

# Crop Production Training Manual for Agriculture Extension Workers



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## Acronyms and Abbreviations

BRIDGE	Building Responsibility for Delivery of Government Services
CAG	Community Action Group
MAF	Ministry of Agriculture and Forestry
NBG	Northern Bahr el Ghazal
RSS	Republic of South Sudan
TOT	Training of Trainers
USAID	United States Agency for International Development
WSG	Women's Support Group
YATC	Yei Agricultural Training Center

## Foreword

The U.S. Agency for International Development (USAID)-funded Building Responsibility for Delivery of Government Services (BRIDGE) Program has worked since 2009 to strengthen the ability of government to meet the needs of its people in Northern Bahr el Ghazal (NBG), Warrap, Unity, Jonglei, and, to a limited extent, in Upper Nile State. In Warrap, BRIDGE has provided substantial training and material support to farmers and technical assistance to the Ministry of Agriculture and Forestry (MAF), employing a “Training of Trainers” (TOT) approach that emphasizes the paramount importance of building the government’s capacity – at the state and local (county) level – to take the lead in improving food security, livelihoods and economic growth through the advancement of improved agricultural practices.

BRIDGE agriculture programs and participants have benefitted from strong working relationships between BRIDGE and MAF, with technical expertise and instruction provided by the Yei Agriculture Training Center (YATC), located in Central Equatoria State. Collaboratively, this partnership has helped government extension workers in BRIDGE target states provide extensive training on new techniques including ox-plowing (animal traction) and crop production/management to more than 1,000 farmers, to date<sup>1</sup>. Material support provided by BRIDGE to growers has included farm equipment and tools (ox-plows and hand tools including rakes, hoes, picks and shovels) and distribution of more than 10 metric tons of staple crop seeds including sorghum, maize, sesame and groundnuts to ensure farmers can immediately begin to practice their newly gained skills.

The purpose of this Crop Production Training Manual is to assist government agricultural extension workers to plan and carry out crop production and management training sessions effectively to farmers at the county, payam and boma levels. Ideally, the use of improved crop production training techniques will increase the volume of land cultivated and boost productivity. This handbook is meant to complement and augment a separate BRIDGE-supported agricultural guide, the Animal Traction Training Manual, and to help farmers acquire additional knowledge and experience during participatory and practical training exercises. Subsequent to training, it is anticipated that MAF extension staff in cooperation with BRIDGE will conduct follow-up visits to growers, to ensure they are actively able to adopt the improved/best practices in their fields.

This training manual was adapted by staff at YATC from a previously-utilized Norwegian People’s Aid/YATC training manual to suit ecological and growing conditions in Warrap State, specifically. It is hoped that this manual will be useful, and that it will be further adapted to

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<sup>1</sup> From FY 2009 – FY 2011, BRIDGE agriculture program was implemented in Northern Bahr el Ghazal, Warrap and Unity. In FY 2012, BRIDGE program approach was adjusted and agriculture sector work was focused on Warrap addressing sector integrated planning and budgeting support for MAF, coupled with technical assistance for extension workers.

include lessons emerging from field experiences in order to enhance the work already being performed by state extension service officials in support of South Sudanese farmers.

### **Important Note to Trainers**

Agricultural extension workers, for whom this manual is intended, are advised to ensure that they *thoroughly* understand the lessons described herein, before undertaking training exercises for targeted farmers. In the event of questions or concerns about the content of the manual, and/or if clarification is required, trainers are strongly encouraged to contact BRIDGE agricultural specialists for assistance. The lessons described within this manual are prepared so that trainees can easily learn from discussions, questions and answers in the process of training. Extension workers should be aware that farmers generally possess a good understanding of their production situation, as well as the physical and social environment that influences their production and production capacities. Therefore, during trainings, **extension workers should recognize that farmers, though they may have questions, are not ignorant of the various subjects under discussion. Trainers are expected to listen carefully and respectfully** to farmers' ideas and opinions during each session, and to understand exactly what is required (i.e., elaboration, clarification, repetition, or additional practical application) to ensure farmers can readily utilize new techniques and skills.

Extension trainers are advised to inform farmers that **they should feel comfortable when raising issues or questions of importance to them.** Farmers need to be able to share their views, discuss constraints, and achieve collective understanding of challenges. In other words, the extension workers need to know that the purpose of training farmers is to build on existing indigenous knowledge without undermining the traditional practices. Extension workers should understand that they are taking farmers from “the known to the unknown.”

Further, extension workers are strongly advised not to provide answers or conclusions based solely on their personal opinions or views. When questions arise, trainers should invite and encourage *the participants* themselves to find solutions, first. **It should be acknowledged at the outset that not all trainers will be able to answer all conceivable questions.** Trainers should not feel embarrassed if they are unable to provide answers to all questions, though they should make diligent attempts to research and follow-up with informative responses, as appropriate, to outstanding questions.

Such participatory methods will enable beneficiaries to achieve the paramount goals of crop production and management training, which are to increase household food production, improve community welfare, and to successfully bridge the annual food gap that threatens the lives of thousands of people in South Sudan.

## SECTION 1: INTRODUCTION TO CROP PRODUCTION

Understanding the existing crop production situation and conditions in the areas where training will take place is extremely important. This knowledge is critical to ensure that farmers move successfully from *the known to the unknown* – that is, as they adapt and build upon their knowledge as indigenous growers to acquire more modern agriculture production skills and techniques.

At the start of training, consensus should be reached by trainees on prevailing, existing production systems in the area, including a review of agricultural production methods and existing farming constraints and challenges.

### The Existing Production Situation

In this session farmers will discuss their current agricultural (food) production situation in relation to traditional farming practices, current socio-economic conditions and environmental concerns such as droughts, floods and insecurity. The goal is to enable farmers to identify major production constraints (including technical, social and economic challenges.)

### Objectives

By the end of the session participants will be able to:

1. List agricultural constraints in their area; and
2. Appreciate improved production methods.

**Time required:** One hour

### Methods:

- Group discussion
- Presentation

### Materials required:

- Flip charts
- White board or black board
- Markers/pens

### Procedure

1. Introduce session and objectives;
2. Ask if people in the area produce enough food to both meet their household food requirements *and* sell some to cover other basic costs including clothing, soap, school fees, etc.;

3. In groups, encourage participants to analyze why farmers may not always be able to produce sufficient quantities of food to meet basic needs, especially when/where there is adequate arable land and rainfall;
4. Groups present their findings through representatives;
5. Facilitator guides participants through discussions, and systematically categorizes the problems/challenges identified into two groups:
  - a. Problems that cannot be avoided; and
  - b. Problems that can be addressed.
6. Facilitator explains to participants that it is possible to solve problems via the use of improved and/or new production techniques;
7. Facilitator asks participants to describe their existing crop production methods, including the following:
  - a. The type of tools used for land clearing, preparation (digging);
  - b. The type of seeds used for planting;
  - c. Land clearance and preparation methods;
  - d. Length of time required for weeding, and frequency of weeding;
  - e. Division of labor within families (who does what).
8. Facilitator provides examples to participants of improved techniques;
9. Facilitator explains that in the training session to follow, they will discuss improved farming practices which can be easily adopted if they are interested in increasing production.

### Learning Points

From our experiences living among and working with farming communities we have noted that people have not been able to cover their food requirements throughout the year AND have enough surplus food left to sell, for purposes of raising household incomes.

Some of the main reasons why farmers are not able to produce enough food and make use of their produce to improve their lives include:

1. Insufficient labor;
2. Insecurity;
3. Insufficient rain (drought) or too much rain, resulting in floods;
4. Exhausted soil or naturally poor soil;
5. Insect pests, diseases or weeds;
6. Lack of food during cultivation periods or hunger generally;
7. Lack of enough and quality seeds and tools.

These reasons can be categorized into two main groups: Unavoidable and Avoidable.

**A. Unavoidable**

1. Flooding and drought
2. Insecurity

**B. Avoidable**

1. Lack of labor
2. Lack of seeds and tools
3. Lack of food
4. Lack of improved production skills
5. Insect pests and diseases

It is possible to reduce problems mentioned in Category B (Avoidable) through introduction of new agriculture techniques and by improving upon existing traditional methods. Many farmers may be unaware that their methods of production are inefficient, because they have been using the same traditional methods for so many years. Many different examples can be given to farmers about improved techniques, depending on the areas in which they live and farm. Growers who have visited areas outside of their own may have seen land preparation with hoes or ox-plows, farmers planting crops in rows, etc.

## SECTION 2: CROP HUSBANDRY

### Session 1: Land Clearing

Land clearance is one of the first activities necessary when preparing a plot for agricultural use. For new land it can be an extremely laborious exercise. This session will discuss the importance of land clearance and different techniques used. The session aims to create understanding of the negative effects of traditional clearance techniques such as grass burning, and emphasizes alternative practices that maintain soil fertility. The tools used in land clearance, as well as planning timeframes for clearance will also be discussed.

### Objectives

By the end of the session, participants will be able to:

1. Explain the importance of well cleared land;
2. Explain the effects of different clearance techniques;
3. Identify different types of tools used for land clearance;
4. Appreciate the importance of timeliness of land clearance;
5. Use various organic resources around their farms to improve soil fertility and prevent soil degradation.

**Time required:** Two hours.

### Methods:

- Group discussion
- Brainstorming
- Plenary discussion

### Materials required:

- Flip chart
- Manila paper
- Markers/pens
- White board

### Procedure

1. Introduce the topic and objectives;
2. Ask participants to explain how they currently clear land for planting;
3. Discuss the need for nutrients (plant food) for plant growth and development and explain how burning can destroy some nutrients;
4. Ask participants what alternative methods of land clearance can be applied, other than burning.
5. Ask participants when they typically clear their farms for planting;

6. Discuss the advantages of clearing land immediately after harvesting;
7. Facilitator concludes session by summarizing the main learning points regarding methods and schedule for land clearing.

#### Note to Facilitator/Extension Worker

This session will require practical demonstration of clearing an area and selective tree cutting pruning.

#### Learning Points

Traditional clearing practices typically involve the collection of sorghum, simsim and millet stalks for firewood, followed by the burning of other plant remains in the field. Burning has some advantages for local farmers, in that it kills weed seeds, insects/pests and plant diseases and reduces the amount of labor required for land clearance and preparation. However, burning fields after harvest also has disadvantages, of which farmers may be unaware.

Like humans, all plants need food and water in order to grow and to give fruits or seeds. Plants build their bodies from the food and water they obtain from the soil, which are distributed to plant roots, stems, flowers, fruits, seeds, and branches. When farmers burn plant residues after harvests, ALL plant food contained in various parts of the plants is also burned or destroyed.

Therefore farmers should know that by burning residues in their fields during the clearance process, although there are some advantages, they are in effect also destroying important plant foods taken up from the soil during plant growth, and which cannot be easily replaced.

Instead of burning, farmers are advised to slash down all plant parts and leave them on the ground, or to plow under plant residues so that soil organisms may decompose them and replace foods which have been used up. Farmers also should be advised on selected cutting and pruning techniques of trees instead of cutting or burning down ALL trees in their fields.

If farmers plow under or slash plants and leave the remains in the soil during the clearance phase, they will:

- Help their soil conserve moisture;
- Improve the water-retention capacity of sandy soils and water-infiltration capacity of clay soils;
- Increase soil fertility -- very important for the poor soils.

In villages where firewood is not readily available, farmers are advised to use stalks of the sorghum for firewood instead of felling live trees. Farmers should identify how best to use their limited resources, but are advised to learn how to grow trees for firewood and fencing, so that they may make better use of stalks for mulching and fertilization of their soils. The use of fuel-efficient cooking methods like mud stoves, which can be made locally to minimize the rate of firewood consumption, could also be beneficial.

## **Time of Land Clearance**

Traditionally, land clearance is conducted prior to the onset of rains, between the months of January and March, depending on the land to be cleared. However, it is generally advisable to clear land immediately after harvesting. This provides time for crop residues to decompose over time, prior to the next cultivating season, making nutrients available for the coming season.

## **Summary of Main Points of Land Clearance**

1. If plant residues are not burned in the field, advantages include:
  - Improved soil fertility
  - Increased water holding capacity of soils
  - Protection from soil erosion.
2. Where stalks are collected and used for fencing and cooking, farmers should collect the largest stalks and leave behind the small ones and remaining residues to cover/re-fertilize the soil.
3. Farmers should be aware of alternative land clearance methods including being more selective when cutting down of trees (instead of felling all trees in the area to be cultivated), and using fuel-efficient mud stoves to conserve firewood consumption.
4. Land clearance is highly recommended immediately after harvesting.

## Session 2: Land Preparation

Land preparation is one of the most laborious activities performed during crop husbandry. Different methods and tools are used to prepare the land. This session will discuss the various methods and tools being used to prepare land for crop production. The aim in this session is to ensure that participants understand good land preparation methods and their advantages, compared to traditional methods which often result in significantly lower yields. The importance of timely land preparation also will be discussed.

### Objectives

By the end of this session, participants will be able to:

1. Know the advantages of different methods and tools used in land preparation;
2. Understand the importance of timeliness on land preparation; and
3. Understand that poor crop performances and subsequent low yields can result from poor land preparation practices.

**Time required: 3 hours**

### Method:

- Group discussion
- Brainstorming
- Plenary discussion
- Practical and demonstration.

### Materials required:

- Flip charts
- Manila papers
- White board
- Marker/pens
- Digging tools (moloda, hoe and plow)

### Procedure

1. Introduce the topic and its objectives;
2. Define land preparation and explain its importance;
3. Ask farmers to explain how they prepare their lands for planting and what kind of tools they use to prepare the land;
4. Explain to the participants the advantages of good land preparation;
5. Ask participants whether traditional tools such as molodas can help them achieve the advantages of land preparation mentioned in point no. 4 (above). For example, can molodas dig deep enough and/or turn over enough soil to secure all possible advantages during land preparation?

6. Ask participants if they have observed other tools such as hoes and plows being used. Let them describe the advantages of using hoes and ox-plow;
7. Explain the use of hoes and ox-plows for land preparation;
8. Ask farmers when they start preparing the land in their areas;
9. Explain to farmers the importance of timely land preparation in crop growth;
10. Wrap up the session by summarizing points about better land preparation using different tools and the advantages of timely land preparation.

#### **Note to facilitator**

In this session, practical demonstration on the use of hoes and ox-plows must be conducted. Explain plow parts and uses. To demonstrate different tool efficiencies, demonstration plots should be used to compare various methods of land preparation.

### **Learning Points**

Land preparation means digging or plowing the soil to make it soft and smooth for planting the seeds. Plants need soil in which first they will germinate, develop their roots and stem. Therefore the land (soil) on which the farmer plants or sows seeds must be prepared smoothly, so that seeds can germinate and grow without much difficulty.

### **Advantages of Good Land Preparation**

1. Kills harmful insects inhabiting in the soil. By digging into the land, some harmful insects and/or eggs that normally live inside the soil will be exposed to the sun and either weakened or killed by the heat and/or by birds that feed on insects;
2. Kills weeds and weed seeds. Some weeds that have deep roots and/or remain under the soil will be brought to surface and will be killed by sun/heat;
3. Seeds will germinate evenly and quickly;
4. Young plants will have good growing conditions, enabling their roots to grow deeper into the soil, to draw more water and absorb plant foods.

With tools like molodas, farmers are not able dig as deep or turn over as much soil. Farmers who use molodas require a lot of time to dig even a small plot of land. Observations show it can take 10 - 15 days for one person to dig a single feddan when using moloda.

### **Advantages of Plowing with Hoes or Ox-plows instead of Molodas**

1. Deeper digging;
2. Turning over the soil;
3. Breaking up undesirable clumps of soil;
4. Brings harmful insects/weeds to surface, facilitating their elimination by sun/heat/birds;
5. Buries insect eggs and weed seeds deeper so they can't survive;
6. Allows more land can be cultivated within a shorter time period;
7. Less labor required to cover the same area;

8. Not as tiresome as using molodas.



**Land preparation using Moloda**



**Land preparation using Toria/Jembe**



**Land preparation using oxen**

### **Time of Land Preparation**

A majority of farmers prepare their fields after the onset of reliable rain, in the March to June timeframe. To secure all of the advantages discussed in the land preparation portion of this manual, the timing of land preparation is extremely important.

If the land is new, it should be prepared on two or three separate occasions prior to planting. Ideally, the first preparation would occur after land clearance (following the previous harvesting, or around January to February). The second preparation should occur in March, and then again, prior to planting. If land has been used previously (i.e., is not newly cultivated), two preparation periods may suffice, depending on soil type.

However, after harvest season, traditionally most family members around the swamps (touch) and riverbanks engage in tobacco growing and fishing. A lot of people also stay in cattle camps from February to May, depending on the onset of the rain. Most family members will return to their homesteads as soon as rains begin, meaning that land preparation and planting occur at approximately the same time. Unfortunately, this timeframe does not allow enough time to properly prepare the land for planting, because farmers simply pick up their molodas, remove weeds from the top portion of the soil, and plant seeds the same or following day. Such practices do not provide optimal growing conditions for seeds and plants. As a result, the yield of crops is low. Earlier and proper land preparation will help families prepare a larger area of their lands, even with the same size work force.

Farmers should not prepare the soil (by digging or plowing) when the soil is too wet, because large clods may form which do not break easily. After these clods are formed, they can dry out and create difficulty for both planting and seed germination.

### **Summary of Main Points on Land Preparation:**

1. The use of improved tools, including hoes or ox-plowing (instead of molodas) can increase the volume of land available for cultivation;
2. Timely preparation can help improve the volume and fertility of land for cultivation;
3. Good land preparation techniques should be practiced (For example, not preparing land when wet.)

### Session 3: Planting

The time of planting and methods used are very important. Delays in planting can cause farmers to have poor harvests. Different methods used in planting have advantages and disadvantages. The aim of this session is to ensure that farmers understand the importance of timely planting and to compare different methods of planting. Farmers are encouraged to continue to practice mixed cropping, while giving increased consideration to inter-cropping patterns and optimum spacing.

### Objectives

By the end of the session, participants will be able to:

1. Explain the importance of planting early in the seasons;
2. Appreciate the advantages of planting in rows;
3. Explain different factors that should be considered when inter-cropping.

**Time required: 3 hours**

### Methods:

- Group discussion
- Brainstorming
- Plenary discussion
- Practical/demonstration

### Materials required:

- Flip chart
- Manila paper
- White board
- Markers/pens
- Tools (hoes, sisal twine, pegs), seeds, etc.

### Procedure

1. Introduce the topic and its objectives;
2. Ask about the planting time for different crops, and what factors drive the planting schedule;
3. Explain the importance of planting at the right time;
4. Ask participants whether they plant in rows or broadcast;
5. In groups, ask participants to list down the advantages and disadvantages of planting in rows versus broadcasting;
6. Groups present their conclusions their group representatives;
7. Following procedure 6, facilitator summarizes the advantages and disadvantages of row planting;

8. Ask participants why they plant different kinds of crops in the same plot;
9. Elaborate on the advantages of mixed cropping;
10. Ask farmers which crops they intercrop and which ones they plant as stand-alone crops, and why;
11. Explain points to consider when intercropping;
12. Following procedures 10 and 11, list intercropping patterns (combinations of different crops) and brainstorm which pattern yield more or less;
13. Wrap up the session by summarizing the main points of importance to consider in early planting and intercropping.

#### **Note to facilitator**

For this session, practical demonstration of planting in rows must be done. Demonstration plots should be used to indicate various methods of planting.

#### **Learning Points**

Most farmers have been cultivating for many years and they know the exact times for planting different crops. Crops give the best result when they are planted at the right time. It is best to plant long sorghum, maize and groundnuts as soon as rains start. For these crops, early planting has many advantages.

1. Crops can make use of the first rains, which can help plants grow quicker;
2. Plant foods in the soil will not be washed deep down into the soil, but will instead be used by early crops;
3. Plants will grow stronger and be more resistant to weeds;
4. Early crops are less prone to damage from insects and disease.

#### **Methods of Planting**

There are two main methods of planting: broadcasting and row planting. In broadcasting, seeds are not planted in rows but instead are scattered at random.

#### **Advantages of Broadcasting**

- It is especially convenient with small seeds, including sesame, finger millet and tobacco seeds;
- It also requires less labor.

#### **Disadvantages of Broadcasting**

- Many seeds are wasted;
- Uneven plant populations;
- Impossible to use machinery to facilitate weeding or harvesting;
- Traditionally men will not participate in weeding, only women.

## Advantages of Row Planting

- Optimum plant population per unit of area is achieved;
- Subsequent agronomical practices such as planting, fertilizing, weeding, thinning, harvesting are more easily carried out; and
- Both women and men will participate;
- Fewer seeds required than in broadcasting.

## Disadvantages of Row Planting

- Requires more labor and skills than broadcast method.

## Mixed Cropping/Inter-cropping

Farmers traditionally grow two, three or four different crops in the same field. This method is called inter-cropping and is not suitable for mechanized farming where most of the operations like planting, weeding, chemical spraying, harvesting, etc. are carried out by machines. But for many farmers in South Sudan, mixed cropping has several advantages, and it remains advisable for farmers to continue their mixed-crop farming methods. Advantages include:

1. Risk of crop failure is reduced;
2. Helps reduce and suppress weeds;
3. Improves soil fertility;
4. Higher total production from the farm.

While inter-cropping has many benefits, farmers should consider differences in plant root systems, length of time to maturity, nutrient requirements and spacing. The combinations of crops should be planned so that varying crops will have no or less competition for different nutrients. For example, groundnuts planted with long sorghum is a bad combination.

## Summary of Main Points

1. Plant crops early, with the onset of rains;
2. Inter-cropping is beneficial, with consideration of some factors;
3. Planting in rows has many good benefits.

## Session 4: Weeding

Weeding is another crucial activity in crop husbandry. To minimize competition from weeds and unwanted plants, farmers should do weeding at various stages of plant growth. The aim of this session is to help farmers appreciate and understand the importance of timely weeding. Farmers will be advised to weed at the early stage of crop development, when plants are more susceptible to competition from weeds. Discussion also will be focused different types of weeds and control methods.

### Objectives

By the end of this session, the trainees will:

1. Appreciate the importance of timely weeding;
2. Identify the right tools for weeding;
3. Identify common weeds in the area and share control methods.

**Time required: 2 hours.**

### Methods:

- Discussion
- Brainstorming
- Pair wise ranking
- Practical demonstration

### Materials required:

- Flip chart papers
- Manila papers
- White board
- Markers
- Tools and seeds

### Procedure

1. Introduce the topic and its objectives;
2. Define what weeding means;
3. Ask participants why they do weeding;
4. Explain the reasons for weeding;
5. Ask participants where weeds come from;
6. Ask participants to name all types of weeds affecting their crops in the field;
7. Following procedure no. 3, together with participants, use pair wise ranking, rank the weeds in the area based on their effect on crops;
8. In groups, ask participants to discuss different methods that can control and reduce weeds;

9. Groups present different methods of weed control;
10. Ask participants about when they do weeding and specifically, when do they weed their crops after germination?
11. Explain to participants the proper times for weeding;
12. Wrap up the session by summarizing the main reasons for weeding, sources of weed seeds, methods of weed control and the importance of timely weeding.

## Learning Points

- Weeding is the removal of unwanted plants that grow together with the crops.
- Most farmers remove weeds from their field once or twice from their field.

## Reasons for Weeding

There are several reasons why farmers should do weeding. The first reason for weeding is to reduce the competition for plant food, water and sunlight with our crops. The plant food and water needed for plant growth, development and maturity are found in the soil (in varying quality depending on the soil type and other factors). Like our plants, weeds use the food and water from the soil that is being used by our crops. These weeds, once removed, will in healthier plant growth and larger increases in crops yields. The second reason for weeding is to improve the quality of the harvest. Weeds produce a lot of seeds. If left in the field during harvest, weed seeds can mix with produce and reduce the quality of the harvest.

Weeds are unwanted plants that grow amongst crops in the field. If not weeded, they will produce seeds and can be accidentally harvested with the crops. Some weeds arrive with seeds transported from other areas.

## Methods of weeds control

There are several ways that we can reduce weeds in our fields.

1. Hand-pulling of weeds growing on the surface of the ground;
2. Use of hoes or molodas to dig out weeds and then leave them on the surface to dry and decompose;
3. Slashing the grass, using tools like slashers;
4. Mulching to suppress germination and growth of weed seeds;
5. Introducing good crop cover to ensure quick coverage over the ground by wanted crops, suppressing weeds through shading;
6. Crop rotation: different weeds accompany different types of crops, so by arranging various crop sequences, some weeds can be controlled. For example, planting of groundnuts in a plot previously occupied by sorghum will control striga weeds;
7. Early land preparation and planting will greatly reduce weed growth and therefore save labor for weeding;
8. Use of clean seeds (uncontaminated by weed seeds);

9. Weeding must be done during early stages of seed growth. It is important to start weeding 2-3 weeks after crop germination. Crop plants will be healthier if weeds are eliminated as early as possible.
10. Weeds should be removed before they become strong. If farmers fail to weed early or wait too long to begin weeding, weeds can suffocate the crops, depriving them of nutrients and water and causing them to grow weakly, resulting in poor production;
11. When weeds grow tall, they cause trouble during harvesting. Most weeds have seeds and if weeding is not done earlier, they will produce seeds which can easily mix with the crops during harvesting and storage and will actively germinate and grow faster the following year, creating fields full of weeds. This will create problems during land preparation;
12. Weeding can/should be done 2-3 times prior to harvest depending on the intensity of weeds and crop growth.



**Etiolated maize crop due to weeds competition**



**A stand of well-spaced and weeded maize crop**

### **Summarize the Main Points**

1. Weeding is important since it reduces competition from weeds against the crop plants;

2. Different methods can be used in weed control such as hand pulling, cultivation, mulching, crop rotation, good land preparation and early planting. Our aim is to give our plants the best conditions to grow vigorous and healthy for high yields;
3. For successful crop growth and production, weeding must be done early enough – ideally 2-3 weeks after germination – should be performed 2-3 times prior to harvest;
4. It is easy and cheap to reduce weeds through proper land preparation, early planting and use of clean seeds;
5. It is important not to conduct weeding when the ground is very dry.

## Session 5: Harvesting and Drying

The final stage of crop production consists of harvesting and post-harvesting practices. The aim of farmers during these stages is to minimize losses and maintain the quality of grains for prolonged storage and future use. This session is divided between different topics, with the goal of ensuring that farmers understand the optimum time to harvest and important practices during harvesting, drying and storage.

### Objectives

By the end of the session, participants will be able to:

1. Appreciate the optimum time for harvesting;
2. Practice good seed selection;
3. Appreciate the importance of drying seeds for proper storage.;
4. Use by-products from threshing for improvement of soil fertility.

**Time required: 2 hours**

### Methodology:

- Discussion
- Brainstorming

### Materials required:

- Flip chart
- Manila papers
- White board
- Markers

### Procedure

1. Introduce the topic and the objectives;
2. Ask farmers when they harvest different crops;
3. Explain how harvest time differs between crops;
4. Ask them how they select seeds during harvesting for the coming season;
5. Explain the procedures farmers could follow before harvesting;
6. Ask participants why they dry crops after harvesting;
7. Explain the reasons for drying;
8. Ask participants to name different methods of drying produce;
9. Summarize different drying methods;
10. Define threshing;
11. Ask the participants to describe their own ways of threshing;
12. Explain the need to dry produce well for effective threshing;

13. Ask participants what they normally do with by-products such as shells, stalks or pods after threshing;
14. Explain how these by-products can be used to improve soil fertility;
15. Wrap up the topic by summarizing the main points.

## Learning Points

### Harvesting

In most cases crops are harvested when they are fully matured in the field. But some crops like green grams can be harvested before they are fully matured in the field because their pods will split or shatter and fall on the ground. In the case of groundnuts the pods can remain in the ground and germinate. Crops like finger millet and sorghum can easily be attacked by wind and the heads can easily be broken. Sometimes the seeds will germinate in the field. Losses can also be caused by insects, pests and diseases.

### Seeds Selection

Proficient farmers visit their fields regularly and to locate and observe plants which appear healthier than others in the plant population in the field. The farmer needs to follow the progress of these robust plants until harvest. Especially for sorghum, the farmer can see good looking heads and harvest them separately as seeds to save for the next season.

### Drying

Once crops are harvested they must be dried before threshing and storage. Proper drying of harvested grains is important so that they store well over a long period. Drying prevents seeds from germination, growth of molds and diseases, and reduces conditions favorable for insect infestation. If grains are improperly dried, they can be attacked by insects and diseases while in storage, causing loss to the farmer. Drying is normally done by spreading harvested crops (heads, nuts and pods) on a clean and well-smearred ground for sun drying. While drying in the sun, the farmer should stir seeds regularly to distribute the heat equally over the bulk. For crops like sorghum, maize and millet, it is possible to let the crop dry in the field, after which it is harvested. Farmers usually check the seeds using their teeth or fingernail to see whether they are well dried or not.

### Threshing

Threshing is the extraction or separation of seeds, nuts, and grains from their covering materials like shells, pods, fruits, etc. Threshing should be done on well-smearred and dry ground using sticks or other implements depending on the area. Threshing should be conducted only for crops that have been dried very well.

### **Crop By-products**

Crop by-products contain important plant foods taken up from the soil. If the farmer keeps all the by-products after threshing in the same place (hole, pit, etc.) and spreads them all over the field or garden, they will add food to the soil and improve soil condition and fertility.

### **Summary of Main Points**

1. Timely harvesting of crops is important to reduce losses which can occur as the result of delay;
2. Farmers need to select seeds before harvesting by sorting and separating the healthy and good-looking plants from the rest;
3. Well-dried grain will keep longer;
4. By-products of the plants can be used for improving soil fertility.

## Session 6: Storage

### Objectives

By the end of the session, the participants should be able to:

1. Appreciate different ways of storing grains;
2. Improve on their traditional storage facilities.

**Time required: 1 hour**

### Methods:

- Discussion
- Brainstorming

### Materials required:

- Flip chart
- Manila papers
- Marker pens
- White board

### Procedure

1. Start by introducing the topic and the objectives;
2. Ask participants about traditional ways of storing produce;
3. In groups, invite participants to review storage methods with respect to:
  - a. How the storage facility is made;
  - b. Whether it is really safe from rodents and insect pests;
  - c. Whether there are no losses on produce.
4. Ask groups to present their reviews of different ways of storage;
5. Discuss how to improve local granaries;
6. Wrap up the discussion by summarizing the main points.

### Learning Points

There are simple techniques of constructing small stores which can reduce grain losses so the grain will last longer with minimal losses. Proper drying followed by traditional smoking to fumigate bundles of grains should be encouraged, as this can be effective for reducing damage of grains by weevils and other pests.

Local granaries can be improved by:

1. Increasing the height of the granary by 1 meter;
2. Putting metal flaps (rat guards) on the granary's posts;
3. Smearing the granary's posts with cow dung;

4. Attaching a well-thatched roof;
5. Mixing some crops together in storage.

### **Summary of Main Points on Storage**

1. Many simple techniques exist to store grains without problems;
2. Some traditional, low-cost techniques exist for good storage;
3. Local granaries can be improved for food storage.

## Session 7: Protection of Stored Grains

### Objective

By the end of the session the participants should be able to:

1. Appreciate different categories of store pests;
2. Explain the most important steps in storage pest control;
3. Apply protective practices for store pests.

**Time required: 2 hours**

### Method:

- Discussion
- Brainstorming

### Materials required:

- Flip charts
- Manila papers
- White board
- Markers/pens.

### Procedure

1. Introduce the topic and its objectives;
2. Explain why some insect pests infest stores;
3. Ask participants what type of pests commonly attack stores in their area;
4. Describe the three most common types of pests that attack store grains;
5. Elaborate on the importance of only storing undamaged grains in the granary;
6. Ask participants about their local practices to control store pests;
7. Explain different protective practices against insect pests;
8. Wrap up the session by summarizing the main points.

### Learning Points

Insects need food, water and air to live. In most cases grains in storage provide a perfect place for insects to live and grow because food, air and water are available in sufficient quantities. This is why some insect pests infest stores.

### Types of Store Pests

The two major pests in stored grains and pulses are beetles and moths. However, store pests can be divided into three categories:

1. **Primary pests:** These insects can break down the hard seed coat of the undamaged grain. Some may lay their eggs inside the kernel and the growing larvae eat the inside of the kernel. Others lay eggs on the outside of the kernel. The hatched larvae eat their way through the hard seed coat towards the very nutritious inside.
2. **Secondary pests:** These are not able to break through the hard undamaged seed coat. They follow the first attackers. They feed on grains with cracked and/or broken seed coats.
3. **Tertiary pests:** These feed on broken grains, grain dust and powder left by the previous groups.

Primary pest insects are the most dangerous ones. They damage the intact kernel so that larvae can develop inside the kernel. In this way, they also provide secondary and tertiary insects an opportunity to infest the stores. This is why it is important, if possible, to introduce only undamaged grains into the store. Even in grain stores with little damage, there will be larvae of primary pests waiting to feed. If you have a lot of broken grains in your store products, secondary and tertiary pests will be attracted.

### Protective Practices against Insect Pests

A farmer can reduce the occurrence of pests in his/her crops by carefully choosing certain resistant crop varieties, planting/sowing at the right time and other cultural operations including harvest, drying and threshing. Proper treatment of the grains before storage, along with locating the store in a good place and consistent maintenance to keep the store area clean will help protect stored grains against pests. A farmer can also use various non-chemical (organic) materials to control insect pests in the granary.

Below are some examples of ways to control pests.

- a. **Choice of varieties:** Farmers should take into account the susceptibility of different varieties of grains to store pests. Through experience, a farmer can learn to select varieties that are resistant to pests -- e.g., a hard seed coat or tightly closed husks can act as barriers to larvae which die before they are able to bore their way through to the inside kernel.
- b. **Time of harvesting:** Crops should be harvested as quickly as possible to avoid infestation of the grain in the field.
- c. **Site selection for storage:** Stores should be built on well-drained ground so that the granary or the container does not take too much moisture from the ground. It should be built far away from the grains in the fields so that it is protected from insect pests flying from the field to the storage. It should not be built in a place where animals are kept.
- d. **Select clean and healthy grains:** Through the careful selection of grains to be stored, the risk of losses is reduced.
- e. **Hygiene:** Stores and the immediate surrounding must be kept as clean as possible. Before use, storage facilities must first be checked for leaks, splits or cracks and should be repaired. A new harvest should not be stored with a previous harvest. Stores and containers must be

cleaned before bringing in new harvest. Never store produce in unwashed bags; if necessary, bags should be repaired before use. Used bags or sacks should be boiled in hot water or dried in a hot sun.

- f. **Drying:** Exposure of grains to sun and spreading them on a plastic sheet, smeared ground or hard surface will cause adult insects to fly away, as they are unable to withstand high temperature or bright light.
- g. **Use airtight containers:** Insect pests inside stores can die if the storage is made as airtight as possible. Various containers such as tight lids, plastic bags, can be used. A farmer can make his/her own airtight containers. A woven basket can be smeared with clay to make it airtight. After the basket is filled with grains, it can be sealed with a layer of clay. Then insert a burned wick through a small hole to use up the oxygen to make it completely airtight. When the flame goes out the wick is removed and the hole covered.
- h. **Local plants:** Whole, dried leaves of certain plants can be mixed with certain produce -- e.g., a ratio of 2-5 kilograms of dried neem leaves to 100 kgs of grain can be combined in layers and/or at random into the granary. In addition, 0.3 kg of unbroken beans of hyptis can be sufficient to protect 100 kg of grains against weevils.  
Certain seeds can also be ground and used as powder. It is also possible to extract some oil from neem seeds for use as insecticides.

### Summary of Main Points

1. Stores provide insect pests perfect conditions in which to thrive, because there is usually plenty of available food, water and air;
2. Store pests are divided into three categories: primary pests, secondary pests and tertiary pests, each of which can inflict different levels of damage;
3. A clean, dry and cool storage place, combined with clean, dry grains are by far the most important steps to ensure successful storage of grain;
4. Store pests can be controlled by selection of resistant varieties, harvesting on time, careful site selection for construction of the store, sorting grains before storage, maintain hygiene in and around the store, proper drying, and application of other plant materials.

## Session 8: Soil Fertility

In crop production, soil is the topmost portion of cultivated land on which plants grow. Like human beings, plants need water, food, air, light and support. The soils provide everything needed for plant growth. This session aims to ensure farmers understand the importance of maintaining soil fertility for sustainable productivity, and the different methods that will restore soil fertility. Farmers are encouraged to continue their use of traditional methods to increase soil fertility and to improve upon them.

### Objectives

By the end of this session participants will be able to:

1. Appreciate the importance of soil fertility in crop production;
2. Understand how soil loses its fertility;
3. Familiarize and make use of methods that can maintain/restore soil fertility.

**Time required: 2 hours**

### Methods:

- Discussion
- Brainstorming

### Materials required:

- Flip chart
- Manila papers
- Marker pens

### Procedure

1. Introduce the topic and its objectives;
2. Ask participants about the importance of soils in crop production;
3. Explain why soil is important in crop production;
4. Ask participants why farmers practice shifting cultivation methods;
5. Explain how soil loses its fertility.
6. In groups, ask participants to list methods they practice to restore or maintain soil fertility;
7. Invite groups to present different methods practiced to restore or maintain soil fertility;
8. Explain methods to restore soil fertility;
9. Wrap up discussion by summarizing the main points on loss of plant nutrients from soils and ways to restore or maintain them.

## Learning Points

In crop production, soil is the top portion of cultivated land on which plants grow. Like human beings, plants need food, water, light and support. The soil usually provides everything needed for plants to grow and give production. The soil is considered to be rich when it contains and can provide all necessary food and water to crops. Soil is considered to be poor when plant foods and water are not available in sufficient quantities to allow plants to grow and give good production.

A soil which has been rich at one time can become poor in short time. Water and plant food cannot naturally remain permanently in the soil. Sufficient quantities of nutrients and moisture may be naturally available for 1-2 years, but as crops, trees and other plants feed on the soil, these vital components will be depleted unless replaced by some means.

## Losses of Plant Food from the Soil

1. Plant foods can be leached away (washed down) by rains to a deeper level that crop roots may be unable to reach;
2. Weeds can consume a great quantity of available soil nutrients;
3. Crop plants also consume considerable quantities of available nutrients;
4. Growing one type of crop year after year in the same piece of land (mono-cropping) will deplete nutrients;
5. Wind can remove top soil from the land if left bare (without any cover from crop residues, trees etc.);
6. Heavy rains can wash away the top soil (soil erosion);
7. Trees also eat up food and water for crops;
8. Burning of land can cause loss of soil fertility.

## Lost Plant Food can be Replaced Using the Following Practices

1. By cutting leaves and small branches of trees, chopping and leaving them in the field to decompose instead of cutting down whole trees;
2. Digging under or leaving crop residues laying atop the field to decompose. A clever, hard-working farmer can dig his land early, before the last rains, leaving the grasses to decompose inside his fields to enrich the soil with fertilizer;
3. Add animal manure;
4. Add composted manure;
5. Add crop by-products after threshing;
6. Mulching (spreading especially dry grasses on top of the soil);
7. By growing selected trees and shrubs in the field which can increase the soil fertility either through their roots or leaves;
8. By protecting the farm from burning;
9. Leaving the garden fallow;
10. Practicing crop rotation with plants that can add soil fertility;

11. In most countries there are chemical fertilizers that contain plant foods that can be applied to enrich the soil.

## Session 9: Summary of Locally Applicable Methods to Increase Crop

### Production

To achieve an increase in crop production, the application of improved practices at all stages of crop production will give farmers better results. This session will summarize discussions from previous sessions by outlining suitable practices at each stage and their expected results. The aim is to ensure that farmers grasp the main learning points for practicing good crop husbandry. Farmers are encouraged to take note of practices that can be applied in order to increase the volume and productivity of land cultivated.

### Objectives

By the end of this session, participants will be able to:

1. Review improved practices discussed in previous sessions;
2. Appreciate/understand results expected from the suggested methods.

**Time required: 2 hours.**

### Methods:

- Discussion,
- Group discussion,
- Brainstorming.

### Materials required:

- Flip chart
- Manila
- Markers/pens

### Procedure

1. Introduce the topic and the objectives;
2. In groups, ask participants to list some improved practices discussed in previous sessions (e.g., in land clearance, land preparation, planting, weeding, harvesting, drying, threshing, storage, store pests and soil fertility.) Provide each group with one or two examples of traditional/cultural agriculture practices;
3. Invite groups to make presentations;
4. Summarize/explain the improved practices covered in the training as well as the expected results.

## Learning Points

### Land Clearing

Apply the following:

- Selected cutting down (pruning) of trees;
- Controlled burning by making fire lines;
- Digging or slashing down weeds and small plants immediately after harvesting.

The results would be:

- Increased water infiltration and retention capacity;
- Restored fertility of soil through decomposition of plant materials dug under or slashed down, chopped, and left atop fields;
- Reduced soil erosion from wind;
- Reduced temperature of the soil, which will decrease the evaporation rate (loss of water from the soil).

### Land Preparation

Apply the following:

- Start land preparation immediately after land clearance and during the dry season, as early as possible before planting;
- If possible use the most efficient tools available, such as ox-plows, for land preparation;
- Do not cultivate (dig) when the soil is too wet as this will form undesirable clods which will hamper planting and germination.

The results would be:

- Improved conditions for planting, germination and crop growth;
- Increased water retention capacity of the soil;
- Allows crops to develop their roots deep in the soil;
- Reduces weeds, insect pests and plant diseases.

### Planting

Apply the following:

- Start planting as early as possible;
- Plant only carefully selected, healthy, high-quality seeds.

The results would be:

- Plants will benefit from early rains and will grow quickly;
- Stronger, healthier plants which can compete with weeds.

## Weeding

Apply the following:

- Remove weeds early, preferably by hoe, (or by moloda or hand pulling if necessary), within 3-4 weeks after planting;
- Destroy/remove weeds before they flower.

The results would be:

- Crops avoid competition with weeds and therefore would benefit fully from all available food, water and sunlight;
- Less labor in weeding since weeds were removed before flowering, thus limiting seed dispersal;
- Fewer grains mixed with weed seeds;
- Harvesting will be easier.



**Maize crop ready for first weeding**



**Etiolated unwedded maize crop due to competition**

## Harvesting

Apply the following:

- Timely harvesting;
- Saving seeds from the healthiest, strongest plants.



**Sorghum crop ready for harvest**

The results would be:

- Reduced loss of crops from early maturity or over-staying in the field;
- Farmers will collect and save good quality seeds;
- Reduced loss of grains from shattering (pulses and oil crop seeds).

## Drying

Apply the following:

- Prepare clean ground for drying the crops;
- Make sure seeds are well dried and ready for threshing.

The results would be:

- Reduced loss from insects because conditions favorable for insects (i.e., moisture, air) are limited;
- Eases threshing.



**Drying maize on hard ground**

### Threshing

Apply the following:

- Prepare clean ground for threshing;
- Save and use the by-products from threshing to re-fertilize fields.

The results would be:

- Clean grains;
- Production of extra and useful by-products for fertilizing fields.

### Storage

Apply the following:

- Construct improved storage facilities from locally available materials;
- Keep produce in the store.

The results would be:

- Reduced losses from improper storage;
- Increased life of grains in the store.



**Maize for food stored in sacks inside store-house or granary (Jong)**



**Maize for food stored in a granary**

## SECTION 3: VEGETABLE GARDENING

Vegetables are important components in crop production. They can supplement the farmer's diet, are rich in minerals and vitamins and are a good source of household income. This section discusses the importance of vegetable production and practices involved in growing vegetables. It aims at improving farmers' understanding of the benefits of vegetable growing and different to improve their production.

### Objectives

By the end of the session, participants will be able to:

1. Appreciate the importance of vegetables;
2. Select good sites for vegetable growing;
3. Apply different methods to improve vegetable production.

**Time required: 3 hours**

### Method:

- Discussion
- Group discussion
- Brainstorming

### Materials required:

- Flip chart papers
- Manila paper
- White board
- Markers/pens

### Procedures

1. Introduce the topic and objectives of the session;
2. Explain vegetables and gardening;
3. Ask participants to name wild vegetables that are used in the area;
4. Explain the importance of vegetables;
5. Ask participants where they normally grow vegetables;
6. Explain the possibilities of growing vegetables in areas where there is water and shade;
7. Ask farmers about the qualities of the soil and land they use to grow vegetables;
8. Explain the various practical stages of vegetable gardening;
9. Wrap up the session by summarizing the main points.

### Note to facilitators

Practical demonstrations on vegetable nursery establishment and transplanting must be done in this section.

### Learning Points

Vegetables are small plants grown by farmers around the homestead or which can be found naturally anywhere. They may be classified into two general categories:

1. Native vegetables that grow naturally (e.g., wild vegetables)
2. Vegetables planted by farmers (e.g. okra, pumpkins, tomatoes, kale, eggplants, onions)

Gardening is the practice of cultivating vegetables. A garden is the place where vegetables are grown.

### Importance of Vegetables

1. They are good sources of nutrients to help the body fight off disease and enable the body to function properly;
2. They can provide flavor and variety when mixed with staple foods;
3. When sold, they can be good sources of income to the family;
4. They are especially needed by growing children, lactating and expectant mothers due the vitamins and minerals they contain.

Farmers traditionally grow vegetables like okra and pumpkins around their houses. In fact it is possible to grow them anywhere there is water and shade. Many farmers grow vegetables or tobacco near streams during the dry season. It is possible for farmers to cultivate more vegetables around their homesteads by practicing improved methods such as the application of manures or composts, and/or rotational kraals which can increase vegetable production.

### Practical Requirements of Vegetable Gardens

Vegetable growing involves several different stages:

#### Land preparation

Most vegetable seeds are very small in size. Therefore, they need a fine, well- prepared seedbed in order to ensure germination and growth. During the dry season, especially, seedbeds should be prepared in such a way that it will hold water during/after watering.

#### Planting

1. Direct planting of seeds in the prepared soil/fields, to grow until harvesting. This type of planting is called direct planting;
2. Planting seeds in carefully prepared seedbeds, and later transferring them to another place to grow to maturity. This type of planting is called *transplanting*.

Normally farmers practice the first method of direct planting of vegetable seeds in a fairly big piece of land, both for family consumption and sale. In locations where this practice is successful, farmers are encouraged to continue.

### **Nursery establishment**

1. The site selected for nursery establishment should be close to the permanent garden where seedlings will be transplanted, and should have a permanent source of fresh water close by;
2. Measure out the nursery bed to be at least 1.2 meters wide, by any convenient length;
3. Nursery beds must be dug deeply, and big clods of soil, thorns and other things should be cleared out. Seed beds must be prepared with fine soil;



**Nursery bed deep digging to loosen soil**



**Breaking hard clod to ensure fine bed for easy germination**

4. The soil must be moist and not dry before planting/sowing of the seeds. During dry spells, water the seed bed the evening before sowing seeds;
5. While sowing, drill holes in a straight line, sow seeds thinly and cover lightly with soil;
6. Cover the seed bed with grass until germination to protect seeds from being eaten by birds, washed away, or compacted by heavy rain;



**Sowing seeds in nursery bed**



**Covering sown nursery bed with dry grass**

7. Immediately after germination, prepare a raised shade for the bed, recommended to be 0.5 meters above the ground, and cover with grass;
8. Reduce the grass gradually as the seedlings grow so that the seedlings can receive adequate sun light;



**Raised nursery shade after seed germination**



**Reducing shade gradually to harden seedlings**

9. Watering must be done in the morning and evening, not during the day when the sun is hot;
10. Thinning: This is the removal of seedlings which are closely congested in the nursery bed. This is done by removing the weak and thin seedlings and leaving healthy ones. This will provide enough space between seedlings so they can grow vigorously. The same practice apply to vegetables that are planted directly; they can be thinned to allow adequate space for growth;
11. As noted above, transplanting is the practice of transferring seedlings from the nursery bed to a permanent bed where they will grow to maturity. In preparation for transplanting, reduce shade gradually, and finally remove the shade three days before transplanting, while simultaneously reducing the frequency of watering to harden the seedlings. Transplanting should be done on cool days or early in the morning and/or late in the evening;



**Transplanting of hardened seedlings**

12. Weeding is the removal of grass and unwanted plants from the garden. Like any other crops, vegetable crops need to be free of weed competition for nutrients and water;
13. Harvesting: Different vegetables require different vegetable harvesting times and methods. The general principle is to harvest the leaves, fruits or roots when they are matured. Early harvesting has some disadvantages – e.g., plants will be weaker if harvested early. Late harvesting is not good, either, for the following reasons:
- a. Some vegetables may lose their nutritional value;
  - b. Some may crack while still in the field;
  - c. Some may be more susceptible to insects and disease.



**Kale ready for harvest**



**Cabbages**



**Green pepper**



**Tomatoes**

### **Summary of the Main Points of Vegetable Gardening:**

1. Vegetables are useful plants that grow naturally or may be planted;
2. There are different stages of vegetable growing, each with their own practical requirements;
3. To give good care to vegetable seedlings, it is advisable to raise seeds in nursery beds first;
4. Vegetables grow better in rich, fertile soils. Farmers can improve soil conditions by applying manure and compost;
5. Before transplanting, vegetable seedlings need to undergo hardening;
6. Thinning is needed after germination, even when direct planting;
7. It is important to harvest leaves, fruits or roots when they are mature and before they lose their nutritional value and quality.