional way of weed control and it is done with hoe. Its main advantage is its flexibility in the sense that it may be employed whatever the conditions even when the soil is waterlogged and whichever method of sowing that is being used. Nevertheless the procedure is very laborious and demanding. In terms of labour up to 300 man hours per hectare, divided over two or three passes may be required depending on when the operation is carried out and the stage of development attained by the weeds. In rice weeding should be thorough and should be done within 2 to 3 weeks after emergence, using hoe instead of cutlass (The earlier the first weeding is done the better). Second weeding should be done 6 to 7 weeks after emergence. Weed a third time, if necessary.

ii. **Weeding with Draught animals:** In this weeding method only the space between the rows is weeded. The time saving compared with manual weeding is considerable as the operation takes 1-4 days per hectare.

iii. **Chemical weed control;** this involves the use of chemicals called herbicides in the control of weed. This method requires only very few man hours per hectare.

**Methods of Herbicide Application**

Herbicides are applied either to the soil (soil application) or to the foliage (foliage application). Depending on the properties of the herbicides, mode of action and selectivity, different methods are adopted. Environmental factors, convenience and cost are other factors that influence the choice of correct method of application. An improper method of application can result in poor weed control or severe crop injury.

1. **Soil Application**
   a. **Soil Surface Application:** Herbicides are sprayed on the soil surface to form a uniform herbicide layer. Weeds germinating in the top layer are killed due to incidental absorption of herbicides.
   b. **Soil Incorporation:** Volatile herbicides are incorporated into the soil to reduce their rate of escape into the atmosphere. They kill weeds as soon as they appear in the soil. Examples of such herbicides are aniline and carbamate groups.
   c. **Sub-surface Application:** This is done by injecting herbicides into the soil at several points.
   d. **Band Application:** Herbicides can be applied as narrow bands over or along the crop row. The weeds in between the rows can be control led by inter cultivation or by non-selective herbicide.

2. **Foliar Application:** Foliar application is done by praying herbicide on the leaves of the crops.

**Qualities of a Good Herbicide**

1. **It must be effective:** Its effectiveness depends to a large extent on the conditions under which it is applied. It must be applied at the right time under very specific conditions.
2. **It must be selective:** Selective herbicides destroy certain weeds without damaging the crop being grown. Not all herbicides are selective some othersare total in destroying both economic crops and weeds.
3. **It must be Persistent:** It is important for the products to have as long lasting an action as possible so as to minimize the number of applications. .

**Time of Application**

i. **Pre-emergence:** Apply Ronstar™ 25(EC) 2-3 days after sowing or just after seeding at the rate of 4–6 litres/ha. Spray Gramoxe™ at 2 ltr/ha when weeds have grown in the

field. DO NOT spray Gramoxe™ after the germination of paddy seeds.

ii. **Post-emergence:** Apply RonstarTM (PL) 14 to 21 days after planting at the rate of 5–6 litres/ha. Use Propanil (Stan F34), Tamarice or Propanil-Bentzon (Basagram) 14 to 21 days after planting at the rate of 3 kg a.i. (10 liter tin) per hectare. With a knapsack sprayer, use 220 cc of Propanil or Tamarice, except Basagram which should be used at the rate of 150 cc, in 10 liters of water. Any resistant weed species or newly germinating weeds like corn grass—Rottboellia cochinchinensis should be rogued. A weed-free seed-bed at planting also contributes to the effectiveness of the herbicides.

## LESSON 7

## PESTS AND DISEASE CONTROL

### 7.1 Overview

Pest and disease control is the act of eliminating pests and diseases that cause plants infections from the farm. Disease control in rice begins with seed treatment. The negative effects of pests and diseases on plants yield cannot be overemphasized hence the need to eliminate them as soon as their signs and symptoms are noticed on crops.

### 7.2 Lesson Objectives:

At the end of the lesson students should be able to:

- State the common diseases and pests of rice
- Explain the control measures to take

### 7.3 Key Concepts:

- **Crop Rotation:** This involves planting of difference crops alternatively on the same piece of land in regular sequence with regular pattern.

### 7.4 Pest and Disease Control

Common rice pests are grasshoppers, beetles, termites, birds and rodents. Common diseases are rice blast, leaf spot, seedling blight, scald, stem rot bacterial blight, streak and yellow mottle. Of all these disease, rice blast is the worst and is caused by Percularia oryzae.

Pests are controlled by good agronomic practices and use of chemicals such as Karate EC, upper cott while birds and rodents by scaring and traps respectively. Rice disease are controlled by use of resistant varieties, farm sanitation, crop rotation and the use of chemicals like propit, microzeb, Benlate and Bentax

# LESSON 8

# HARVESTING

## 8.1 Overview

Harvest when 80 percent of the grains have turned straw colour to avoid shattering. Rice is harvested after 3-4 months of planting depending on the variety, the matured plant turns yellow with little or low moisture content of about 20-24%. Rice is cut at 10-14cm above ground level, kept in bundle and left for 2-3 days before threshing. Threshed rice is dried for 9-10 hours to 13-14% moisture content before storage.

## 8.2 Lesson objectives:

At the end of the lesson students should be able to:

- Identify the harvesting period
- Describe how to harvest rice
- Give the expected yield/ha

## 8.3 Harvesting of Rice

When to harvest rice is dependent on the purpose whether it is for planting or consumption. Maturity is attained when the grains have a water content of about 22% in certain regions where the dry season is particularly marked at the time of maturity, the water content of the grains may be well below that figure at the time of harvesting. It is important to harvest at the right time, if the rise is gathered too early, there is a loss in weight and many immature grains or green grains are collected. If however the rice is harvested when it is over ripe there is considerable risk of shattering and breaking. Where the grains are to be used for seed it is necessary to wait for physiological maturity. Harvesting is done in two ways:

1. **Manual harvesting:** Manual harvesting is done using a knife cut only the panicles which he puts in bundles. This is usually a very slow operation which may take as long as 100hour per hectare. The use of sickle in harvesting however makes it

faster and harvesting can be done at 75hour per hectare.

**Figure 26: Harvesting of Rice Using Sickle**

2. **Mechanical Harvesting;** this is done using large machineries like combine harvester which cuts the straw, gathers and threshes the grain in one or two hours per hectare.

**Threshing**

Thresh immediately after harvest to avoid losses. Use wacking frames or mechanical devices, but avoid threshing on bare floor. Thresh on a mat or tarpaulin over concrete floor by flailing (i.e. beating rice against the floor,or against a stick or drum). Thresh carefully and avoid dehusking the grains. Damaged grains become stained and coloured after parboiling and milling.

**Expected Yield**

If above recommendations are followed, and rainfall is adequate, an average yield of 1.5–2.0 t/ha could be obtained.

**Drying**

Dry paddy properly to a safe moisture content of 13–14 percent, by spreading on clean concrete floor, mat or tarpaulin. Sun-dry slowly for 2–3 DAYS to reduce breakage during milling. On a clear bright day, sun-dry for one day only by spreading paddy thinly on clean concrete floor, mat or tarpaulin. Use mechanical drier if possible.

## LESSON 9

## PROCESSING & STORAGE

### 9.1 Overview

After harvesting, rice goes through the threshing and drying phase before they are stored in jute bags or air tight containers. Before consumption it goes through the parboiling and milling stages and subsequently drying.

### 9.2 Lesson Objectives:

At the end of the lesson students should be able to:

- Explain how rice can be processed
- Explain the concept of storage

### 9.3 Processing and Storage

After harvesting rice is dried to reduce the moisture content and then it is threshed either locally or by the use of a pedal operated threshing drum. Rice is best stored in its pad with about 14% moisture content. Rice is stored in airtight containers and jute bags in cool and dry stores.

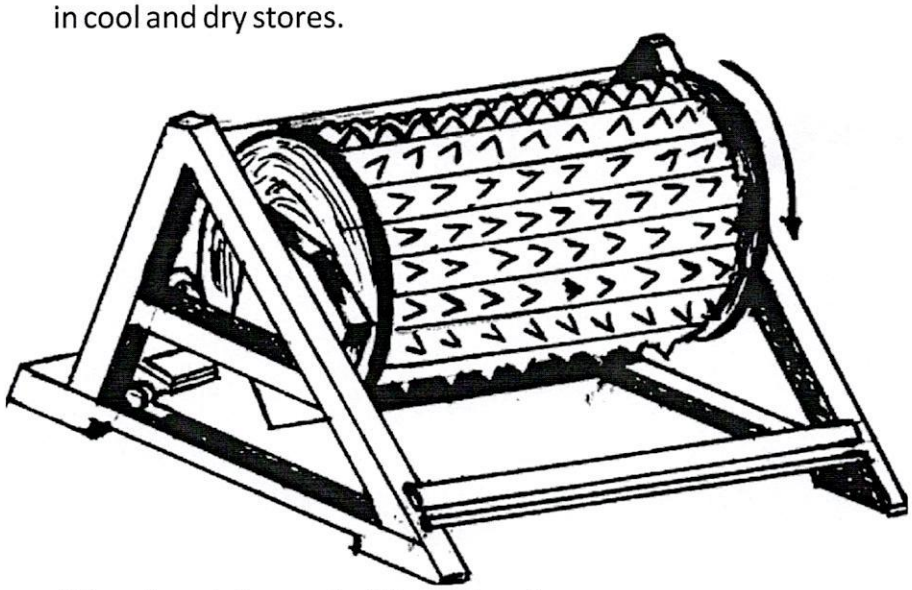


**Figure 27: A pedal operated threshing drum**

## 9.4 Processing

i. **Parboiling:** Soak paddy in hot water at 70oC for 5 to 6 hours. Discard all floating empty grains. Parboil rice by steaming soaked paddy put in a jute bag for 10 to16 minutes by suspending the bag over steaming water in a drum. Stop parboiling when rice husks start to split open. Chalky grains or white centres indicate incomplete parboiling, which may cause breakage of grains during milling.

ii. **Milling:** Mill rice in a two-storage milling machine. Always mill one pure variety at a time.

## 9.5 Storage

Store in cool, dry rodent-proof conditions. Infested paddy should be fumigated with phostoxin in air-tight containers at the rate of one tablet per jute bag (100 kg paddy) or 10–15 tablets per ton of paddy.