



USAID
FROM THE AMERICAN PEOPLE



ipa
INNOVATIONS FOR
POVERTY ACTION

COMMUNITY EXTENSION AGENT LEGUMES HANDBOOK 2015



Extension Agent Handbook for Soya, Cowpea and Groundnut Production in Northern Ghana



Extension Handbook for Soya, Cowpea and Groundnut Production in Northern Ghana, 2015.

**Produced by : Disseminating Innovative Resources & Technologies
to Smallholders (DIRTS) Project, IPA**

Compiled by: Adzoyi Fred Xorla

Reviewed by : Dr. Benjamin D. K. Ahiabor

Dr. Mathias Fosu



DISCLAIMER: While USAID provided funding for the project, they are not responsible for the content of the handbook.

For any suggestions, clarifications or more information, please contact:
elegovini@poverty-action.org / mhusselman@poverty-action.org /
fadzoyi@poverty-action.org

TABLE OF CONTENTS

TABLE OF CONTENTS	ii
ACKNOWLEDGEMENTS	vi
PREFACE	vii
HOW TO USE THIS HANDBOOK	x
CHAPTER ONE LEGUMES	1
1.0 Introduction	1
1.1 Soybeans	1
1.2 Cowpea	1
1.3 Groundnut	2
CHAPTER TWO SITE SELECTION	3
2.0 Introduction	3
2.1 Site selection for Soybean	5
2.2 Site selection for Cowpea	5
2.3 Site selection for groundnut	5
CHAPTER THREE FIELD MEASUREMENT	7
3.0 Introduction	7
3.1 Measuring your farm	7
3.2 Important Conversions	9
3.3 Important Dimensions	9
CHAPTER FOUR LAND PREPARATION	13
4.0 Introduction	13
4.1 Manual land preparation	13
4.2 Tractor ploughing	15
4.3 Benefits of proper land preparation	18
4.4 Benefits of early land preparation	19
4.5 Factors that determine method of land preparation	20
CHAPTER FIVE USING CERTIFIED SEEDS	22
5.0 Introduction	22
5.1 Benefits of using certified seeds	24
CHAPTER SIX GERMINATION TEST	25
6.0 Introduction	25
6.1 Conducting a germination test	26
6.2 Calculating the Germination Percentage	27
6.3 Benefits of conducting a germination test	29
CHAPTER SEVEN INOCULATION OF LEGUME SEEDS	30
7.0 Introduction	30
7.1 Inoculants application	30

7.2	Benefits of using rhizobium Inoculant	33
7.3	Composition of Inoculants.....	34
7.4	Materials needed for inoculation	34
7.5	Practical steps to inoculant application	35
7.6	Common Types / Forms of Inoculants	36
7.7	Guidelines for Storing Inoculants.....	36
CHAPTER EIGHT TIMELY AND PROPER PLANTING		38
8.0	Introduction	38
8.1	Timely and proper planting of soybean.....	38
8.2	Timely and proper planting of groundnut.....	40
8.3	Planting periods in Northern Ghana	42
8.4	Estimated seed rates per acre.....	42
8.5	Benefits of Timely and proper planting.....	42
8.6	Plant spacing and arrangement	43
8.6.1	Planting distance for groundnut	43
8.6.2	Planting distance for cowpea.....	43
8.6.3	Planting distance for Soybean	44
8.7	Ensuring proper plant density	44
CHAPTER NINE REFILLING AND THINNING		46
9.0	Introduction	46
9.1	What is refilling and thinning?	47
9.2	Reasons for germination failure	48
9.3	Refilling and thinning procedure	49
CHAPTER TEN MULCHING AND ORGANIC FERTILIZER APPLICATION		50
10.0	Introduction.....	50
10.1	What are organic fertilizers?	50
10.2	Mulch as organic fertilizer	50
10.3	Animal waste as organic fertilizer	52
10.4	Zai method of organic fertilizer application	53
10.5	Examples of mulch materials	53
10.6	Soil mulching.....	53
10.7	Benefits of mulching	54
CHAPTER ELEVEN SOIL MANAGEMENT AND CONSERVATION		56
11.0	Introduction.....	56
11.1	Soil fertility management	56
11.2	Soil structure	56
11.3	Soil preservation and conservation.....	57
11.4	Bad soil management practices.....	57
11.5	Good soil management practices.....	58
CHAPTER TWELVE MINERAL FERTILIZER APPLICATION.....		61
12.0	Introduction.....	61
12.1	What to consider before fertilizer application.....	61
12.2	Types of fertilizers.....	62
12.3	Management/handling of mineral fertilizers	62
12.4	Fertilizer calculation	63

12.5	Applying the fertilizer	63
12.6	Commonly made mistakes in fertilizer application	65
CHAPTER THIRTEEN COMPOSTING		67
13.0	Introduction.....	67
13.1	Compost materials	67
13.2	Methods of preparing compost.....	69
13.3	Heap/pile method of composting.....	69
13.4	Conditions that facilitate good composting.....	71
13.5	Organisms that facilitate good composting.....	72
13.6	Benefits/importance of Compost.....	73
CHAPTER FOURTEEN PEST MANAGEMENT		75
14.0	Introduction.....	75
14.1	Rodents	75
14.2	Insects.....	76
14.3	Nematodes	78
14.4	Integrated pest management (IPM)	79
14.5	Practical examples of IPM strategies.....	79
14.6	Chemical control of pesticides.....	85
CHAPTER FIFTEEN MIXED FARMING		86
15.0	Introduction.....	86
15.1	Why mixed farming	86
15.2	Improvements to traditional animal raising techniques	88
15.3	Types/times of fodder cultivation	88
15.4	Improved health care for livestock.....	89
15.5	Common diseases.....	89
15.5.1	Internal parasites.....	89
15.5.2	Coccidiosis.....	91
15.5.3	Brucellosis	92
15.5.4	Bronchitis	92
15.6	Basic housing and shelter.....	92
CHAPTER SIXTEEN FARM SANITATION		94
16.0	Introduction.....	94
16.1	Some good farm sanitation practices.....	94
16.2	Some farm sanitation tips	97
16.3	Benefits of good sanitation practices on your field.....	98
CHAPTER SEVENTEEN PROPER AND SAFE USE OF AGROCHEMICALS		99
17.0	Introduction.....	99
17.1	Guidelines for proper use of agrochemicals.....	100
17.2	Steps to take when chemical contact/poisoning occurs.....	103
17.2.1	Contact of chemicals with eyes	103
17.2.2	Chemicals getting inhaled.....	103
17.2.3	Chemicals in contact with the skin.....	104
17.3	Symptoms of chemical poisoning.....	104
17.3.1	Mild poisoning	104
17.3.2	Severe poisoning	104

CHAPTER EIGHTEEN	CROP ROTATION	106
18.0	Introduction	106
18.1	Benefits of crop rotation	106
18.2	Guidelines and principles of crop rotation	107
18.3	Crop types and examples	109
CHAPTER NINETEEN	WATER MANAGEMENT	110
19.0	Introduction	110
19.1	Role of water in the growth and development of crops	110
19.2	Common symptoms of water stress	111
19.3	Impact of water shortage	112
19.4	Soil water conservation techniques	112
CHAPTER TWENTY	RECORD KEEPING	115
20.0	Introduction	115
20.1	Expenditure records	115
20.2	Revenue record	116
20.3	Operational records	116
20.4	Benefits of proper record keeping	117
20.5	Recommended record keeping practices	118
20.6	Recommended transaction practices	118
CHAPTER TWENTY ONE	INTERCROPPING	120
21.0	Introduction	120
21.1	Types of intercropping	120
21.2	Considerations when intercropping	122
CHAPTER TWENTY TWO	TIMELY AND PROPER WEED MANAGEMENT	124
22.0	Introduction	124
22.1	Methods of weed control	125
CHAPTER TWENTY THREE	LABOUR MANAGEMENT	130
23.0	Introduction	130
23.1	Proper labour management tips	131
CHAPTER TWENTY FOUR	FALLOWING	134
24.0	Introduction	134
24.1	When to allow your farmland to fallow	134
24.2	Fallowing practices	135
24.3	Characteristics of a good fallow species	135
24.4	Why fallowing?	136
CHAPTER TWENTY FIVE	TIMELY AND PROPER HARVESTING	138
25.0	Introduction	138
25.1	Time to harvest soybean and cowpea	138
25.2	Time to harvest your groundnut	140
CHAPTER TWENTY SIX	THRESHING	143
26.0	Introduction	143

26.1	Proper threshing procedure.....	144
26.2	Manual threshing techniques.....	145
26.2.1	Flailing.....	146
26.2.2	Jogging.....	146
26.2.3	Rubbing.....	146
26.2.4	Beating.....	146
26.2.5	Shaking/tumbling.....	147
CHAPTER TWENTY SEVEN DRYING.....		148
27.0	Introduction.....	148
27.1	Proper drying procedure.....	148
27.2	Tools use in drying.....	150
27.3	Tips for proper drying.....	151
27.4	Benefits of proper drying.....	151
CHAPTER TWENTY EIGHT WINNOWING AND CLEANING.....		152
28.0	Introduction.....	152
28.1	Methods of winnowing.....	152
CHAPTER TWENTY NINE BAGGING AND STORAGE.....		157
29.0	Introduction.....	157
29.1	Benefits of storing produce.....	159
29.2	Improved cowpea storage.....	160
29.3	Storage of groundnut.....	162
29.4	Conditions for good storage of groundnut.....	162
29.5	Storage of soybean.....	163
29.6	Good bagging and storage practices.....	163
CHAPTER THIRTY FINDING BUYERS AND SELLING YOUR PRODUCE.....		165
30.0	Introduction.....	165
30.1	Guide to finding buyers for your produce.....	166
CHAPTER THIRTY ONE RECYCLING SEEDS.....		168
31.1	Introduction.....	168
31.1	Steps involved in properly recycling seeds.....	169
31.2	Disadvantages of continuous seed recycling.....	170
CHAPTER THIRTY TWO PREPARING FOR NEXT SEASON.....		172
32.0	Introduction.....	172
32.1	Some activities to undertake prior to next season.....	172
32.2	Why prepare in advance?.....	173

ACKNOWLEDGEMENTS

This CEA Handbook is the culmination of many months of conversations, ideas, edits and, most of all, hard work by many individuals. Without the contributions of these individuals and organizations this Handbook would not have assumed its

current state. Most of all, we would like to thank the Ministry of Food and Agriculture (MoFA) and CSIR-Savanna Agricultural Research Institute (CSIR-SARI) for their assistance in developing the extension messages, which constitute this handbook and for partaking in our Content Development Fora. Specifically, we would like to thank Mr. Williams K. Atakora of CSIR-SARI and Mr. William Boakye-Acheampong, Northern Regional Director of MoFA, for their support in this process.

Further appreciation is given to CARE and RAINS, who willingly shared their extension materials to help form ours. Lastly, we extend a big appreciation to two Agricultural Extension Agents (AEAs), Mr. Otoo James and Mr. Rasheed Amadu of Tatale District and Savelugu-Nanton Municipality Directorates of Agriculture Department of Agriculture Offices, respectively, who worked with us to provide the finishing touches to this book.

We recognize that the science of agriculture is always evolving and all the related information herein is far from complete. We hope that rather than regarding this as a final product, we have provided an excellent starting point that can, and should, be revised in the future.

PREFACE

Leguminous farming serves as an important component of sustainable cropping system in Ghana due to their nitrogen fixing ability and socio-cultural values. Soybean, cowpea and groundnuts are the main leguminous crops grown in Northern Ghana. Others include Bambara, dawadawa, pigeonpea.

The seeds of many legumes are an important food staple worldwide because they are rich in both oil and protein. They are higher in protein than any other food plant and are close to animal meat in quality. In fact, they are often called “poor man’s meat” because they are an inexpensive source of high-quality protein.

The high protein content of legumes is correlated with the presence of **root nodules** which contain **nitrogen-fixing bacteria**. These bacteria, which are species of the genus *Rhizobium*, are able to convert free atmospheric nitrogen into a form that can be used by plants in the making of protein and other nitrogen-containing compounds. Because of the presence of nitrogen fixing bacteria, the cultivation of legumes enriches the soil. For this reason farmers often rotate legumes with crops that deplete soil nitrogen.

In Ghana, soybeans is cultivated mainly in the Northern, Upper West, Upper East, Central and Volta Regions. Among these regions, the largest production occurs in Northern Ghana, which lies within the Guinea Savanna and Sahel agro-ecological zones. At the household level, farmers in Northern Ghana use soybeans in the preparation of dawadawa, soups, koko (porridge), milk etc. as it is considered as a source of inexpensive dietary protein, mineral, and vitamin for both rural and urban dwellers.

Cowpea another leguminous crop, is an important crop in Ghana due to its contribution to national GDP, farmers’ income, food and nutrition security. Consumption of cowpea per capita in Ghana is estimated at 9kg each year. It is a major source of plant protein (23-30) contains minerals (e.g. iron, zinc, phosphorus and calcium) that improves human nutrition and health status.

Households generates annual income of about GH¢760 to GH¢800 through production of cowpea. For the whole of Northern Ghana, an additional income of between GH¢15 to GH¢16 million is generated annually with at least 40 percent of this directly going to women farmers. Despite the nutritional and economic value of cowpea, a demand deficit exist because it has been established that Ghana imports about 10,000 metric tons of cowpea annually.

Groundnut (*Arachis hypogaea* L.) is a cultivated annual of South American origin, domesticated in the broad area between Brazil, Argentina, Paraguay, Peru and Bolivia. The cultivation of the crop is a major agricultural activity for the people of

the Northern Regions of Ghana. It is both a commercial and subsistence venture for majority of the inhabitants.

Groundnuts may be chewed uncooked, but are usually eaten boiled or roasted. The nuts can also be boiled, fried, ground into groundnut butter, or crushed for oil. The oil is used to make margarines, mayonnaise and for edible purposes.

Despite the socio-economic importance of these leguminous crops discussed above, the production of these crops have been faced with several challenges that results in massive crop lost (both quantitative and qualitative) among which include low yields as a result of bad farming practices that can be traced to varietal selection, agronomic practices and harvesting methods and time. For example, soya yields in Ghana average only 0.8 metric tons per hectare, although, it has been demonstrated to grow at yields of as much as 4.5 metric tons per hectare under best commercial agricultural practices. Average yields of groundnuts also remain below 1 ton per hectare which is far below the potential yields of 2.0-3.0 tons per hectare. Others also noted pod yields of groundnut in Ghana to average only 840 kg/ha which is low compared to yields of 2,500 kg/ha found in some developing countries.

Poor quality of produce owing to inappropriate handling after harvesting, processing and through distribution to the point of consumption has also been noted to be a major cause of crop loss leading to food and income insecurity among smallholder farmers in the country. It is against these drawbacks that IPA-Ghana found it imperative to develop this handbook to equip CEAs and AEAs to be able to communicate new innovations that spun the production of these crops.

HOW TO USE THIS HANDBOOK

The Community Extension Agent (CEA) programme is based on the idea that **community members** are able to serve as responsible and effective resources to farmers in their respective communities. They have been given the tools, such as extension messages, agricultural training, and this handbook to help them transfer agricultural knowledge to their communities.

This handbook should be used when

- The CEA does not know the answer to a farmer's question
- The CEA is unsure of what s/he was trained on or does not remember something
- The CEA simply wants to learn more about the subject.
- The CEA believes some of the picture diagrams found in this book will help their community members

We would like to stress here that the CEA **SHOULD NOT** share **ANY** information with their farmers that is not specifically outlined in the training, this handbook, or by an AEA.

We thank the CEAs for their dedication and hard work throughout this program and look forward to a prosperous farming season!

CHAPTER ONE

LEGUMES

1.0 Introduction

Legumes are plants of the beans family, Fabaceae, which includes all types of beans and peas as well as soybeans. This large widely distributed family also includes various trees and ornamentals. Most members of the legume family share a very similar flower and fruit structure. The five-petaled flower is irregular with bilateral symmetry, and has been described as either butterfly shaped or boat shaped. The fruit is a pod with one row of seeds. The seed contain two prominent food-storing cotyledons.

In this handbook we are going to dwell only on three leguminous crops, namely; soybeans, cowpea and groundnut. These crops are briefly describe in the sections that follows.

1.1 Soybeans

Soybean (*Glycine max*) is a leguminous plant of the family leguminosae native to tropical and warm temperate regions of Asia. The crop can grow in a wide range of soils, with optimum growth in moist alluvial soils with good organic matter content and in an equable climate without excessive rainy periods; Soybeans can only withstand a little water logging conditions. Mean temperatures of 20°C to 30°C are suitable for the cultivation of this crop. Temperatures below 20°C and over 40°C will significantly reduce the growth of the crop. Soybeans matures within 3–4 months after planting and requires timely harvesting to check excessive yield losses. The seed of soybeans consist of 40% protein, 18% fat, 6% ash and 29% carbohydrates.

1.2 Cowpea

Cowpea (*Vigna unguiculata*) is another major grain legume in Sub-Saharan Africa and it is widely grown and consumed in Ghana. The crop is able to tolerate hot and dry weather conditions, but is intolerant of water-logging and very low temperatures. Germination is rapid at temperatures in the range of 25°C to 30°C. Temperatures below 18°C slow germination as cowpea is sensitive to low temperatures. Cowpea is well adapted to sandy soils, and will perform well on rich well-drained sandy-loam soils.

1.3 Groundnut

Groundnut is a self-pollinating, intermediate annual, herbaceous legume. The fruit is a pod with one to five seeds that develops underground within a structure called a peg, an elongated ovarian structure. Groundnut emergence is intermediate between the epigeal (hypocotyl elongates and cotyledons emerge above ground as in soybeans) and hypogeal (cotyledons remain below ground as in field pea types). The groundnut plant can be erect or prostrate with well-developed taproot and many lateral roots and nodules.

Groundnut is not suited to growing in very dry areas or at altitudes above 1500m (around 5000ft). Optimum temperatures are 27-30 for vegetative growth and 24-27 for reproductive growth. Although the groundnut plant is fairly drought resistant, between 450mm and 1250mm of evenly distributed rainfall is required annually for good growth and yield.

All soils, other than very heavy, are suitable for growing groundnut, but the best are deep, well drained sandy, sandy-loam or loamy-sand soils. Groundnut will not grow well or fix nitrogen in acidic soil. Soils for growing groundnut should have pH between 5.3 and 7.3.

CHAPTER TWO

SITE SELECTION

2.0 Introduction

There are six main agro-ecological zones in Ghana: (1) Guinea Savannah (2) Coastal Savannah (3) Semi-deciduous Forest (4) Transitional Zones, (5) Sudan Savannah and (6) Evergreen Forest zones. All of these zones are suitable for the cultivation of groundnut, cowpea and soybean except the Evergreen forest zone.

Northern Ghana is within the Guinea and Sudan Savannah Zones. There are areas with sandy soils, loamy soils and clayey soils and it is up to you to examine the type of soil you have and determine if it is suitable for the crop you want to grow. In this message, we are going to discuss special signs you should look out for when selecting a new site for cultivation of legumes next season.

First, it is crucial to know why site selection is an important activity. If you have been cultivating your field for over 10 years continuously without allowing a fallow period, it has most likely lost all of its fertility. Traditionally fallowing allows the soil to regenerate its fertility naturally. However, due to pressure on land, fallowing is no longer an option in many places. . The best way to improve your soil with legumes is to rotate them with other crops especially cereals. This will ensure that the health of your soil is maintained as the legume and cereals mutually benefit from the rotation effects. You may also select a new field to grow your legume crop. Where fallowing is possible a fallow period of 1 year for each 4 years of continuous cultivation should be given.

In selecting a new site observe the vegetative cover of the field very closely. Plant growth on a field is indicative of the fertility level of the land. Fields with good growth of weeds that look very green are likely to be fertile enough to support the growth of your crops. The mere presence of weeds is, however, not enough. You need to observe the kinds of weeds that are growing on the field – the more varieties of weeds/plants you notice on the field, the better the soil will be for your

crops. This is because nutrient requirements vary for different plants so therefore a field that is able to support different plants at the same time indicates a soil that has good levels of all the major and minor nutrients needed for good plant growth.

Now it is time to focus on the soil itself. A good soil for groundnut, cowpea and soybean cultivation is one that has a high organic matter content and also has good drainage. The high organic matter content tells you that the soil is veryfertile and cultivation might need only small supplementary mineral fertilizers such as NPK, for high yields.

This is how you tell the level of organic matter in the soil: first, dig up the soil with your hoe and collect a handful of soil. If the soil has good organic matter, you should observe some leaves or organic residue in the process of decaying. Also, the colour of the soil should be dark. Soil with good organic matter should also have living organisms in it such as earthworms and ants that aid in the decay of organic residue and improve soil structure and aeration. Remember that both **clayey and very sandy soils are not suitable for groundnut, cowpea and soybean cultivation**. A clayey soil will not have good infiltration so water that collects on the surface will take a very long time to go into the ground. In addition, when dry, it becomes hard and difficult to work and in the case of groundnut you will lose a lot of the pods at harvest. A sandy soil has a poor water retention capacity so water rapidly infiltrates through the soil and is not retained at the right depth to be accessed by the roots of the crops. In addition, a sandy soil loses water quickly through evaporation when the weather gets hot.

For groundnut production, one very important thing you should consider is soil compaction because groundnut pods are produced underground. Hence, with very compact soils, penetration of pegs on which the pods are formed will be difficult and will cause the pegs to break during harvest – this is why clayey soils are not suitable. Groundnuts require levelled or gently sloping fields with well-drained sandy-loam soil that facilitates penetration of the pegs after pollination and easy digging without loss of pods. Cowpea and soybean also require well-drained sandy-loam soil as this ensures good seed germination and plant establishment resulting in a healthy plant growth and high yield.

As you already know, good rainfall or water supply is essential for the cultivation of all crops. You should select sites in areas where the annual rainfall does not fall below 700 mm and is distributed well throughout the season. All areas in Northern Ghana receive rainfall ≥ 700 mm so rainfall amount will not be a problem. The main problem is the distribution of the rainfall.

If you follow the above guidelines in the selection of your site for cultivating legumes, you will be on the right path to making a good decision that will lead to a good yield. However, once you have selected your site based on the criteria mentioned above, you should proceed to have your soil tested to confirm that it has the essential nutrients (Phosphorus and Potassium) and other elements that are necessary for groundnut, cowpea and soybean production. We will tell you another message that will teach you more about the steps to follow to have your soil tested.

2.1 Site selection for Soybean

Soybean can be planted in any soil that is suitable for growing maize but performs badly on poor sandy soils with low content of organic matter. Generally soybean is better suited to heavier soils than most other crops. Soils that easily compact and form a crust must be avoided for growing soybean because the protruding soybean seedling (hypocotyl) breaks easily under pressure.

2.2 Site selection for Cowpea

Cowpea is well adapted to sandy soils, and will perform well on rich well-drained sandy-loam soils but should not be grown on wet or poorly-drained soils. Cowpea does not tolerate excessively wet conditions.

2.3 Site selection for groundnut

Select fields that are flat and avoid sloppy lands and areas that are likely to get waterlogged. Also, avoid fields that are stony, very sandy or with a lot of gravel.

Soils with a high clay percentage in the topsoil may cause the groundnut pegs to break at harvest.

Soil compaction can also be a problem if the fine sand fraction of the topsoil is high. This situation can be aggravated in soils with low organic matter. Shallow soils must be avoided because of their low water retention capacity as well as the possibility of waterlogging.

CHAPTER THREE

FIELD MEASUREMENT

3.0 Introduction

In farming, field size is the most fundamental measurement because it guides almost all the activities that happen on the farm. It ensures better planning of your farm and guides all farming operations that will be undertaken during the farming season. From charges by manual labourers or tractor operators to the amount of inputs and yield expected after harvest, the size of your field plays a key role.

Sadly, however, most farmers cannot accurately tell the size of their farms and this negatively affects their farming operations either due to underestimation or overestimation of the size of their fields. In this message, we are going to talk about the ways to measure the size of your field and how that knowledge can greatly improve your farming operations and activities.

3.1 Measuring your farm

The easiest way of measuring the size of your farmland is by using a device equipped with GPS technology. With this kind of device, all you have to do is take a reading or press a button at the starting point of your field and walk all the way round your field back to the point you began. After returning to that point, you then press another button to stop reading and you will know the size of the area you just walked around. The device will then calculate the size and display it boldly on its screen for you to read and record.

Even though this method is very highly effective and gives you a very accurate measure, GPS devices can be expensive and hard to come by at the village. This means that farmers would have to come up with more innovative ways of knowing the size of the fields they are cultivating. For the easiest way to do this, you will need a few items. Get some pegs or sticks and a long rope. Now, begin at the shorter side of your field and mount one of the pegs there. Now, move to the other

end of that side and mount another peg. If your rope is long enough to reach one peg from another, tie them and measure the length of rope it took from one end to the other. Note down this distance.

However, if your rope is not long enough, you will need to measure a fixed length, tie it at one end with a peg and keep moving the pegs until the length of the side is exhausted. Now, you can get the full length of this side by measuring the length of rope you used and the number of times you moved the pegs to exhaust the distance and multiply. This is the measurement of one side of your field.

Now that you have the distance for one side of your field, you need to get the distances for the other three sides of your field in the same way. Do not move the peg at the corners of the side you just measured. With those points as starting points, move the pegs along the sides until you have completed each side of your farm. As you move the pegs around, try to not lose count. At the end of each side, obtain the distance covered by multiplying the number of times you moved the pegs by the length of the rope tying the pegs.

After completing this for all sides of your field, you can now give the figures to your CEA to calculate the size of your field in acres (or hectares) for you.

With the accurate measurement of the size of your field, you can now carry out your farm operations better. For example, if the size of your field is actually three acres and not the five acres you previously thought it was, you will be able to manage your money better by paying your tractor service operator the amount for three acres and not for five acres. This way, you would have saved the surplus for two acres, which you can invest in other areas of your farming.

Knowing the right size of your field will also help you to know how much seed to purchase for planting. ***For cowpea, groundnut and soybean, you'll need 8-10, 16-24 and 16-20 kg per acre, respectively for good seeding.*** Equipped with accurate information on the size of your field, you can now purchase the right quantity of seed for your field, use the recommended planting distances and be able to achieve the optimum planting density or population.

Knowing the right size of your field also helps you to better estimate the harvest you should be getting from your farm. For example, ***in northern Ghana, the***

potential yield per acre of groundnut is 10-12 (unshelled) bags, cowpea is 6-8 (shelled) bags and soybean is 8-10 (shelled) bags and maize is 18-22 bags. By knowing the accurate measurement of your field, you will know whether you are getting the most from your field or not. By underestimating the size of your field, you might think you are getting good yields, which might not be the case if you knew the correct field size.

Remember, knowing the size of your field is very important and can help improve your farming operations considerably. Follow the above guidelines and work with your CEA to know the size of your fields for better practices and planning.

3.2 Important Conversions

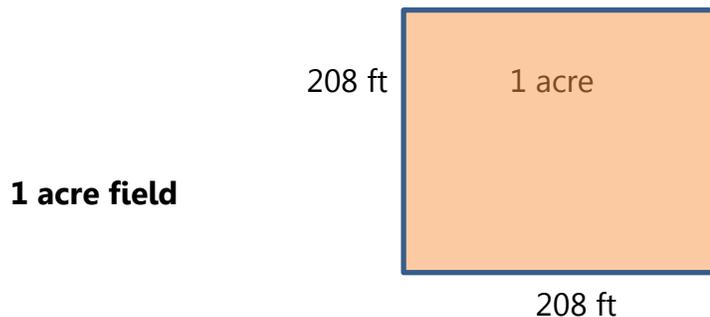
1 mile	=	1.6 kilometres (km)
1 kilometer (km)	=	1,000 meters (m)
1 meter	=	3.28 feet (ft)
1 foot (ft)	=	12 inches
1 inch	=	2.54 centimetres (cm)

3.3 Important Dimensions

- An acre is about 40% the size of a hectare. This means that two and half acres make up one hectare.
- A standard acre is about 43,560 square feet.

This means that for a one-acre field that is square in shape, each side will be exactly 208.7 ft (ie; $208.7 * 208.7 = \sim 43,560$).

208 ft



But it is very difficult to find a field that is perfectly square – most fields are rectangular in shape. And since the length of the sides for a rectangular field will not be fixed as is the case in square fields, you need to know how to determine where an acre ends by calculating the dimensions.

Problem. *You have a rectangular field that is 100 ft wide, how do you determine where an acre ends?*

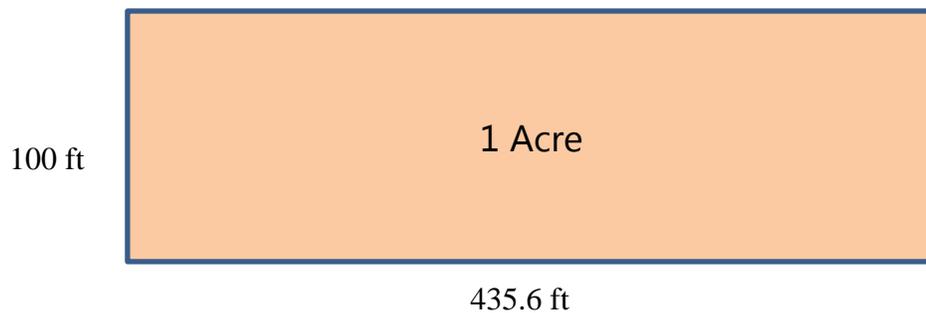
Solution

1 acre = 43,560 sq. ft. (Note that sq/ft means ft * ft)

You already have the length of one side=100 ft, so you only need to divide the 43,560 sq. ft by that.

= 43,560 sq ft / 100 ft = **435.6 ft.**

This means that when you measure 435.6 ft on the long side of the field, you will have reached the length of 1 acre for that field. From that point, you only need to cross the field to the other side in a straight line and join all 4 corners to demarcate your one acre.



Summary

Rectangular fields are the most efficient to manage. They make farming operations such as row planting and land preparation with tractors very easy. If your field is irregularly shaped, try to measure the sides in straight lines to the exact acreage you want to cultivate and carve out the excess parts on the sides that make the shape un-uniform. After measuring your field, if you confirm that you are cultivating

multiple acres, it is advisable to mount posts at the 1-acre boundaries. This will help you in managing your labour and other activities on your field much better.

In determining field sizes, always divide 43,560 by the measurement you got from the first side of the field (in feet). The figure you get from this calculation is the length you need to measure on the adjoining side to get 2 sides of an acre.

On the other hand, if you have already measured the length and width of a field and want to determine the size in acreage, the first step is to multiply the 2 figures. Now after multiplying them, you have to divide the product by 43,560. The result of dividing them is the size of the field in acres.

Example. If width=145 ft, length=670 ft.

Width * length OR $145 * 670 = 97,150$ sq ft.

Field size = $97,150/43,560 = 2.23$ acres

Assignment

Question 1

Your farmer asks for help in measuring the size of her cowpea farm so you go with her to the field with a measuring tape. Her field was rectangular and after measuring the 4 sides of the field, the dimensions you got were 215 ft, 860 ft, 215 ft and 860 ft.

- A. In total, what is the size of her field (in acres)?
- B. She tells you that she only wants to cultivate 1.5 acres so you should help her determine where 1.5 acres of her field would end. How will you determine exactly 1.5 acres of her field?

Question 2

A 4-acre rectangular field was cultivated to groundnut and maize. If the width of the field was 500 ft, what is the length of the field?

Question 3

One of your farmers measured his field and brought you the dimensions – 600 ft, 200 ft, 200 ft and 600 ft. Now, he tells you that he wants to cultivate 1 acre to

soybean, 1 acre to cowpea and the rest to groundnut. What will be the size of the field cultivated to groundnut?

CHAPTER FOUR

LAND PREPARATION

4.0 Introduction

Land preparation is usually the first activity carried out when the farming season begins, which is usually between the months of April and July. It is an activity which is very critical to the establishment of the farm and the farming operations that follow. There are three methods you can choose from when you decide to prepare your land. You can decide to do manual land preparation, Bullock ploughing or use of tractor. These three methods are discussed in the sections that follows.

4.1 Manual land preparation

In this message, we will discuss how to properly prepare your field manually if tractor services are inaccessible in your community or if you cannot afford to pay for a tractor to clear your field – you will need a good hoe, sharp cutlass, a lot of time and possibly a few neighbours to help you.

Like all other farm operations, it is advisable to start very early in the morning so that you can work for several hours before the sun comes out when it becomes more difficult to work. If possible, get extra hands to help you on your field so that you can return the favour when they are preparing theirs. For proper labour management, you should mark out and assign clearly defined portions of the field to all hands that will be assisting you on the field.

If the weeds on your field are very tall, you need to slash them with your cutlass until you can almost clearly see the ground or soil. You should know that **slashing does not kill weeds** so it should always be followed by hoeing. Slashing alone allows weeds to re-establish very quickly on your field.

Legumes require a tillage depth of at least 30 cm for proper root penetration and plant establishment so it is important to ensure that your hoe digs deep enough into the soil and so using a hoe with a big head will be very helpful.

However, average hoeing achieves a range of 10 to 15 cm of tillage depth so it might be necessary to carry out some kind of ridging on the field to attain the optimum tillage depth.

Remember, the weeds you clear from your field should not be removed or burnt. They will later decompose to become organic matter in the soil and make your land more fertile. Leaving the weeds on the field also helps conserve soil moisture which is very important because temperatures are generally very high in Northern Ghana and soil moisture is easily lost if not protected. In addition, leaving the cleared weeds on the field helps minimize soil erosion and controls growth of new weeds.

Manual land preparation is very hard work and even more so when the ground is very hard. So if you plan to prepare your field manually, you should wait for one or two rains when the ground becomes soft before you proceed to hoe your field and construct ridges. Remember, good land preparation improves soil aeration by loosening the topsoil enhances weed management by killing the weeds on the field and also enhances the moisture-holding capacity of the soil by improving soil structure.

Constructing Ridges

When constructing ridges, they must be done well and should be made across the slope of the field to prevent erosion of the soil when it rains. Properly constructed ridges help reduce weed growth, make farming operations easier and help the plants achieve proper root penetration. To construct ridges on your field, follow the instructions below:

- Use a rope and pegs to clearly mark out the field for the recommended inter-row planting distances for your variety.
- Using your hoe, heap up the soil (already loosened from hoeing) along the line marked out with the ropes. Make sure that the amount of soil you remove from the inter-row space is shared evenly between the two adjoining ridges. This will ensure that the ridges are all evenly sized.
- Do this for the entire field from one end to the other and you will have good ridges that create straight lines across your field.

4.2 Tractor ploughing

Mechanical land preparation through the use of tractors is by far the preferred method of land preparation in Northern Ghana because the traditional method of land preparation (manual) with hoes and cutlasses is very laborious and time-consuming. With the current increased access to tractor services, farmers are moving more towards tractor ploughing.

In most cases, all the farmer does is to inform the tractor operator to work on his/her field and is usually not present on the field when the ploughing is done. In this message, we will discuss mechanical land preparation and why it is advisable for you to be there on the day the tractor works on your field.

Before the day of ploughing, make sure you have slashed all tall weeds on your field. When you do this, the discs of the tractor will reach the soil more easily and turn the soil better. For good tillage patterns, **ensure that your tractor operator has a furrow wheel** – this helps keep the plough in straight line or in direction of traction which will ensure uniform ploughing across the field. A good tillage pattern reduces the time spent in non-productive work. The tractor operator should plan the ploughing in such a way that it minimizes the number of turns and maximizes the length of the tillage runs.

Ploughing should begin in the centre of the field and work out to the edges. The result will be a levelled field with open furrows on the edges of the farm and not in the middle. As always, ensure that the tractor operator ploughs across the slope. Note that **if you plan to ridge your field, the tractor operator has to set the plough to a depth of about 30 cm.** If this is done, it will be easy to create ridges on the field. It is therefore very important that on the day of ploughing, you are present on the field to ensure that the tractor operator adheres to all the above guidelines necessary for good ploughing.

Figure 1 Mechanical land preparation



4.3 Animal Traction.

Another method by which you can till your field is by the use of animal drawn ploughs. If draught animals are used for land preparation, the quality of the tillage will depend on their training. Also, their age will suggest how long they can work. When using bullocks to prepare your land, check their age and make sure they are not too young or too old. Some farmers can tell the age of a bullock by observing their teeth.

Good tillage requires good training. Animals with equal or similar size and heights should be re-trained and well-conditioned before the first rains so that they are ready to work well during land preparation. Draught animals are normally weak at the beginning of the rains when there is little food so you should give them extra feed to make them strong for tillage work. **A bull should be at least three years old to start ploughing.** The depth and width of the cut of the plough should be correctly set. **Always remember that you need a tillage depth of at least 20 cm for legume cultivation.**



Figure 2 Animals ploughing

Ploughing fields by animals or tractors sometimes results in soil with large clods which is not good for legume cultivation. If you observe this on your field after ploughing, you need to harrow. Harrowing can be done manually with a hoe or by a tractor with a harrow attached. Harrowing breaks up all the clods and levels the field for planting activities.

Remember; do not leave the tractor operator to plough your field without your supervision. They might not do it properly and this would result in bad crop establishment. And you might even have to spend extra time and resources to work on the field again before you can plant. Follow the above guidelines and you will be on the way to a good harvest.

4.3 Benefits of proper land preparation

Time efficiency in subsequent farming seasons

After land preparation, the first major activity to be carried out on your field will be planting. After this, there will be other activities such as weeding, fertilizer application and harvesting. If land is properly prepared, dibbling to plant your seeds will be easier because the soil would have been loosened for easy penetration of your dibbling stick. The same applies to fertilizer application if you will be burying your fertilizer. **A poorly prepared field results in quick re-establishment of weeds**, which means you will have to weed more times than another farmer who properly prepared his/her field. Also, using a hoe to clear weeds on a poorly prepared field is always more labour-intensive because the soil may still be very compact making it more difficult for the hoe to reach the roots of the weeds.

For groundnut—because its pods are formed under the ground, it is wise to ensure that you loosen the soil to the right depth during land preparation. Otherwise, the pegs of the groundnut will find it very difficult to break through the hardened soil to form pods. And even if they do, during harvest, a field that was not properly tilled to the right depth will surely have some pods remain in the ground due to compaction of soil.

Note: SSP & TSP fertilizers contain phosphorus and calcium and must be buried.

Higher rate of seed germination

Even if you purchase certified seeds with very good germination test results, your seeds will germinate poorly if the field on which you plant them is not properly prepared. Imagine a situation where after ploughing, you do not harrow your field to break down the large lumps of soil to create a level ground. Seeds do not need nutrients to germinate— they already have all the nutrients they need stored in them. **What seeds need to germinate is moisture from the soil.** So if you did not harrow after ploughing, your seeds will struggle tapping water from the big and hardened lumps of soil to germinate well.

Optimal crop establishment

Good land preparation should result in the right depth of tillage on your field. For groundnut, cowpea and soybean, this depth should be about 20 cm. If you are able to achieve this depth after tilling your field, the soil will be loosened to the appropriate level and will allow for the roots of your plants to penetrate and tap nutrients and moisture from the soil without stress. This will make it easier for your plants to establish on your field early and will not be easily disturbed by wind, human movement or other environmental factors that threaten the establishment of your crops.

4.4 Benefits of early land preparation

Land should be prepared as early as possible to ensure early planting which gives your crops an advantage over pest and diseases that are likely to occur during the growing season. Remember ploughing and harrowing once or twice will provide good root growth that enables plants to get moisture from the soil. The following are the reasons why you need to plough your land early enough.

Reduction of competition over limited land preparation resources

Unfortunately, limited supply of tractor services causes significant delays in farm activities. This is because everyone waits until late to begin preparing the field. If you decide to prepare your field earlier, you will be able to secure a tractor operator before the peak time arrives when they are very scarce and difficult to find.

Sufficient time for organic matter decomposition

We advise that farmers should not burn the weeds on their field after land preparation. This is to allow the weeds decompose and form organic matter for the soil to make it richer and provide more nutrients for the crops. However, it takes time for cleared weeds, crop residues and other organic matter to decompose. By

preparing your field early, you will have more time for these materials to decompose and enrich the soil so that by the time you plant and your crops establish, the decomposed materials will be able to supplement the nutrient needs of your crops.

Reduced possibility of plant pests

A significant percentage of plant pests are migratory, which means that they move from place to place depending on the time of year or season. If you prepare your field and plant early, by the time pests arrive your plants would have advanced in growth and strength thereby reducing the damage that can be caused by pests.

Reduced possibility of diseases

Diseases are caused by pathogens which spread from field to field through the air, water or by agents such as humans and insects. Pathogens need to infect crops at specific stages in order to result in economic loss for you. If you prepare your field early and plant at a time when all others have not done so, the chances of your farm getting infected by pathogens from a different field are reduced drastically. By the time pathogens become present in your area, your crops would have passed the stage of infection. Hence, your field will not suffer from those diseases but if it does, it will not result in significant economic losses for you.

Guaranteed higher yields

All the factors mentioned above come together to ensure very healthy and conducive conditions for your plants to do well. Therefore, by preparing your field early, you would have started a chain of events that will lead to high yields at the end of the farming season.

4.5 Factors that determine method of land preparation

1. Availability of tractor services
2. Availability of labour
3. Farm Size

4. Financial resources (money)
5. Density of the bush on the field
6. Time of the season

Summary of land preparation steps

1. Slash the field and cut down all tall weeds and grasses (using both manual and mechanical methods)
2. Till the land and ensure a tillage depth of about 20 cm. Remember you need a tillage depth of 30 cm for your soybean. When using a tractor, make sure the operator sets the plough discs at the right level for this depth. If manual, get a hoe with a big head and make sure you dig deep to achieve this depth. If you do not achieve it, follow ridging instructions to construct ridges on the field.
3. After ploughing with a tractor, examine the field to make sure it does not have excess of large lumps of soil. If you have these lumps, make sure you harrow the field to level it. If manual preparation is used, be sure to break up huge lumps of soil with your hoe as you move along the field.
4. To avoid erosion of the topsoil from your field when it rains, make sure you always plough across the slope of the field. If your field is unevenly sloped, make sure to plough in a direction that is always against the slope. So parts of your field can be ploughed from north to south while other parts are ploughed from east to west depending on the slope on particular areas of the field.

CHAPTER FIVE

USING CERTIFIED SEEDS

5.0 Introduction

The seeds you plant play a very important part in deciding what your harvest will be at the end of the season. There are several varieties of groundnut, cowpea and soybean that have been developed and released by CSIR-SARI and CSIR-CRI (Crop Research Institute) which are cultivated throughout the country. These varieties are high-yielding and therefore can provide you with good yields. For groundnut, some of these improved varieties are Chinese, Nkatiesari, Kpanielli, Manipintar, Edoorpo-Munikpa, Gussibalin, Nkosuor, Azivivi, Adepa and Jenkaa and for cowpea, some of the improved varieties are Apaagbala, Songotra, Padi-tuya, Marfo-tuya, Bawutawuta, Zaayura, Asutenapa, Vallenga and Bengpla. Some examples of improved varieties of soybean are Jenguma, Salintuya I, Salintuya II, Quarshie, Anidaso, Suong-Pungun, Songda and Afayak. Jenguma is low-shattering, high oil content and with very good and attractive grain colour.

It is important to know that all these different varieties have their special attributes. Your CEA can take you through the details of all the different varieties and how they vary from each other. With this information, you can then decide together with the CEA or AEA on which of the varieties will be most appropriate to cultivate in the current farming season.

There is however, one very important thing you should remember-- the best seed you can plant are certified seeds which are available for all the varieties. These certified seeds are usually contained in sacks, packets, or boxes which are endorsed by a certification scheme. The certification scheme is backed by national legislation and international regulations to ensure seeds produced and sold meet set standards. In this message, we are going to discuss the benefits of using certified seeds.

The first thing to know when you decide to use certified seeds is that if you recycle them over a long period of time, they lose their potency and become like ordinary seeds. It is advisable that you recycle them for at most 2 or 3 seasons before purchasing another set of certified seeds for your farm. A quality seed is one that has high germination percentage, suits your farming conditions and still maintains the major traits characteristic of the variety. All these will gradually reduce over time resulting in lower yields if the seeds are recycled for a long period of time so it is important to purchase seeds again after a few seasons if you cannot always get new seeds each season.

After discussing with your CEA or AEA and deciding which variety of groundnut, soybean or cowpea to cultivate this season, obtain directions to certified input dealers from your CEA or AEA. Remember that not all seeds sold in the market are certified so it is very important to get directions to certified dealers where you can get seeds that have been certified and approved by MoFA. If possible, make arrangements with fellow farmers to buy the seeds together as this would reduce the cumulative cost involved.

When buying the seeds, do not buy more than you need for your current season because they might get damaged in storage or you might need to change varieties for the next season. Also, buy slightly more than the exact amount you might need for the size of your field just in case some seeds do not germinate and you need to refill.

Remember that the seed you use is one of the most critical decisions you have to make concerning your farming. If you use poor seeds, you will not be able to get a good harvest even if you apply the recommended amounts of fertilizer and practice all the agronomic best practices we will be sharing with you this season. So if you have not used certified seeds in the past 2 or 3 years, kindly purchase them for this season and you would have taken the first step in ensuring a good harvest.

5.1 Benefits of using certified seeds

- Certified seeds on average provide higher germination percentages as compared to non-certified seeds. This means that if you cultivate certified seeds, you will most likely be spending less time on refilling your fields for un-germinated seeds. This saves you time that can be invested in other activities.
- Certified seeds are usually uncontaminated. This means that if you use certified seeds, they will be pure for the variety they represent. For uncertified seeds, chances are always high of having one or more varieties mixed together resulting in plants with different traits on your field – e. g. short plants with tall plants, white-grain with coloured grains, etc.
- Certified seeds have characteristic traits expressed fully. Crop varieties are developed for particular traits such as drought resistance, grain colour, grain size, disease resistance, etc. From continuous recycling of seeds, these traits identifiable with specific varieties are gradually lost. With certified seeds, however, due to careful breeding and selection, the seeds provided are entirely pure to the varieties they represent and will most likely fully express the traits for which they have been developed.

CHAPTER SIX

GERMINATION TEST

6.0 Introduction

In farming, almost everything begins with your seed. Ironically, however, farmers do not pay much attention, or invest as much as they should, in the seeds they plant. When you sow poor seeds, even good fertilizer application cannot provide you with the potential yield. It is therefore very important to ensure that the seeds you plant are of the right quality.

Buying certified seed is the first step in ensuring that you have a good harvest because they perform better than uncertified seeds. Due to the unpredictable nature of the rains, it is not advisable to wait for the actual sowing in the field to confirm whether or not your seeds are of high quality.

In order to be sure of the quality of your seed even before planting time, **it is important to conduct a germination test to determine the viability** (emergence rate) of your seed sample. This is basically performed to determine what proportion of seeds planted will germinate under favourable conditions and produce normal seedlings (seedlings that have the essential structures – roots, shoots and sufficient food reserve) capable of development into reproductively mature plant.

If you conduct a germination test, you will be able to determine ahead of time what seeding rate would be the most appropriate and also save the time spent on subsequent refilling or thinning. This message will teach you how to carry out a germination test properly to know the quality of the seeds you intend to plant.

It is advisable that you conduct the germination test at least two weeks before the date you have scheduled to sow your seed. This gives you enough time to get new seeds if your current seeds fail the test.

6.1 Conducting a germination test

Follow the instructions below carefully to conduct a successful germination test:

- a) Get a small piece of land very close to your house that is somehow similar to your actual field or farm. If your farm is quite close to your house, you can conduct this germination test on it. This way, you will be able to provide the care and protection needed to ensure reliable results.
- b) Now that you have acquired your germination test plot, mark out an area of about 7 ft x 7 ft. This plot size is big enough to contain the seeds you will use for the test but also small enough for easy care and management.
- c) Clear all the weeds on the marked out area of the plot and leave them on the soil. This will help the soil retain more water which helps in germination.
- d) Use your hoe to till the soil to make it loose – the same way you do on your real farm during land preparation before you sow your seed. This will make it easier for your seed to germinate. A well prepared land for your germination test should look like what is in Figure 3 below.



Figure 3 A well prepared land for a germination test

- e) Now count out 100 seeds or more from the seeds you intend to sow this season. Make small holes the size of your thumb in the soil and place your seeds in them. Gently cover every seed you placed in the hole with soil.
- f) You can water the plot right before you sow or immediately after you  have sowed. Whichever you decide, make sure that you water the plot sufficiently (without logging it) on the day of sowing.
- g) Now that your seeds have been sown, you have to protect and take good care of the plot to ensure that your results are reliable. Water every two days if necessary and keep away fowls and other pests that may try to pick the seeds or feed on the young plants.

From the fourth day after sowing the seeds, the seedlings should begin to emerge but you should wait for at least 6 to 7 days to take the results of the test because some of the seeds might germinate later than others even if they are also good. **If a seed has not germinated after 7 days then it means there is a problem with that seed.** Now that your seeds have germinated, you should count the number of seeds that have emerged.

6.2 Calculating the Germination Percentage

The rate of germination is calculated in percentages. This means that you should find a way of converting the results of your test into a percentage. The easiest way to get a percentage is to **use exactly 100 seeds for your germination test.** In that case, the number of germinated seeds is the same as the percentage of the germination rate. However, if you have a very large field which requires several bags of seeds for sowing, testing only 100 seeds might not give you a true representation of the whole sample of seeds. Below are two simplified methods you can use to test your seeds and get your percentage germination.

Method 1- Multiples of hundred seeds

1. Count the number of seeds you want to use in multiples of 100. You may use 200, 300 or 400 seeds.
2. Now divide the number of seeds you decided on by 100 to get the number of germination test plots you need. For example, if you decided on 400 seeds, dividing by 100 will give you 4.
3. Now you need to create 4 test plots as described in the extension message script above.
4. On each of the 4 test plots, plant exactly 100 seeds.
5. After about a week, count the number of emerged seeds on each of the plots and add them up. For example, if 82, 73, 89, and 69 seeds germinated on plots 1, 2, 3, and 4, respectively then the calculation is as follows: 82 on plot 1 + 73 on plot 2 + 89 on plot 3 + 69 on plot 4 = 313 total germinated seeds
6. Now divide the total number of germinated seeds by the number of test plots used. i.e. $313/4 = 78.25$

The result you get is the germination percentage of your seeds. In this case it is 78.25 %, which implies that you should sow 3 seeds per hole.

Method 2 – Desired number of seeds

1. Count out your desired number of seeds for testing. E.g. 280 seeds
2. Create a bigger test plot and sow all the seeds (280) you decided on
3. After emergence, count all the seeds that germinated. E.g. 245
4. Now, divide the number of germinated seeds by the total number of seeds sown and multiply by 100 i.e. $245/280 = 0.875$. So $0.875 \times 100 = 87.5 \%$.

With the germination percentage of 87.5%, you can plant 2 seeds per hole.

Refer to the table below for interpretation of your germination test results.

Germination test result	Seed grade	Action to take
85 or more seedlings emerged	Very good seed	Plant 2 seeds per hole
60 to 84 seedlings emerged	Good seed	Plant 3 seeds per hole
Below 60 seedlings emerged	Bad seed	Get different seeds

Before purchasing certified seeds from your input dealer, inquire about the guaranteed germination rates of the different brands available. It is advisable to buy the one with the highest germination rate (written on the pack) if they are all the same variety. Some dealers also guarantee germination rates and allow customers to return the seed if they experience germination rates lower than what is indicated on the pack. So, make sure you talk to your input dealer before you make the decision on which seed to buy.

Seeds bought from uncertified sources are not recommended because they are usually of poor quality and might be a mixture of two or more different varieties.

Conducting a germination test helps save money and time. Without a germination test, you might spend more time on refilling if your seeds turn out to be of low quality. Also, conducting a germination test helps you to estimate more accurately the number of seeds to place per hole. You will therefore spend less time thinning your plant stands if the seeds were of very high quality.

Additional Information/Summary Highlights

6.3 Benefits of conducting a germination test

1. It helps inform you on how many seeds you should sow when planting your field
2. It helps you know ahead of time whether or not the seeds you intend to plant are of good quality or not

CHAPTER SEVEN

INOCULATION OF LEGUME SEEDS

7.0 Introduction

All crops depend on nutrients from the soil to develop and grow well. Examples of the **major nutrients required by plants are nitrogen (N), phosphorus (P) and potassium (K)**. Most fields require these nutrients to be added through mineral fertilizers or organic supplements to supply these nutrients in the quantities needed to support good yields.

Legumes have the ability to convert nitrogen in the atmosphere into forms that can be used up by the plant from the soil. They are able to do this because they have certain microorganisms (precisely some strains of bacteria called rhizobia) that invade their roots. Biological nitrogen fixation thus occurs as a result of the symbiotic association between a leguminous crop and a compatible rhizobia. The symbiotic association between the rhizobia and the host legume is such that the host legume provides nutrition for the bacteria and the rhizobia fixes nitrogen for the plant. Unfortunately, only legumes have the ability to do this – your cereal, root, and tuber crops cannot do this. In order to take advantage of this miraculous association of bacteria and leguminous plants, it is often necessary to provide dependable legume inoculants to ensure effective nodulation of leguminous crops. The application of these bacteria to seed or soil is called inoculation.

The advantage of this ability to you is that you might not need to provide as much supplementary nitrogen to the crops and therefore need to focus on the P and K that the soybean, cowpea and groundnut will depend on heavily.

7.1 Inoculants application

Now, let's get back to the bacteria in the roots that help the fixation of nitrogen from the atmosphere into the soil. **Soybean and cowpea can obtain between 50**

to 75% of the nitrogen they require from fixation if the bacteria that convert it are well established and form nodules on the roots. If this process is happening well, you will only need to supply a little nitrogen fertilizer to get a very good yield. As mentioned in the introduction above, sometimes, these bacteria do not get well established on their own – that is where you come in! In this message, we are going to teach you about inoculation – this is the process you will use to ensure that these rhizobia in the form of inoculants are present to help in trapping the nitrogen from the air.

The inoculants can be produced in a liquid, granular or a powder form. They can be used by applying them onto the seeds before sowing. Because these are living organisms, they are only produced at the laboratory and have to be handled with care after you purchased them. Note that you should only purchase the amount you will need for a season when it is close to the start of the season though you can sometimes buy and store them like fertilizers or other chemicals if only you can follow the instructions that come with them. Upon purchasing the inoculants, you will receive more instructions on how to handle them before applying onto your seeds.

After you have applied the inoculants to the seeds, do not wait for too long before sowing the inoculated seeds. When the seeds begin to germinate, the microorganisms (called **rhizobia**) invade the root hairs of the seedling and begin to multiply. Small balls (nodules), which contain the bacteria (i. e. the rhizobia) will begin to form on the roots in the soil. Under the right field conditions, the first small balls should form within three weeks after the soybean, groundnut & cowpea seedlings have emerged—they become more visible as they increase in size.

To determine whether there is nodule formation, gently pull out few plants of your leguminous crops on the field. You should be able to see nodules on the roots of the plants as shown in Figure 4 below.



Figure 4 A cowpea plant with nodule formation on roots. Source: M. Fosu, SARI-Ghana, Tamale

Between weeks 4 and 5, the organisms will begin the conversion of nitrogen from the air for use by the plants. From this stage onwards, the number of small nodules and corresponding amounts of nitrogen trapped by the organisms will increase steadily. Note that **demand for nitrogen in soybean, for example, is highest from weeks 11 to 14** (late varieties) when seeds are being formed and developed.

Inoculation does not completely replace nitrogen fertilizer application because at best nitrogen fixation can only provide an average of about 75% of the needed nitrogen by the soybean and cowpea plant but it reduces the amount of nitrogen fertilizer needed significantly. Comparing the cost of inoculants (about GHC20.0 per acre) to fertilizers and their corresponding contributions of nitrogen to the soil for use by your crops, it will always make more sense financially to invest in inoculants to boost the nitrogen supply to your plants. You can apply small amounts of mineral nitrogen fertilizers to your fields between weeks 1 and 2 to boost the initial growth of the plant but note that too much nitrogen fertilizer at this stage can suppress the positive effects of the inoculation.

Inoculation is strongly recommended if you will be cultivating an entirely new field. Also, **if your field has not been cultivated with soybean, groundnut or cowpea for over three years, it is highly recommended that you adopt inoculation in the current season for good yields.** Inoculation is also highly recommended if your field has recently been flooded for over a week because floods create anaerobic conditions within the soil which adversely affect any native rhizobia and make it difficult for the legumes to grow well if not artificially inoculated.

Inoculation is a new technology in northern Ghana but people who have used it have seen positive results and improvements in their yields. Like all new things, you might not want to readily accept it but it can surely boost your yields if you decide to use it.

7.2 Benefits of using rhizobium Inoculant

High legume grain yields

Using inoculants on your seeds will result in higher grain yields of legumes. Even if you are unable to purchase and apply costly fertilizers to your crops, your crops can still perform significantly better if you inoculate your seeds before planting.

More nutritional grains

Grains produced from inoculated plants show higher levels of protein as compared to non-inoculated crops. This added protein enriches the diet of the household and fights protein deficient conditions such as kwashiorkor.

Residual nitrogen substitutes for N fertilizers

When you apply inoculants to your seeds, the plants' ability to fix nitrogen from the air into the soil is significantly increased. This means that you will not need to apply NPK to your field to provide additional nitrogen. Also, if you practice crop rotation on the field and follow your soybean with maize, the extra nitrogen that remains in

the soil after cultivating inoculated soybean (or cowpea and groundnut) will reduce the amount of NPK you will need to apply for your maize crop to do well.

Extra nitrogen from decomposition

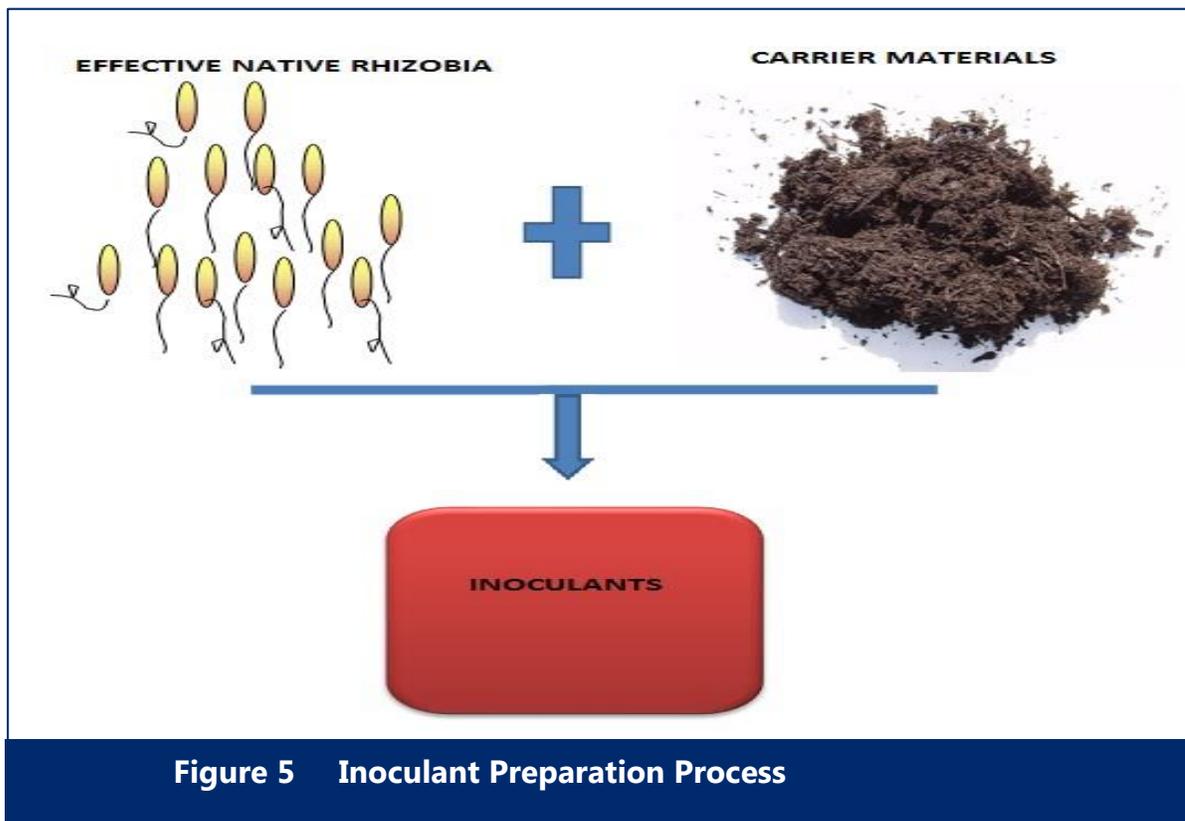
Inoculated crops grow healthy and produce nitrogen-rich green leaves. After harvest, the leaves or biomass can be left on the field to decompose and form a very rich organic matter for your soil. In the decomposition process, nitrogen and other nutrients are released into the soil which become available to the crops grown on the particular field.

7.3 Composition of Inoculants

The inoculant material you purchase consists of (i) a sticker material that is used to bind the rhizobia onto the seeds (examples of a sticker are Gum Arabic (10%), Sugar solution (20%), honey, evaporated milk, etc.), (ii) a carrier (e.g. peat, bagasse, etc.) and (iii) the bacteria (Rhizobia).

7.4 Materials needed for inoculation

1. A medium-size container with air-tight lid or an open one
2. Water that shouldn't contain heavy metals
3. Tablespoon/coca cola bottle lid/ mineral water bottle top
4. Wooden stirrer/spatula. Any other appropriate material can be used as a stirrer
5. Sticker – dissolved earlier in warm water but allowed to cool
6. Rhizobium inoculants



7.5 Practical steps to inoculant application

Slurry method

If the inoculants supplied contain stickers, there is no need to apply more before adding the inoculants.

Steps

1. Pour 2kg (one olonka or kruga) of certified seeds into the medium-size container
2. Sprinkle small amount of water onto the seeds; this is to ensure adhesion of the inoculants on the seeds. DO NOT WET THE SEEDS
3. Gently stir to ensure uniform mixing of the seeds and water

4. Using a tablespoon or mineral water bottle top measure and pour the inoculants onto the seeds. A mineral water bottle top-full of inoculants weighs about 5g.
5. Cover the plastic container with the lid
6. Swirl gently to ensure proper mixing and adhesion of inoculants onto the seeds.
7. If you are using a container without a lid just stir the inoculant-seed mixture gently and carefully with the stirrer.
8. Occasionally remove the lid and check for proper mixing.

Note: Seeds turn black or dark when properly coated with the inoculants. Depending on the colour of the carrier used the colour of the inoculated seeds can be different. So it isn't that it is always black or dark.

7.6 Common Types / Forms of Inoculants

1. Liquid
2. Granular
3. Powder **inoculants**



Figure 6 Seeds coated with inoculants



Figure 7 Scientist preparing in the laboratory

7.7 Guidelines for Storing

Inoculants

The bacteria in the inoculants are perishable and as such it needs to be handled properly.

- i. Rhizobium bacteria are sensitive to heat and sunlight. Do not leave the packages lying in the sun or under a metallic roofing sheet
- ii. Unused inoculants should be stored in a cool location; a refrigerator (4°C) is best.
- iii. Use legume inoculants before their expiry date and avoid or discard all expired stock.
- iv. Inoculants can be stored for up to six months in a well-sealed ceramic jar and buried in a shady spot underground. The jar should be covered with a thick wooden lid to serve as protection as well as insulation from heat
- v. Once inoculants are opened, reseal inoculant package to avoid contamination and moisture loss
- vi. Plant immediately after inoculation (within 24 hours).
- vii. Never store inoculated seeds for next planting because it is best to inoculate seeds just before planting. Otherwise, re-inoculate the seeds before you sow them
- viii. Avoid freezing temperatures

CHAPTER EIGHT

TIMELY AND PROPER PLANTING

8.0 Introduction

In this message, we will learn about proper timing for planting, distance to use when planting and also good techniques for planting soybean.

In Northern Ghana, the right time for soybean pre-planting activities is May so that planting can be done between June and mid-July. Around this time, most households would have finished planting their maize fields which is considered as the primary crop. Also, most communities would have recorded enough rainfall making the ground moist and suitable for sowing which helps seeds to germinate easily. Note that **the longer your seeds stay in the soil before germination, the more susceptible they are to soil pests and diseases**. Do not sow unless you have recorded at least three heavy rains.

Also, note that if you plan to intercrop your soybean into maize, your time of sowing the soybean will depend on the growth stage of the maize. The message on intercropping will talk more about the different types of intercropping systems and their accompanying times of planting.

The second factor you should consider when sowing is the planting distances to use between rows and within rows. The planting distance you use on your field will depend on the variety you cultivate, the layout of your field and the intercropping method you choose (row, strip or mixed).

8.1 Timely and proper planting of soybean

Soybean can be sown on ridges or on a flat and plain field. For early-maturing soybean varieties such as **Songda** and **Suong-Pungun**, the recommended planting distances on ridges are 75 cm x 20 cm if dibbling and 60 cm x 5 cm if drilling. The recommended planting distances when sowing on the flat ground are 60 cm x 10 cm if dibbling, and 60 cm x 5 cm if drilling. Sowing seeds more than 2-5 cm deep is

not recommended as deeper planting may result in loss of vigour or failure of seedling to emerge.

For medium and late-maturing varieties such as **Anidaso**, **Jenguma**, **Quarshie**, **Salintuya 1**, **Salintuya 2** and **Afayak**, the recommended planting distances on ridges are 60 cm x 10 cm if dibbling and 60 cm x 5 cm if drilling. For a plain field, the recommended planting distances are 60 cm x 10 cm if dibbling, and 60 cm x 5 cm if drilling. Maintaining the above spacing on your entire field provides adequate space for your plants to grow well, minimizes competition, suppresses weed growth and facilitates effective nitrogen fixation into the soil. Adequate spacing between rows also provides good sanitation, helps improve upon farm operations and maintain the optimum plant population for your field.

Follow these instructions when seeding or planting your field to obtain an optimum plant population:

- a) All drilled fields (both flat and ridged) should have only 1 seed per hill.
- b) A dibbled flat field should have 2-3 seeds per hill
- c) A dibbled ridged field should have 2 rows of soybean per ridge (on sides, not valley) and have 2-3 seeds per hill

If the above recommendations are followed, a plant population of about 128,000 should be obtained on drilled fields versus 134,000 on dibbled fields per acre for short- maturing varieties. For the medium/late-maturing varieties, a plant population of approximately 102,000 should be obtained for both drilled and dibbled fields.

Note, however, that if you are intercropping your maize with soybean, the plant spacing for your soybean crop will depend on the layout of your maize field and the planting distances of the maize. Therefore if you decide to practice intercropping, take into account the planting distances for the soybean when you are planting your maize seeds. **On average, you will need about 16 kg of soybean seed per 1 acre of land.**

To plant soybean seeds correctly, you need to use the appropriate seeding depth. Your seeds should be placed in the soil between 2.5 to 5.0 cm deep (about $\frac{3}{4}$ of your thumb or little finger). **Never exceed 5.0 cm (full thumb or index finger)**

when placing your seeds in the soil – this will result in lower emergence and poor plant stands. If you are planting early in the season **when there is a lot of rain, you should plant at about 2.5 to 3.8 cm deep**. This is because the wet soil clogs the seed hole thereby making it difficult for the developing seedling (the plumule) to emerge resulting in the death of the seedling. As with every other crop, it is advisable that you plant your soybean in neat rows on your field. This makes farm operations such as fertilizer application, weed management and harvesting very easy. It also improves upon the sanitation on your farm.

Keep the factors we discussed in mind when you decide to plant your soybean and it will help you in establishing a good crop stand for a high yield. Figure 8 is an example of properly spaced soybean farm.



Figure 8 A well-spaced soybean farm

8.2 Timely and proper planting of groundnut

Now that you have completed preparing your field and have tested the germination rates of your seeds, the next activity to carry out on your field is planting which can

begin as soon as there is enough moisture in the soil. In this message, we will be discussing the preparations you need to make before planting and the right way to sow your groundnut seeds.

During land preparation for groundnut, a plough depth of 15-20 cm should be ensured. On the day of ploughing, you should be on the field with the tractor operator to ensure that the discs of the tractor are set correctly to this plough depth. If the soil is lumpy after ploughing, you should harrow the field to ensure a fine tilth and levelled ground.



After land preparation, it is good to wait for about 2 or 3 good rains before you plant your field. Ideally, planting should be done between April and June because late planting (from July onwards) usually results in lower yields and is therefore not advisable. However, planting too early can cause your whole crop to fail if the rains are followed by long dry spells. It is advisable to listen to the radio or consult your AEA to be sure that the rainy season has begun.

Before sowing your seeds, you should clearly mark out the rows with pegs and lines. Row planting has many benefits for your farm as you will be able to carry out farm operations more efficiently. Also, planting in rows makes it easier for you to achieve the optimum plant population on your field which will help you achieve the best yield from your farm.

When sowing your groundnut seeds, they should be placed at about 5 cm deep, which is about the length of your little finger. After placing the seed in the planting hole, do not compact the soil over the seed excessively. Cover the seed with soil and press down gently to ensure good contact between the seeds and the soil to facilitate high germination rate. Compacting the soil too much will make seedling emergence more difficult as seedlings will struggle to break out.

Groundnuts can either be sown on level ground or on ridges. Ridges should be used only in areas that are very wet as ridging is labour-intensive.

The next thing you should consider when sowing your seeds is the planting distances. There are three main spacing types you can use for your groundnuts: 60 cm x 10 cm, 60 cm x 20 cm and 50 cm x 20 cm. You should use either 60 cm or 50 cm between rows and 10 cm, 20 cm or 30 cm between plants. Use a measuring tape

to measure these distances when sowing your field. It is, however, very important to know that the spacing you use depends on the variety you cultivate which will in turn also determine the amount of seeds to use per acre. **The most common groundnut varieties are Chinese, F-mix, Kpanielli, Nkatie-SARI, Sinkarzie and Mani Pintar.**

With the right plant spacing, a plant population of about 90,000 plants can be achieved per acre. Remember: talk to your AEA or CEA to help decide which variety to cultivate and he/she will advise you on the most appropriate planting distance to use.

8.3 Planting periods in Northern Ghana

Groundnut-Between May & Mid-June

Soybean -Between June and mid-July

Cowpea - With the 1st rains OR 2nd half of July to 1st week in August

8.4 Estimated seed rates per acre

Groundnut – 18-20.0 kg/acre

Soybean- 16.0 kg/acre

Cowpea – 8.0 to 10.0 kg/acre

8.5 Benefits of Timely and proper planting

- a) Timely planting helps your plant escape or avoid severe disease and pest situations
- b) Well-timed planting makes your crop take advantage of the rains and avoid dry spells
- c) Well-timed planting ensures that your crops reach maturity after the rains have ceased
- d) Proper planting with the right distances ensure that you attain the right plant population on your field for optimum yield at harvest time

- e) Properly planted fields make subsequent farming operations such as fertilizer application and weeding much easier and more efficient
- f) Properly planted fields reduce subsequent time spent on refilling and thinning
- g) Proper planting reduces seed wastage as a result of overplanting.

8.6 Plant spacing and arrangement

There are two kinds of plant spacing that should be considered when planting your field:

- 2. Inter-row spacing** refers to the distance between one row and the next. If your field is a ridged one, your inter-row spacing refers to the distance between neighbouring ridges of your field.
- 2. Intra-row spacing** refers to the distance between a plant and the next on the same row.

Plant spacing varies according to crop plant variety. Plant spacing for long-maturing varieties might vary from spacing for short- and medium-maturing ones.

Remember that using the recommended planting distance is very important in ensuring a good plant stand and maintaining the optimum plant population per acre as well as the plant density of the field.

8.6.1 Planting distance for groundnut

Sow groundnut at about 5 cm deep. The recommended spacing for groundnut is as follows: 50 x 20 cm at 2 seeds per hill or 50 x 10 cm at 1 seed per hill. This gives an optimum plant population of about 200,000 plants per hectare.

8.6.2 Planting distance for cowpea

Seed rate depends on the plant type and seed size. Usually, when sowing erect/semi-erect types the recommended spacing is 60 cm x 20 cm at 2 seeds per hill. At this spacing, up to 28 kg of seed is required per hectare. Local prostrate varieties should be sown at a wider spacing of 80 cm x 40 cm. More seeds are required if erect varieties are used than when prostrate varieties are used because of

the closer spacing of the erect varieties. Select good seeds that are not damaged or wrinkled for sowing.

To obtain a good emergence and initiate plant development, sowing should be done in a moist (but not wet), warm and well-settled soil. A sowing depth of 2.5 - 5 cm is satisfactory for cowpea. Sowing seeds deeper than 5 cm will delay emergence and final seedling stand will be uneven. However, seeding depth less than 2.5 cm may also result in poor emergence due to the drying of the soil surrounding the seed. The seed should be covered with soil for good seed-soil contact to aid germination.

8.6.3 Planting distance for Soybean

Soybean can be sown by hand or by a planter. Plant one seed per hole at a spacing of 75 cm between rows and 5 cm between stands.

Alternatively, drill seeds at 50–75 cm between rows and 5 cm within rows. For the early-maturing varieties a spacing of 50 cm between rows and 5 cm within rows is recommended because they respond better to narrow spacing than the late-maturing varieties. **Do not sow seeds more than 5 cm deep.** Deeper sowing may result in loss of vigour or failure of seedlings to emerge.

8.7 Ensuring proper plant density

- Thin out extra seedlings to achieve the recommended population.
- As soon as seedlings emerge, fill in the missing hills by re-sowing with seeds of the same variety.

Important Considerations

- a) You should always know the maturity duration of your crop and the particular variety you intend to plant
- b) You should always plant as early as possible once you have recorded about 3 rains within the window of planting (months) stated above.

Terminologies

Dibbling is a planting or fertilizer application method where a long stick (dibbling stick) is used to create holes in the soil. Usually, one person is responsible for making these holes on the entire field and usually leads the line. A second person then follows with the seeds in the hand or in a bowl and places them in the holes made and covers them up.

Drilling is planting or fertilizer application method where a stick is used to make a long line or channel from one end of the field to another. The farmer may even make this line with his foot. After the line has been created, the farmer then moves along to place the seeds in the line. After placing the seeds, the line is then covered with soil. Usually with drilling, it is very difficult to maintain the proper plant spacing. So drilled fields are usually refilled and thinned after emergence of the seeds.

CHAPTER NINE

REFILLING AND THINNING

9.0 Introduction

If you desire to get good yields at the end of the season, plant population is one of the important factors you need to consider to help you reach that goal. This is because your yield is determined by the number of healthy plants you have on your field and how they interact with other factors such as rainfall, soil fertility and the incidence of pests and diseases.

After germination, there are three possible outcomes: Your field may either be optimally populated, under-populated or over-populated. If you go according to our previous message on proper sowing, getting an optimum plant population should be easier. However, some seeds might fail to germinate which will result in empty patches or spots within your field – this will ultimately result in under-population and lower yields. On the other hand, if you used a highly viable seed and all your seeds germinate, you will be faced with an over-populated field which will also ultimately result in lower yields as a result of increased competition for limited soil nutrients, moisture, space, etc. Should you observe a similar situation as shown in Figure 9, fill in or thin out to obtain an optimum plant population on your farm.



Pic 23.1A -- Poorly germinated field (no refilling done)



Pic 23.1B -- Overpopulated field (no thinning done)

Figure 9 Poorly germinated and overpopulated field

9.1 What is refilling and thinning?

Refilling is what you do when you realize that certain parts of your field have failed to germinate while thinning is what you do when you realize that you have too many plants on your field. Simply put, refilling is when you replant spots on your field that failed to germinate whereas thinning is when you remove the extra germinated young plants per stand. It is possible to carry out both thinning and refilling on the same piece of land. In areas of your field where the seeds did not germinate, please refill. On the other hand, you should also thin out at areas of your field where all your seeds germinated and you have too many plants per stand. An optimum plant population of a cowpea farm for instance should like Figure 10 below.



Figure 10 Optimally populated field cowpea farm (Refilled & Thinned)

Source: Archives of IPA-Ghana, Tamale.

Thinning can also be done to plants which appear weak and diseased after germination so that you can replant those spots and get healthier plants.



Figure 11 A weak seedling being thinned out

9.2 Reasons for germination failure

There are a few reasons why some seeds will not germinate. It could be because the seed was not good, the soil moisture was not sufficient or the seeds got eaten up by rodents or other pests. Before you refill, it is important to check the soil around that spot for any signs of pest presence or activity and then refill immediately.



Figure 12 A farmer checking soil at un-germinated spot before

placing in new seeds

9.3 Refilling and thinning procedure

Under normal conditions, cowpea, soybean and groundnut should all germinate 5-7 days after planting. If after 7 days you notice that some seeds have not germinated, it means that there is a problem and you have to take steps to do refilling. Also, you should monitor closely all the young plants and identify all the ones that appear weak and diseased and remove them so their spots can be refilled.

When refilling, you should always make sure that you use the same seed you used for the first planting such that you don't contaminate your crops or the harvested grains.

Refilling should always be done 7 to 10 days after the first planting so as to avoid a wide gap in growth between the plants that germinated and the ones that were refilled.

During refilling, ensure that you place the seeds at the same spots or close to the original spots. This will ensure that you maintain the original planting distances you used in setting up your field and reduce over-spacing and overcrowding.

To carry out thinning, the weaker- or smaller-looking plants need to be pulled out gently to avoid damage to the other plant. Timely thinning should also be done 7 to 14 days after planting. This ensures that plants do not suffer from unnecessary competition before extra plants are removed.

It is important to remember that both refilling and thinning can be carried out on the same field. All spots that did not germinate need to be refilled while stands that have excess plants need to be thinned out.

If after germination, your field is neither under-populated nor over-populated, you will not need to refill or thin out your field.

Note: If you use certified seeds, conduct germination tests and plant correctly so that you spend less time on refilling or thinning.

CHAPTER TEN

MULCHING AND ORGANIC FERTILIZER APPLICATION

10.0 Introduction

All crops depend on nutrients from the soil to support their growth and development. Due to continuous cultivation without fallowing, most fields are depleted of the nutrients needed to effectively support the growth and development for good harvest. This is why adequate and timely fertilizer application has become so crucial in farming in Northern Ghana.

Most often when talking about fertilizer application, consideration is only given to chemical fertilizers such as NPK, sulphate of ammonia, Urea, Single Superphosphate or Triple Superphosphate. In this message, however, we are going to talk about another kind– the organic fertilizer.

10.1 What are organic fertilizers?

Organic fertilizers refer to all natural materials that can be added or incorporated into the soil to provide nutrients and make the soil richer. When these organic fertilizers are added to the soil they undergo decomposition to become organic matter. These kinds of fertilizers are relatively cheaper, more environmentally friendly and offer more benefits to the soil than mineral fertilizers.

In addition to providing the nutrients necessary to support the growth of your crops, organic fertilizers are able to improve the structure of the soil making it better and more stable to withstand unfavourable conditions whereas chemical fertilizers do not provide this structural benefit.

10.2 Mulch as organic fertilizer

Mulching is the practice of leaving a protective covering of leaves, weeds or other plant residues/products on the surface of the soil around the base of your plants. This prevents the loss of water from the soil through evaporation and also restricts

the re-emergence of weeds on your field. It also improves the microclimate in the soil which benefits the uptake of nutrients by the roots of your crop. It is known that soil moisture reserves are higher on farms with mulch than without mulch and weed infestation at the un-mulched farm are usually higher by as much as 11 times or more than that of mulched farms. also grain yield obtained from mulched farms is known to be higher than that obtained from un-mulched farms. The Organic materials will decompose to release nutrients to enrich your soil. It is good practice to always make sure that your soil is covered with a layer of organic matter which can be leaves or dead weeds so when the first layer has completely decomposed and the soil is again exposed to the sun, it is recommended to apply more organic matter.

In this message, we will discuss mulching and the application of organic fertilizers to your field. There is a separate message that takes you through the step-by-step process of preparing compost which is another form of organic fertilizer.

During land preparation and weeding, weeds are slashed and cleared from the field. Usually farmers gather these weeds and burn them. This is not a good practice; you should not burn the weeds. During land preparation, leave the slashed weeds on the field for them to be ploughed into the soil. After your crops have germinated and you carry out weeding activities on your field, do not collect the weeds from your field but leave them on the soil. If your field is near your home, you can use the leaves that you sweep or any other organic waste to mulch. You can equally use the husk or shell that you remove from your maize, rice or legumes. Figure 13 below is a soybean farm spread with mulch materials.



Figure 13 Soybean farm spread with mulch materials

10.3 Animal waste as organic fertilizer

Another kind of organic material that can serve as fertilizer is animal waste or droppings such as cow dung or poultry droppings. Even though they are rich in nutrients for your soil, gathering them in large quantities can be very difficult. If there are persons in your village who rear animals, you can arrange with them to collect the droppings from the barn. Once you collect them in sufficient quantities, you can transport them to your field and keep them covered or under a shade. Now that you have the animal droppings collected in heaps on your field, wait for the early stages of the farming season when the first rains come. You can then spread the waste on the field to be ploughed into the soil during land preparation a few weeks before you plant your field. This will give enough time for proper decomposition to avoid burning or scorching your young plants. Application that is done too early might lead to a loss of the nutrients before they can be used by the plants due to mineralization and leaching of the nitrogen in the droppings. About 15 donkey truckloads (2-3 tons) per acre should be mixed thoroughly with the soil. Application is also best done in the morning.

10.4 Zai method of organic fertilizer application

This is common in Burkina and other Sahelian countries. For this method, early land preparation is necessary. After preparing your field, you will need to mark out the entire field for the planting zones of your cowpea, groundnut or soybean variety. You will then need to dig holes with your hoe or cutlass at your marked spots over the entire field. Collect and fill holes with your organic matter or animal droppings as you move around the field until all the holes are filled. With this method of application, you make the most of the manure you have by applying it at the very spots where your plants will stand. It is also better because the manure is applied at the depth where it is not easily lost to the environment and is available for optimal use by the crops. This should be done when the rains have just started and there is some moisture in the soil to help in the dissolution of the nutrients into the soil. This method of organic fertilizer application is very labour-intensive but it is very effective in rejuvenating fields and in cases where you have a limited supply of organic matter.



Remember that application of organic fertilizer will eventually reduce the amount of chemical fertilizers needed by your crops to grow and do well.

10.5 Examples of mulch materials

1. Leaves
2. Dead weeds– from clearing of land or weeding
3. Other plant residues or plant products – organic wastes like the husk or shell removed from maize, rice or legumes
4. Plastic sheets

10.6 Soil mulching

This is the practice of heaping up soil around the base of the plant. This serves to regulate the immediate temperature around the roots of your plants and conserves moisture of the soil around the reach of the roots of your crops.

10.7 Benefits of mulching

Below are some benefits derived from mulching;

1. Prevents easy loss of water from the soil
2. Restricts the re-emergence of weeds
3. Improves the climate around the plants -e.g. increased microbial activity and good moisture conditions
4. Improved uptake of nutrients by the roots

Note: Some mulch materials may attract pests such as rodents, ants and termites to your field. So anytime you transfer organic materials or mulch to your field, be extra careful to check them before sending them.

Types of organic amendments (fertilizers)

- Farmyard manures, e.g. cow dung & household food waste
- Compost
- Crop residues – especially legumes
- Cover crops
- FertiSoil is a mixture of:
 - Poultry manure
 - Neem residuals

Application of Organic Fertilizer

- Spread the organic matter on the field and plough it in (incorporation) at least 2 weeks before planting to give enough time for proper incorporation into the soil.
- Do not apply too early. This results in loss of nutrients (via leaching) before plants use them.

Zai Method of Application / Spot Application

This method of organic fertilizer application is highly labour-intensive and commonly practised in the Sahelian countries.

Steps

1. Mark out the field according to the planting distances to be used
2. Dig holes at the marked out spaces about 1 foot deep
3. Fill holes with the organic matter
4. Cover the organic matter with a small layer of soil

Benefits

- Very economical i.e. limited quantity of organic matter can be used for a big field
- Manure is not easily lost to the environment
- Manure is applied at points where roots of crops will be exactly located for efficient uptake

Bio-fertilizers

1. Rhizobium: for biological nitrogen fixation
2. Arbuscular mycorrhiza: mainly for P & micronutrient uptake

CHAPTER ELEVEN

SOIL MANAGEMENT AND CONSERVATION

11.0 Introduction

Some of the messages discussed have touched on practices that cover some aspects of soil management and amendments. Farmers are sometimes forced to use extractive practices on their farmland year after year for food production. This refers to removing plants nutrients in harvested grain and tubers without replenishment of the soil. Managing soils and restoring eroded/degraded soils should be topmost priority for every farmer for sustainable agricultural production. That is to say that, with good soil management and conservation practices, farmlands are able to maintain high levels of fertility and productivity over long periods of time.

Soil management practices can be categorized under fertility management, structure and conservation.

11.1 Soil fertility management

Soil fertility management covers all practices carried out to boost the fertility and nutrient content of the field. The most important nutrients to consider in legume farming are nitrogen, phosphorus and potassium. These nutrients can be added to the soil through biological N₂-fixation in the case of nitrogen and use of inorganic fertilizer application in the case of P and K.

11.2 Soil structure

Soil structure refers to the form and arrangement of the soil particles on your field. Soil structure -has direct effects on the cultivation of crops because it is usually related to the level of organic matter contained in the soil. Even though inorganic fertilizers add nutrients to the soil, they do not affect the structure of the soil. This is why you need to add organic matter to your soil regularly to improve upon the structure of the soil. Maintaining good soil structure on your field is important

because it helps infiltration and soil-water relations as well as root development and penetration for good nutrient uptake.

11.3 Soil preservation and conservation

Preservation and conservation is another important thing you should consider in soil management. Soil conservation refers to all management practices that are applied to a field to protect it from erosion or loss of fertility caused by overuse or bad management. The vegetation in Northern Ghana is mostly grass Savannah with scattered trees. What this means is that the land is not completely protected and can be exposed to wind and water erosions which result in the loss of top soil from the field. Erosion can be controlled by creating stone bunds, ploughing across slopes and green manuring.

Contour bunding is another method of soil conservation which is very useful on sloping fields. Using stones or organic materials such as felled trees and branches create bunds and arrange them along the contour lines of the field. These will serve as barriers that will block the washing away of the top soil from your field. Over time, as the soil gradually deposits above each bund and is eroded below, rough terraces are formed that serve as a long-term control for water and wind erosion of the topsoil.

If you apply all these practices on your field, your soil will be properly managed and conserved to support farming activities for you, your children and your children's children.

11.4 Bad soil management practices

- **Slash and burn**

This refers to the practice where farmers burn their fields after clearing weeds during land preparation. Burning of bushes results in damaged soil structure and death of soil organisms that play very important roles in the health of the soil.

- **Misuse use of chemicals**

Misuse of chemicals on a field can lead to the damage of the soil, water sources and the environment as a whole. Examples of such chemicals are mineral fertilizers, weedicides and pesticides.

- **Overgrazing**

Excessive overgrazing on fields can lead to the complete removal of the surface vegetation. This results in the exposure of the soil to the destructive effects of wind and water erosion. Also, without a surface cover to regulate the temperature of the soil, organisms living in the soil might struggle to survive.

- **Continuous cropping**

Some fields can be cropped multiple times in a single year. Doing so for an extended period of time without proper management or fallowing results in the complete depletion of soil nutrients. Such soils become unable to support the cultivation of crops without significant addition of supplementary nutrients through fertilizers.

- **Persistent flooding**

Persistent flooding of fields arising from improperly managed irrigation or lack of drainage can destroy fields. Flooding results in anaerobic conditions within the soil that hinder the survival activities of soil organisms. Persistent flooding might also result in higher acidity of soils that make it unfavourable for cultivating some crops.

11.5 Good soil management practices

- **Crop Rotation**

Crop rotation is the practice of alternating the crop grown on a particular field according to a pre-designed cropping schedule. Properly designed crop rotation

schemes are able to sustain soils well because nutrients depended on heavily by certain crops are usually replaced by the next cultivated crops. This system allows fields to regenerate and not easily get destroyed.

- **Fallowing**

Fallowing is the practice of giving rest to a field that has been continuously cultivated over an extended period of time. The period of rest might be cultivated to special fallow crops such as calopogonium, mucuna or crotalaria to shorten the fallow period or simply allowed to lie without any activity. Periods of fallowing give the field the opportunity to rest and regain the fertility lost through multiple years of cultivation. With increasing pressure on land for other uses, fallowing is no longer an option in many places in Northern Ghana.

- **Organic fertilizer application**

Organic fertilizers greatly improve the structure of the soil by introducing organic matter or manure. These materials help the soil in retaining water better making them more readily available for crops. Also, organic matter helps bind the particles of the soil together making it less prone to erosion by water, wind and other agents.

- **Ploughing across slopes and planting trees as windbreaks**

One of the biggest problems of soil conservation is erosion. Erosion could either be caused by wind or water. Erosion caused by water can be greatly reduced by ploughing across the slope of the field. This is because erosion by water is usually caused by runoff after rainfall thereby washing away the top soil. By ploughing across the slope, it makes it more difficult for water to run off the field carrying away the top soil.

In savannah zones, there are only few trees in open fields. This situation leaves fields vulnerable to effects of harsh and windy conditions. By planting trees and shrubs around your fields, you will be providing a cover to your field and the soil from being blown away by the wind. Even though you might not immediately notice the

effects of wind erosion on your field, overtime it can result in a significant loss of soil from your fields.

CHAPTER TWELVE

MINERAL FERTILIZER APPLICATION

12.0 Introduction

On smallholder farms, soil fertility decline has been recognised as one of the major biophysical constraints affecting agriculture, particularly nitrogen (N) and phosphorus (P) deficiencies. Generally, Ghanaian soils are of low inherent fertility and therefore require external inputs to improve fertility. The soils in Northern Ghana in particular are not very fertile and cannot support the proper growth of crops on their own. Hence, there is need for inorganic fertilizer application to supplement the little nutrient in the soil. The use of fertilizers is the most effective and convenient way to improve soil fertility.

12.1 What to consider before fertilizer application

For an effective fertilizer application system, the most important things to consider are the nutrients that are lowest in your field and match that against the nutrients needed by your crops because every crop requires nutrients in different proportions. For most crops, the most important nutrients needed for good growth are nitrogen, phosphorus and potassium commonly referred to as N.P.K.

Cowpea, soybean and groundnut need these three nutrients to grow properly. These crops, however, can fix nitrogen (N) from the atmosphere into the soil. This means that when purchasing fertilizers for these crops you do not need to focus too much on nitrogen (N) as these crops only need a small supplement to meet their requirements. However, they depend entirely on the soil for the supply of phosphorus (P) and potassium (K). Therefore, you have to supply your field with enough P and K if you want to get a good harvest.

12.2 Types of fertilizers

- Mineral Fertilizers
- Organic Fertilizers
- Bio-fertilizers (Microbial Fertilizers)

Mineral fertilizers

- **Compound fertilizers:** they contain two or more nutrients, e.g. NPK 15-15-15; NPK 20-20-0; NPKBS 10-18-18-6-1; NPKSMgZn 23-10-5-3-2-0.3
- **Straight fertilizers:** they contain only one nutrient, e.g.
 - Triple Superphosphate (TSP) contains only phosphorus (P)
 - Muriate of Potash (MoP, KCl) which contains only potassium (K)
- **Liquid fertilizers:** these are compound or straight fertilizers which are formulated in a liquid form

12.3 Management/handling of mineral fertilizers

Mineral fertilizers deteriorate with time but proper care of them can greatly lessen the deterioration. To ensure safety and maintain the efficiency of these fertilizers, the following should be observed:

- Do not leave fertilizer bags open
- Store mineral fertilizers in well-ventilated rooms (i.e. rooms with good air circulation) to avoid accumulation of ammonia and other gasses which can explode and cause fire.
- Do not store or mix different fertilizer products together. It is advisable to put each type of fertilizer in a separate stack
- Bags of fertilizer placed outside should be covered with tarpaulin or large plastic sheets, etc.

12.4 Fertilizer calculation

1. Determine size/area of the field
2. Select fertilizer rate to be applied
3. Select source of fertilizer nutrients (whether straight or compound fertilizers or a combination of both) with their respective grades

Example:

To apply NPK at the rate of 80-60-60 kg/ha to an area 1 ha in size using SA, TSP and MoP, the calculations are as follows:

(i) Nitrogen amount (kg) to apply = $100 \times \text{rate} / \text{fertilizer \% ai (active ingredients)}$
= $100 \times 80 / 21 = 380.95$ kg. Amount in bags = $380.95 \text{ kg} / 50 \text{ kg}^* = 7.6$ bags.

Note that SA contains 21% N as the active ingredient

Note: Weight of 1 bag of fertilizer is 50 kg

(ii) Phosphorus (P_2O_5) amount (kg) to apply = $100 \times \text{rate} / \text{fertilizer \% a.i.} = 100 \times 60 / 46 = 130.4$ kg. Amount in bags = $130.4 / 50 = 2.6$ bags. Note that TSP contains 46% P_2O_5

(iii) Potassium (K_2O) amount (kg) to apply = $100 \times \text{rate} / \text{fertilizer \% a.i.} = 100 \times 60 / 60 = 100$ kg. Amount in bags = $100 / 50 = 2$ bags. Note that MoP contains 60% K_2O .

Conversion factors:

$$P = \text{P}_2\text{O}_5 \times 0.437 \quad \text{P}_2\text{O}_5 = P \times 2.29$$

$$K = \text{K}_2\text{O} \times 0.83 \quad \text{K}_2\text{O} = K \times 1.2$$

12.5 Applying the fertilizer

For high yields, fertilizer application to legumes can be done twice during the season. The first application should be done after ploughing/harrowing but before ridging and sowing. This is called the starter dose or basal application. You will need one bag of NPK 15-15-15 per acre for a starter dose. Do not use more because in

groundnuts, cowpea and soybean production too much nitrogen causes excessive vegetative growth and delay crop maturity. The starter dose promotes healthy early growth and development of root nodules that will fix nitrogen into the soil. This first application can be done by broadcasting but should be done carefully and orderly to ensure even distribution of the fertilizer across the field. Figure 14 below is a picture of a farmer carefully applying a starter dose before planting.



Figure 14 A farmer applying fertilizer before sowing

The second application should be done at sowing or latest 2 weeks after emergence. One bag of Single Super Phosphate (SUPA) or Triple Super Phosphate (TSP) per acre should be enough to supply your crops with the phosphorus (P) they need to boost growth and give high yields. This second application should be done by band placement and should be drilled into the soil to avoid getting washed away by rain. Placement should also be about 5 cm away from the base of the plant to make it available for uptake and avoid scorching the plants.

With the application of TSP and SSP, you will also be supplying calcium (Ca) which is very important for proper growth. If calcium is not available, there will be poor pod formation or your crops could form pods but be empty.

Calcium also helps to reduce the acidity of soils. If you have never tested soil samples from your field, please listen to the message on soil testing and do it in the next season. Testing the soil on your field will advise you accurately on the nature of your soil and what kind of fertilizer will be best suited for your soil and crops.

As discussed in chapter 3 above, leguminous crops are able to manufacture some nitrogen on their own with the help of bacteria called *Rhizobia* that form round objects known as nodules on the roots. The *Rhizobia* can be added to the seeds in the form of inoculants. However, depending on the nature of your soil, the nitrogen produced might not be enough to fully support proper growth. Also, phosphorus and potassium are needed by groundnut, soybean and cowpea in very high amounts to boost grain formation. If you combine phosphorus fertilizer with *Rhizobium* inoculants, you will get higher yields than average. Finally, remember that you will need two (2) bags of fertilizer per acre of soybean, groundnut or cowpea – 1 bag of NPK (preferably 20-60-30)  during land preparation or before sowing and 1 bag of SSP or TSP between sowing and latest two weeks after sowing.

12.6 Commonly made mistakes in fertilizer application

- **Fertilizer applied too close to the plant.** Application should be done about 5 cm from the base of the plant. If the recommended planting distance for a particular crop variety is exactly 5 cm apart, place fertilizer in the other direction (inter-row).
- **Fertilizer applied too late.** Timing of fertilizer application is very critical. This is because plants need nutrients at specific times or stages during their growth. Therefore if application is delayed beyond the period when it is needed, the fertilizer does not result in any positive impact on the crops.
- **Compound and urea fertilizers left on the surface instead of being buried.** Nitrogen is a very volatile element. This means that if N-

fertilizers are exposed directly to the heat of the sun, the nitrogen content will be lost to the environment and lost to the crops.

Interpretation of figures on fertilizer bags

Figures on fertilizer bags usually refer to the fertilizer grades or amounts of active ingredients the fertilizer contains.

Fertilizer grade

This is the amount of active ingredient in a fertilizer material.

Eg; NPK 15-15-15 means in a bag of fertilizer there is 15% by weight of N, P and K, respectively.

Methods of fertilizer application

- Broadcasting
- Ring
- Banding

Timing of fertilizer application

- **Basal** – at planting or within two weeks e.g. for maize (or more after planting depending on crop type)
- **Top-dressing** – within 4 – 6 weeks after planting depending on crop type

CHAPTER THIRTEEN

COMPOSTING

13.0 Introduction

As you learned in the message, organic fertilizers are very good for the soil and can help your soil support and improve the growth and development of your crops.

One type of an organic fertilizer is compost and in this message, we are going to teach you a fast and effective way of making compost for your field.

For effective use of farm labour, it will be good to locate the site for preparing your compost close to your farm for easy transportation. To begin preparing your compost, there are some materials you will need. Materials needed include various types of vegetative materials such as leaves, tender stems, grasses, etc. You will also need topsoil, animal manure/waste products and wood ash. In addition to these, you will need some tools such as a long and sharp pointed stick, a watering can or bucket, a shovel or a rake.

13.1 Compost materials

Plant materials

For a good compost mix, you will need both green (wilted) plant materials and dry ones. Fresh plant materials can be freshly cut weeds & grasses, tree leaves and branches, etc. which must be allowed to wilt before use. Crop residues from fields such as stems, leaves, straw, etc. can all be used as plant materials for composting. These plant materials form the core of the compost mix and are the components that undergo decomposition to become the nutrients that will be taken up by the plants once the compost is added to the soil.

Green plant materials provide some moisture for the composting process. They give water and nutrients to the microorganisms to aid them multiply and break down the organic materials. Dry materials give structure to the compost mix. They provide space for air circulation for organisms to be active.

Note: In preparing the plant materials for the compost mix, please make sure to chop or cut the big and tough materials with your cutlass into smaller bits. **The smaller the sizes of the plant materials, the faster your compost will decompose and be ready** to be applied to your field.

Animal waste

Animal waste can be in the form of droppings or dung from all domestic or farm animals such as cattle, sheep, goats, chicken, donkeys, etc. Treated human faeces can be used to serve the same purpose.

Animal waste contains moisture, nitrogen, potassium and phosphorus as well as other micronutrients. Both dung and urine help to produce the high temperatures needed for materials to decompose faster with urine particularly very useful in accelerating decomposition.

For faster composting, you can always deposit large quantities of your plant materials as bedding for your farm animals before taking them to your field to prepare the compost. They would have mixed up with the urine and waste products of the farm animals by the time you go to collect them to the field.

Note: All harmful or dangerous parasites that may be contained in waste products of humans or farm animals that are added to the compost mix present no dangers. The heat generated in the compost mix during decomposition kills all such organisms and they do not get spread or contaminate the environment of your field.

Ash

Ash from wood or charcoal is useful because it is a good source of phosphorus and potassium as well as other micronutrients such as zinc, iron and magnesium. **Ash should never be added as a layer on its own but blended in with all other layers in small quantities.**

Note: Putting large quantities of ash in a particular layer will result in high concentration of the above minerals and result in slowed activity of microorganisms or stop them altogether.

Good topsoil or old compost

These organic materials contain bacteria and other microorganisms or small animals that work on breaking down the materials into mature compost. Topsoil can also be used as the final layer before banana leaves are used to cover the compost materials. This would serve to reduce the release or loss of heat from the compost into the environment.

13.2 Methods of preparing compost

✓ **The pit method**

The compost is prepared in a shallow pit made on the farm or close to the farm

✓ **The pile/stack/heap method**

The mound formed with the heap method of composting is very similar to how charcoal is prepared locally.

Below is a table highlighting the main differences between the pit and heap methods of compost preparation.

Pit Method	Heap Method
<ul style="list-style-type: none">• Suitable for areas with low rainfall	Works well in areas with high rainfall
<ul style="list-style-type: none">• Works well during dry season	Does not work as well during the dry season
<ul style="list-style-type: none">• Compost set-up is made in a pit in the ground	Compost is made as a heap or big mound on the surface of the ground

13.3 Heap/pile method of composting

In this message, we will be talking about the heap or pile method of preparing compost. Another message will teach you about the pit method so you can decide which method you want to use depending on what time of the year it is.

To begin, you have to dig a shallow pit of about 1 foot deep and 5-10 feet wide. The size of the shallow pit corresponds to the amount of organic materials you have gathered to be processed into compost for your field. Now fill your shallow pit with

rough materials such as maize straw and hedge cuttings. This should fill up the shallow pit to the surface.

For the second layer add dry vegetation, such as dried leaves and grasses. This second layer should be about 15 cm thick. After applying the second layer, use your bucket or watering can to sprinkle water on the small pile. Make sure to sprinkle enough water to soften the materials to enhance decomposition. About two to four buckets of water should be enough.

For the third layer, add animal manure or animal waste products. You can use cow dung or poultry droppings you collect from someone who raises farm animals. These animal waste products contain some organisms that can help the organic materials decompose faster. After adding this third layer, sprinkle another bucket or two of water on the entire heap.

For the fourth layer, add wood ash, which adds potassium, phosphorus, calcium and magnesium to the mixture. This is particularly very important if you are going to be applying the compost to your legumes farm. Remember that **cowpea, soybean and groundnut require a good supply of phosphorus and potassium to grow and develop well.** The wood ash also neutralizes the acids produced during decomposition.

After the wood ash, add all green materials you can find. This can be in the form of small branches, leaves, grasses, etc. The amount of green materials added should be about 15 cm thick. You can now sprinkle some of the rich topsoil you collected or old compost on the pile. The topsoil equally contains materials that are good for decomposition of the compost heap.

Now your layering for one cycle of compost heap is complete. If you have a lot of supply of organic materials for the compost, you can repeat this order of layering the materials in the quantities indicated until you have finished all of them.

Now that you have completed building your compost pile, you have to cover the whole pile with dry vegetation to reduce the loss of moisture through the heat of the sun. **It is advisable that you build your compost in a shady part of your farm or under a tree to reduce the loss of moisture** from the compost heap.

Also, shady and cool conditions help the organisms in the mixture to facilitate the decomposition faster.

As a final step, drive your long and sharp pointed stick through the pile at an angle and leave it in the pile to serve as your thermometer. Pull out the stick from time to time to check the progress of the process. After 2-3 weeks, turn the pile over to expose both ends to the same conditions. Turn the pile again after three weeks of the first turning. Your compost is now about ready and can be left to mature until it is required for application on the field. A well prepared compost ready for application should look similar to what is in Figure 15 below.



Figure 15 Well prepared compost

Through composting, you are able to ensure a good balance of the nutrients needed for all-round healthy growth of your cowpea, soybean and groundnut. The nutrients in the compost will be released into the soil with time and will be readily available for uptake by your plants when the compost is applied to your field.

13.4 Conditions that facilitate good composting

1. Heat
2. Adequate moisture (not too much)

3. Good humidity
4. Adequate air
5. Soil organisms/micro organisms

Adequate moisture

The presence of moisture/water in the compost mix is essential to the decomposition process because it is required to facilitate the activities of microorganisms. Too much water is also not good for composting because excess water results in rotting of materials and causes a very bad smell from your compost mix.

Adequate air

When there is sufficient air, oxygen enters the compost mix and special bacteria in the compost mix can rely on this oxygen to convert nitrogen to nitrate. When this happens, the materials are decomposed properly and result in a natural soil smell of the compost.

Note: When there is insufficient air but too much water, the nitrogen is converted into ammonia which escapes into the atmosphere resulting in the loss of the nitrogen content. The ammonia also results in a bad odour.

If there is excess air and little moisture, materials dry up and do not decompose to become compost.

13.5 Organisms that facilitate good composting

1. Earthworms
2. Ants
3. Mushrooms
4. Beetles
5. Millipedes/centipedes
6. Woodlouse

13.6 Benefits/importance of Compost

- Compost contains much-needed nutrients for the proper growth and development of crops. They are rich source for nitrogen, phosphorus and potassium.
- Humus, a product of compost, provides important organic matter content for the soil.
- Compost improves the structure of the soil resulting in improved ability for the soil to hold water and increases air circulation both of which are crucial for soil organisms.
- Compost provides trace elements such as magnesium, iron and zinc for all-round growth of crops.
- Compost serves as a cheaper source of supplementing soil nutrients and is more environmentally friendly than mineral/inorganic fertilizers.

Points to Remember when making compost in heap

1. It is good to make a heap in the rainy season when there is plenty of green plants such as weeds in excess, the materials are naturally wet, and water is abundant.
2. The compost heap will be on the ground with its base in a shallow trench to hold the foundation layer.
3. Compost should be in a place where it can be protected and get covered with leaves or straw or plastic sheets during the rains so that the materials are not damaged or washed away.
4. Compost can be made under the shade of a tree and covered with broad leaves or plastic sheets in order to protect the heap from high winds.
5. After the rains have stopped, keep the heap covered and check regularly to see if the moisture and temperature are sufficient as described later in the section on follow-up.

Points to remember when making compost in a pit

1. Pit composting is good for anytime of the year where moisture is limiting and it is the best way to make compost after the rainy season and during the dry season.
2. Prepare and dig the pit, or better still, a series of three pits when the land is moist and easier to dig and/or when there is a gap between other farming activities.
3. If possible, make the compost immediately at the end of the rainy season while there are plenty of green and moist plant materials.
4. In the dry season make the pit near a place where water can be added, e.g. next to the home compound where waste water and urine can be thrown on the compost materials or near a water point, e.g. a pond, or near a stream where animals come to drink.
5. Mark the place of the pit with a ring of stones or a small fence so people and animals do not fall into it accidentally.

CHAPTER FOURTEEN

PEST MANAGEMENT

14.0 Introduction

At the beginning of the season, a farmer's objective is to cultivate his/her field and harvest optimum high yields. However, issues like low rainfall and high input costs have to be overcome to realize this objective. In this message, we are going to focus on one of these issues which can reduce yields by between 50 –100% if not managed properly – we are going to discuss pest management.

A pest is any organism (animal or plant) that causes damage to your crops but in this message we are going to talk only about animal pests. These include farm animals like cattle and sheep, rodents like rats and grass-cutters, insects and nematodes.

14.1 Rodents

Rodents can cause very significant losses in groundnuts, soybean and cowpea.

Most of the damage caused by the rodents is to the leaves and stems. When rodents feed on leaves of the plants they reduce the ability of the plant to trap sunlight which is needed for the plant to produce its food. Feeding on the stems causes plants to die. Rodents also dig up and feed on seeds after sowing usually resulting in low germination rates. You can fight this by treating your seeds with pesticides before sowing. Note that if you decide to also inoculate your seeds, you should consult your AEA (Agricultural Extension Agent) or CEA (Community Extension Agents) because seed treatment with pesticides might reduce the potency of the inoculants. To effectively control rodents, you can place traps or poisoned baits around your field. Pests such as rabbits and grass-cutters captured with the traps can also be eaten by the farmer or sold for additional income. Note, however, that **animals killed with poisoned baits should not be eaten as they will be harmful**. If you decide to use poisoned baits to kill rodents, please inform

all neighbouring farmers to avoid picking dead animals around that may have been killed by the poison. Some common rodents which can invade your farm are shown in Figure 16 below.



Grasscutter



Rat



Wild rabbit



Squirrel

Figure 16 Some common rodents

14.2 Insects

Insects also cause a very significant damage to crops. **Insects can cause your yield to reduce from about 8 to 2 bags if not properly controlled.**

The most common pests that damage soybean are the green clover worm and soybean looper that attack leaves, earworms and stink bugs that attack the pods and the stem borer that attacks the stem causing plants to lodge.

For cowpea, the most common pests that cause serious damage are aphids. Not only do they cause direct damage to the cowpea plants but also act as a vector to transmit the cowpea mosaic virus. There are other pests that cause damage to cowpea by attacking the pods such as the pod borer and pod sucker.

In groundnut, the most damaging pests are termites especially under drought conditions. Termites cause damage by tunnelling through the roots causing the plants to die. Termites also attack the pods at maturity making it easy for

contamination of seeds by soil fungi. Figure 17 below is pictures of some destructive insects that can cause irreversible damage to your crops.

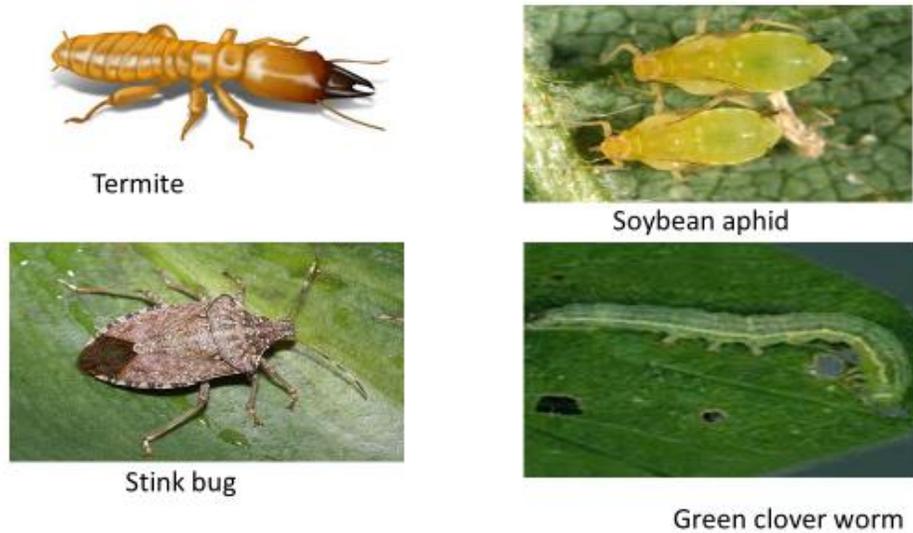


Figure 17 Examples of destructive insects

Note that soybean aphids are tiny insects usually found underneath the leaves of the plant and may require careful observation to see them. In reality this is how they look like.



Soybean aphids

One of the most effective ways to control pests is by cultivating resistant varieties. For example, the cowpea variety, Padi-Tuya is resistant to aphids. You should

therefore consult your AEA or CEA to advise you on varieties that are resistant to the common pests found in your locality.

You can also use the chemicals in the table below to control insect pests by spraying 0.5 – 1.0 litres per acre of your field. Note, however, that you should not use chemicals on your field to control pests unless the infestation is very serious and can cause economic loss. Always consult your AEA or CEA before you apply chemicals on your field. It also worth to note that brand names of these chemicals do change with time. You should therefore always look for the active ingredients written on the container of these insecticides.



List of some insecticides currently on sale

Brand name	Active ingredient(s)
Lamda	Cyhalothrin
Lamda Super	Cyhalothrin
D-Ban Super	Cyhalothrin + Chlorpyrifos
K-Optimal	Cyhalothrin + Acetamiprid
Act-Force	Chlorpyrifos
Lara-Force	Lamda-cyhalothrin
Sumitex	Dimethoate
Lion-Force	Cypermethrin + Dimethoate
Sunhalothrin	Lamda-cyhalothrin

14.3 Nematodes

Finally, we will discuss nematodes. These are microorganisms that live in the soil and prevent good growth of your plants by attacking the roots. Their actions prevent your crops from taking up water and nutrients from the soil. This results in stunted growth and yellow appearance in plants – **yellowing usually occurs around July and August if caused by nematodes**. If you follow the message on soil testing, it can be detected if your field is infested with nematodes. To control

the impact of nematodes on your field, you can use crop rotation and proper farm sanitation that are discussed in other messages.

Good cultural practices such as weed management, also discussed in a different message, help minimize the occurrence of nematodes and other pests on your field since some weeds may even serve as hosts for these pests.

If you follow the above guidelines of pest control, you will be able to minimize the damage caused by pests and achieve good yields for your soybean, cowpea and groundnut.

14.4 Integrated pest management (IPM)

IPM is the use of a combination of pest control practices or methods to manage the presence of pests on a field. You should know that the mere presence of pests on a field does not mean they need to be killed or destroyed because pests can be very useful to your crops and bring about many benefits for your plants. Therefore, **pests should only be tackled when they have reached levels where they can cause economic losses to your crops or to the environment or humans.**

IPM management options

- Cultural control
- Host plant resistance
- Mechanical control
- Biological control
- Bio-pesticides
- Chemical pesticides
- Behavioral control

14.5 Practical examples of IPM strategies

Site Selection

Check the surrounding, landscape, cropping history, pest sampling, presence of alternative hosts of key pests of the crop to be planted, soil pH level, drainage and proximity of the site to infected and /or infested fields.

Good land and seedbed preparation

This involves deep ploughing, destruction of crop residues after harvest by incorporating them into the soil, using them in the preparation of compost or by controlled burning. By this, you deny the pests and diseases suitable places for hibernation and the amount of food available to sustain pests such as termites throughout the dry season is reduced.

Use of disease-free seed or planting material

The use of certified seeds are highly recommended and seed dressing before planting is also recommended in high pest risk areas.

Early planting

It is recommended to plant early in the season when there is sufficient soil moisture to avoid population peaks of certain pests and diseases (e.g. aphids, grasshoppers, striga, etc.). Early planting ensures that the vulnerable stage of the plant such as the seedling stage escapes the peak of key pests and diseases. In general, **prevalence of virus increases as the planting date is delayed both in the rainy season and in the post rainy season.**

Simultaneous planting

Simultaneous planting by farmers in a given community over a large area helps to prevent population build-up of the major pests of a particular crop.

Planting of early-maturing varieties

Varieties of early-maturing legumes have been found to be an important component of IPM. They are capable of utilizing the available resources to form

economic produce before the peaks of the major pests and diseases. By this mechanism, they are able to escape the devastating effects of the major pests and diseases.

Optimum plant population

Close planting of cowpea and groundnut may reduce aphid infestation because of predation by other natural enemies. Aphids have been shown to reproduce less rapidly on closely-spaced plants suggesting a form of pseudo-resistance induced by the physiological state of the host. Replacement of affected seedlings is recommended to ensure optimum plant population.

Field sanitation

- Remove and destroy pest-infested and diseased plants or plant parts and burn them to minimize pest infestation.
- Search and locate where insects have laid their eggs and destroy them.
- Compost crop residues on field to destroy all pests or larvae left on the field after the previous season.
- Clear the field from thick-stemmed grass weeds which act as alternative hosts for stem borers.
- Remove off-season volunteer plants from the vicinity of groundnut fields. This can reduce the level of Groundnut Rosette Virus (GRV) infection.

Mulching as IPM practice

Mulching with neem cake or chopped branches and leaves of *Ipomoea spp.* can protect pods of groundnuts from termite damage.

Timely and effective weed control

- Regular weed control and destruction of alternative host plants.
- Regular weed control has the desired effect of reducing 'off-season' reservoirs of thrips.

Scouting for outbreak of pest and diseases

Scout your field regularly and take appropriate action. When scouting, also look for conditions that can eventually lead to outbreak of pests. These conditions include poor water management, poor field sanitation, overcrowded plant stands, weediness, etc.

Effective water management

Waterlogged conditions on the field of cowpea, groundnut and soybean should not be encouraged. The fields should be kept well-drained to deprive pathogens and other pests conducive breeding grounds. Select a field that is also capable of holding enough moisture for the growth of the crops to avoid water stress conditions that can equally predispose the crops to pests and disease attack.

Soil fertility management

Plants growing vigorously are less damaged by pests. Timely and adequate application of organic and mineral fertilizers should be encouraged using the right method of application.

Prompt harvesting

Harvest as soon as the crops are matured. When crops are left to stay longer on the field after maturity, they are exposed to storage pests and diseases which lay their eggs in the crops on the field to be hatched during storage. **Matured crops left on the field under moist or rainy conditions can easily be infected by pathogens.**

Intercropping

Intercropping cowpea with cereals and other crops have been found to reduce pest damage of cowpea. When cropped with millet, sorghum or cassava, thrips population in cowpea has been observed to reduce in cowpea due to shading from the other crops, a change of environment, a barrier effect or build-up of natural enemies on the accompanying crops.

Intercropping groundnut with field beans reduces the rate of the spread of diseases transmitted by aphids.

Crop rotation

- Decreases pest pressure.
- Enhances biological activity in the root zone.
- Increases the organic matter content and improves soil quality.
- Rotate with non-host crops to starve pests; for instance legume/cereal/vegetable rotation.
- Cole crops (Brassicaceae) can reduce nematode populations when chopped up and incorporated into the soil. When the plant tissues break down, they release cyanide gas thereby “bio-fumigating” the soil. The effect is enhanced by covering the soil with a plastic sheet to trap the gases. Marigold has also been found to control nematodes.

Closed season

At least a two-month closed season of cultivating a particular crop in a given area will prevent population continuity of an associated pest/disease in the area.

Host plant resistance

A resistant/tolerant variety is the most suitable to resource-poor farmers who do not have access to or cannot afford other pest control methods – resistance is within the plant and therefore there is no need for other inputs.

Some varieties of cereals with thick or extensive leaf sheath are not favoured for oviposition. Other varieties have higher silica content in their tissues which are lethal to feeding larvae.

Tough pod wall and pod hairs have been considered as factors involved in cowpea resistance to pod bugs.

Cultivars of cowpea such as Apagbaala and Songotra possess abnormally long peduncles that keep the pods well over the plant canopy at a wider angle than the normal form and also having hard, solid stems and peduncles make them tolerant to maruca and pod sucking bugs.

Mechanical control of pests

- Hand picking and destruction of adult crickets, grasshoppers, beetles etc.
- Collection of egg masses of the moth pests.
- Uprooting of striga plants before they set seeds
- Removal of 'royal couple' from termite nests to prevent breeding and population build-up.
- Mechanical cultivation repeated over a period of time reduces the population of termites.

Behavioural control of pests

Use early warning mechanisms (e.g. use of pheromone traps to detect adult flight pattern of armyworms can pre-empt a major damage by armyworms).

Planting trap grasses such as *Digitaria*, *Cymbopogon* species and *Pennisetum purpureum* around groundnut farms can reduce termite damage to the main crop.

Bio-pesticides

Encourage the use of bio-pesticides such as Bt-insecticide to control pests.

Botanical Pesticides

Apply neem products such as neem seed extract, neem seed powder, neem seed oil and other known botanicals in your community.

Biological control of pests

In nature, populations of aphids, thrips and other pests are regulated by parasites, predators, pathogens, and adverse weather. **Natural enemies, notably coccinellid and syrphid larvae are important in reducing aphid population densities.**

Density-independent factors such as rainfall could be important in the natural control of aphids. Termites in the soil are the natural prey of ants perhaps because they occupy the same or similar niches. Generally ants dominate the invertebrate predator's guild in many groundnut fields and reduce the population of termites and subsequent damage. Predators of white grubs include carabid larvae, toads and

many bird species. Microbial agents include the fungi, *Aspergillus parasiticus*, *Beauveria bassiana* and *Metarrhizium anisopliae*; the bacteria *Bacillus thuringiensis*, *Diplococcus*, *Clostridium*, and *Micrococcus* species. Two scolid parasites, *Scolia aureipennis* and *Campsomeris collalis* have also been reported.

Natural control of groundnut leaf miner by disease pathogens, predators and parasitoids play an important role in suppressing leaf miner populations in groundnut.

14.6 Chemical control of pesticides

Judiciously apply recommended organophosphorus or Pyrethrin insecticides to control the pest when infestation is heavy. Effective insecticides include **permethrin, cypermethrin, chlorpyrifos, dimethoate, endosulfan, fenitrothion** and **phorate** etc.

Destroy invading caterpillars of armyworms with insecticides to avoid their spread to other areas. Farmers should use insecticides judiciously so that they do not interfere with the natural control of pests. Selective aphicides such as menazon and pirimicarb can be used in order not to interfere with natural control of aphids. As white grubs have only one generation per year compared to termites in which re-invasions are common, many short-persistent insecticides can kill the larvae before they lose their potency.

CHAPTER FIFTEEN

MIXED FARMING

15.0 Introduction

In addition to growing crops, most farmers in northern Ghana also rear farm animals. This practice of growing crops and raising farm animals such as cattle, goats, sheep and poultry (ducks, chicken, guinea fowls, etc.) at the same time is called mixed farming. Mixed farming system consists of a range of resource-saving practices that aim to achieve acceptable profits and high and sustained production levels while minimizing the negative effects of intensive farming and preserving the environment. It means that when done properly, both systems of animal and crop production will support each other and result in better farm operations and higher income.

15.1 Why mixed farming

During the rainy season, there is usually a very high demand for tractor services but very few tractor operators are available to meet this demand. This almost always results in delayed land preparation by most farmers who rely solely on tractors to prepare their field. Through mixed farming, you can avoid being one of these farmers. If you raise cattle in addition to your crops and can't find a tractor operator in time to work on your farm, you can use your nourished and well-trained male cattle to manually prepare your land for planting like you have been taught in one of the previous messages. Apart from saving your very precious time and helping you plant on time, it also saves you money that can be invested in other aspects of your farming.

If you own other farm animals such as goats, sheep and poultry, you can use their droppings to fertilize your field and make the soil richer in nutrients. If you do this consistently over time, it will reduce the amount of inorganic/mineral fertilizers you have to apply to your field for a good harvest.

One other benefit of raising farm animals is the milk some of them produce. This can help enrich your family's nutrition or can also be sold to make some money. You must also not forget that if you are raising farm animals in addition to your crops, you don't need to spend money to buy animals during festivals and other social ceremonies. You can kill some and have enough meat for you and your family and also have the hide to decorate your houses.

We have talked about the ways your farm animals can boost your crop production. On the other hand, your crop production can also help in your animal rearing.

After harvest, you don't need to burn the stover/biomass from your soybean, groundnut or cowpea farm. Instead of destroying them or leaving them to waste, you can process them into more digestible forms to feed your animals.

Also, grains from your harvest can be processed with other domestic products to prepare very nutritious feed supplements for your animals so that you don't spend money to buy feed for your animals.

Raising farm animals in addition to cultivating groundnut, soybean or cowpea is a very profitable venture. If you are not raising farm animals in addition to your crops, it will be advisable to start this season. You can begin with just a few animals. Over a few years, they will have reproduced and multiplied in number thereby bringing you high returns on your initial investment. You can easily sell them if you need money to buy inputs for your crops, expand your farm or even for other social responsibilities.

If you want to really benefit from your mixed farming, it is recommended to keep your animals in a pen so that you can ensure that they eat nutritious food and also make it easier to collect their dropping for manure. Also, you can choose to cultivate crops that can be used to feed your animals, so that they grow faster, or you can cultivate animal feed along the borders of your fields.

Mixed farming is very beneficial because it generates an alternate source of income that supplements what you get from selling your produce after harvest. Also, raising farm animals provides cheaper and more dependable options to tractors for land preparation and mineral fertilizers. Try it; it will help you and your farm.

15.2 Improvements to traditional animal raising techniques

- **Fodder systems**

Fodder refers to all feed that is given to farm animals for which the animals do not have to forage for themselves. Fodder is usually cut from the field and taken to the livestock/animals. Different kinds of plants can be planted to a fodder pasture – it does not necessarily have to be a plant that already exists in that area, you can get seeds of plants from other areas from your AEA to grow for your animals. Grasses such as *Pennisetum*, *Panicum* and *Brachiaria* are much diversified and can be successfully cultivated in several ecological zones. Apart from grasses, you can also grow herbaceous legumes such as *Stylosanthes*, *Leucaena*, and *Desmodium* as fodder plants to feed your animals.

15.3 Types/times of fodder cultivation

- **Pasture establishment by sowing after land preparation**

Usually, native species of grasses and weeds of a particular locality have an added advantage of survival and overcoming competition. Therefore if you decide to cultivate an area to a particular fodder plant, it is very helpful if you clear the area of all native plants before you sow in your new fodder plants. Over time, they will adapt to the environment and be able to successfully compete. Clearing existing vegetation before sowing also ensures that you are able to get more fodder from the field since space is not being shared with other plants that may not be edible or useful to your animals

- **Continuous reseeding and rehabilitation**

While your fodder pasture is being harvested for your farm animals, you will only be able to maximize the output of the field all year round if you continue to reseed as the first plants are growing. With this system, cutting of fodder has to be done in a clearly defined order from one side of the field

to another. Once you harvest plants from a side, you must immediately reseed those areas. This way, by the time you finish cutting or harvesting plants at the other side of the field, the first place you harvested would have also reached maturity to serve as quality nutritious feed for your animals. To save labour and also be efficient, you can do this by broadcasting. You only need to make sure that you use the optimum quantity of seeds and do the broadcasting uniformly across sections of the field. Between 10 – 20 kg of plant seeds should be enough per acre.

Note: If you only have one plot, you can begin planting in your fodder plants when your main crops have begun fruiting. At this stage, they will not compete with your crops for nutrients.

15.4 Improved health care for livestock

Farm animals may suffer from ailments that slow down their growth, impede their productivity and might even result in death. It is therefore very necessary to pay extra attention to the health of the animals you are raising to avoid these situations.

15.5 Common diseases

Below are a few common diseases or illnesses that affect farm animals, how to detect them and the best ways of treating them.

15.5.1 Internal parasites

Internal parasites affecting farm animals are mostly worms which are living things which during all or part of their lives live at the expense of another, called hosts, causing it some damage. They live in habitats within their hosts such as intestine, liver, muscles, blood etc. These parasites easily get spread because their eggs will be passed through the wastes of animals, hatch and mix up with feed and taken in when these animals feed.

Worms affecting domestic animals can be differentiated broadly into four main groups namely;

- i. Nematodes (round worms),
- ii. Cestodes (tape worm)
- iii. Trematodes (flat worm)
- iv. Protozoan (coccidian)

Typical symptoms of parasite infestation

Common signs that may indicate the presence of internal parasites in farm animals are restlessness and weakness. Other signs to look out for include the following;

- Weight loss: animals don't get all the nutrients they need.
- Diarrhoea: can be detected by dirty tail and hind end.
- Rough hair coat: when nutrients are insufficient, the animals' hair loses its luster
- Depression: animals keep their head and ears down and are not willing to stand for long periods of time.
- Anaemia: animal's gums, perineum and eyes appear white due to blood loss.
- Fast breathing: animal try to get enough oxygen into their damaged lungs.
- Coughing: animals may cough as a result of the irritation of their damaged lungs.
- Bottle jaw: animals may have fluctuant swelling under the jaw from the accumulation of fluid (submandibular edema). Sometimes it can spread to under the abdomen.

Prevention of parasites

The best prevention is to reduce your animals' exposure to parasites by providing a clean environment and avoiding overcrowding of pen or premises.

Other important preventive measures are;

- Avoid pasturing in damp areas and during early morning and evening hours, when there is dew on the pasture.
- Rotate pastures to avoid high burdens of parasites.
- Select animals from bloodlines that show low worm burdens.

Treating infested animals of parasites

Parasites can be controlled by deworming your cattle regularly (at least once a year) with de-wormers such as *Albendazole*, Althelminctics etc. As the cattle grow, they begin to develop some level of immunity against these parasites.

Note: Before deworming your animals, consult your area veterinarian or AEA through your CEA.

15.5.2 Coccidiosis

Calves are most susceptible at age 1 – 6 months but older animals between 1 – 2 years can also be affected. Animals are usually infected when placed in pastures or barns infected by other animals. Typical signs of infected animals are diarrhea, rough coat, loss of appetite and loss of weight. The weakness caused might cause the animal to defecate without rising resulting in the tail and backsides being stained with faeces. In severe cases, the faecal may contain blood, mucus and other tissues. The spread of the disease can be prevented by separating infected animals from healthy ones, and changing grazing sites of animals. For severe cases, you can administer coccidiostats to your infected animals.

Note: Always consult a veterinarian before administering medicines.

15.5.3 Brucellosis

In infected ruminants, brucellosis commonly causes abortion during the second half of gestation. Retention of placenta and metritis are also common. In male goats, infertility, orchitis and swollen joints are seen. Other symptoms include lesions, rashes or scars around reproductive organs. To prevent this disease, the animals should be tested for brucellosis with infected animals separated from healthy ones. Sheep are less susceptible than cattle, and brucellosis is not considered a common cause of abortion in sheep.

15.5.4 Bronchitis

Occurs due to lung worm infection resulting from contaminated feed. Sometimes, goats get irritation and bronchitis that can be controlled by dampening the mixture with water or molasses water. This way dust in the feed will be reduced. Chronic coughing may also occur with this disease.

15.6 Basic housing and shelter

In most rural households, little or no shelter is provided for animals. This is not a very good practice and should be avoided if proper care is intended for the animals. Providing good shelter for animals have several benefits for you and the animals. Some are listed below;

- Protects the animals against harsh weather conditions such as rain and excessive heat
- Well-constructed shelters for animals reduce the spread of diseases because there will be reduced mixing between your animals and other animals from different households
- Droppings and manure from your animals are easier to collect and gather for your farm
- Keeping animals in shelters helps keep your compound neat and tidy

Sanitation practices in peeping farm animals

- Do not overcrowd animals in pens and barns
- Always observe animals closely and separate sick ones from healthy ones
- Take out droppings and animal waste materials from animal house regularly and use for preparation of compost for your farm
- Replace old feed with new cuttings and feed regularly
- Disinfect all feed materials collected from fields before giving to animals

CHAPTER SIXTEEN

FARM SANITATION

16.0 Introduction

Farm sanitation is a very important aspect of farming which is unfortunately ignored by most farmers because they do not realize how important it is to the farm and the harm it causes if ignored. In this message, we will learn a few basic things about farm sanitation and what you can do to ensure better protection and growth of your crops.

Farm sanitation covers all practices that result in a clean farm environment leading to the farm, around the farm and within the farm. These practices have a direct link with the occurrence of diseases and presence of pests on your farm.

16.1 Some good farm sanitation practices

The first thing you can do is to maintain a clear path from your community to your farm. You do not have to do this alone. Do this with other neighbouring farmers who have their farms around yours and equally stand to benefit. In most cases, these paths exist already but are poorly maintained and are invaded by weeds. A clear path makes it easier for first-time visitors such as the CEA/AEA to find their way to your farm without getting lost. These visitors may be coming to offer advice or help on your farm.

A clear path also makes it safer and easier for you and your family to go to the farm. Cleared paths make it easier to spot dangerous animals such as snakes and scorpions and avoid getting bitten. You also avoid injuries from thorny bushes. Figure 18 below is a well arranged farm with paths for visitors.



Figure 18 A well-layout farm with paths Source: M. Fosu, SARI-Tamale.

In northern Ghana, there are various kinds of weeds. These weeds are spread from one area to another by different agents. We are one of those agents. By having physical contact with these weeds on the way to your farm, their seeds may get caught on your clothes and eventually get transferred to your own farm. With a well-cleared and well-maintained path, your chances of infecting your farm with previously absent weed types are reduced.

Now that you have a clean path to your farm, the next step is to make sure the immediate area around your farm is also kept well. Make sure that you leave enough space {at least 15 feet (about 40 cm)} between you and your neighbours' farm. You can decide to plant little shrubs on these border zones.

Having clear borders prevents confusion about the exact end of one person's field during harvest. This way, nobody harvests what they did not sow. Also, the shrubs or border trees you plant in these border zones can be economic plants such as shea that will someday provide you with additional food or income.

In cases of bush fires that are mostly spread by wind, your crops will be better protected even if your next neighbour's farm catches fire because the shrubs or border trees will prevent the fire from easily reaching your crops.

If you cannot plant shrubs or trees, you can leave the border zone free of weeds and clean all the time. They will also be useful because neighbouring farmers will use them to get to their farms and will not need to pass through your field to get to their farms. This reduces physical damage to your crops especially at the young stage when they could easily be stepped on and be killed.

Another aspect of farm sanitation is maintaining a clean environment within your farm. To have a clean environment within your farm, you must always plant in rows and carry out regular weeding. The messages on weed management and proper planting teach more on how to plant in rows and weeding time intervals and their benefits.

You must also remember to safely dispose of all chemical containers you use on your farm by breaking the bottles and burying them away from areas that can be easily dug up.

Lastly, other farmers might come to borrow your tools such as hoes and cutlasses to work on their farms. After the tools are returned, make sure you wash and clean them carefully to avoid transferring pathogens (disease-causing organisms) and other contaminants onto your farm.

Whenever you detect diseased or pest-infested crops on your field, make sure you inform and consult your CEA/AEA on the best control measure to avoid the spread of the disease or pest to other crops.

Remember to always keep your farm clean; this will help in making your farm operations easy and go a long way to reduce diseases and pests on your farm which can lead to increases in your yields.

16.2 Some farm sanitation tips

- Never leave chemical containers on the field after use
- Keep paths leading to your farm cleared always and devoid of weeds
- Keep clear paths on your field to allow for easy movement between plants
- Use sterilized or disease-free seeds for sowing.
- Properly select healthy plants for transplanting.
- Keep weeds under control at all times. Keep the surroundings of your farm free of weeds, unless they are maintained and intended as habitat for natural enemies.
- Make yourself 'clean'. Always bear in mind that you might be the carrier of the pests while you move from one plant to another.
- Pull plants that are heavily infected with insect pests and those that are showing heavy symptoms of disease infection.
- Prune the plant parts where insect pests are found congregating and those that are showing heavy symptoms of disease infection.
- Properly dispose of all the infested plants. Do not put them on compost pile.
- Pick rotten fruits and collect those that dropped. Diseased and pest infested fruits must be properly disposed. Do not put them on compost pile.
- Plough-under the crop residues and organic mulches. This improves the soil condition and helps disrupt the pest's lifecycle. The pest is exposed to extreme temperature, mechanical injury, and predators.
- Maintain cleanliness on the irrigation canals.
- When possible, remove all the crop residues after harvest. Add these to your compost pile.
- Make your own compost. Your compost pile is where you can place your plant trimmings and other plant debris.
- Clean your farm tools. Wash ploughs, harrows, shovels, trowels, pruning gears, after use. Lightly apply oil to pruning gears.

16.3 Benefits of good sanitation practices on your field

- Reduces the chances of spread of dangerous weed species to your field
- Reduces the chances of spread of diseases from other fields to yours
- Reduces the incidence of pests on your field by eliminating hiding spaces
- Reduces the chances of physical damage to crops by creating lanes on field

It reduces chances of re-use of chemical containers for domestic purposes that may result in poisoning

Key sanitation principles

- **Sterilization** - The destruction of all infective and reproductive forms of all microorganisms (bacteria, fungi, virus, etc.).
- **Disinfection** - The destruction of all vegetative forms of microorganisms. Spores are not destroyed.
- **Sanitation** - The reduction of pathogenic organism numbers to a level at which they do not pose a disease threat to their host.

CHAPTER SEVENTEEN

PROPER AND SAFE USE OF AGROCHEMICALS

17.0 Introduction

Agrochemicals are very useful in farming but because they are chemicals, if they are not properly used they can cause harm to the crops, the environment or the user. As a groundnut, cowpea or soybean farmer, the kind of agrochemicals you will be using most are weedicides, fertilizers, pesticides and fungicides.

Some important benefits of agrochemicals are as follows;

- **Increase food quality and quantity:** Crop protection technologies allow producers to increase crop yields and efficiency of food production processes. Up to 40 percent of the world's potential crop production is already lost annually because of the effects of weeds, pests and diseases. These crop losses would be doubled if existing agrochemicals uses were abandoned. In addition, it allow consumers to consume high-quality products that are free of insect blemishes and insect contamination.
- **Decrease price of food:** Because the use of agrochemicals improves crop yields, crop protection technologies also impact the cost of food. Without crop protection chemicals, food production would decline, many fruits and vegetables would be in short supply and prices would rise. Helping to keep food prices in check for the consumer is another large benefit of these chemicals.

Despite their immense benefits, these chemicals can cause harm to the crops we are trying to protect or to the environment and the user if not properly used. For example agrochemicals use can cause reduction in biodiversity, inhibit nitrogen fixation contributes to pollinator decline destroys habitat (especially for birds) and threatens endangered species.

Other effects found to be associated with use of agrochemicals are;

- Excessive use of chemical fertilizers on the same piece of land for extended periods of time can result in contamination of underground water with nitrate making it unsafe for consumption by humans and livestock
- In sloping fields, run-off that occurs immediately after fertilizer application results in the poisoning of streams and lakes that can cause the death of fishes and the rapid multiplication of algae and other organisms that come along with certain diseases or environmental hazards
- Excessive use of chemicals to control pests can result in the elimination of certain non-target species which can result in the destruction or disruption of the natural ecological system of a particular area.

In view of the side effects associated with use of agrochemicals, we are going to discuss some guidelines to follow when using agrochemicals to make the process safe and effective.

17.1 Guidelines for proper use of agrochemicals

To safely use any kind of chemical on your farm, there are certain basic rules and regulations you need to follow:

Before you decide to use chemicals on your farm, please discuss with your AEA/CEA to help you decide where to find reliable dealers, which type to use and how to properly use them. Without seeking information, you might either over-apply or under-apply which will not give you the kind of results you would have gotten if done properly. As a result, you might spend a lot of money buying the chemicals but without any benefit to your crops. If you are using weedicides on your field which is under cultivation, you can use selective weedicides which will only target the weeds on the field without affecting your crops. You should always read the label of the chemical container for guidelines on how to properly prepare the mixture and properly apply it to your crop. This will contain information on the mixing ratios for that particular chemical per acre and what kind of weeds, pests or diseases it is best suited for.

You also need to remember the following safety tips whenever you are working with chemicals:

- Make sure there are no kids, animals and other unprotected people around you when you are preparing your chemicals.
- Wear overalls if available. If not, wear shirts with long sleeves, thick pairs of trousers or jeans and boots (not sandals) before you begin working with the chemicals.
- Do not forget to buy your gloves and nose masks when you visit your dealer to buy the chemicals. They are very important.
- You should always mix chemicals outdoors away from your compound and not in your room.
- Only mix the amounts you can use at a time. Don't mix in excess and store the rest because the chemical might become less potent and also pose danger to others. Follow recommended mixture ratios accurately and avoid using too little water or too much water. Too little water makes the chemical hazardous to crops and the environment and too much water makes the chemical weak or less potent.
- During application, always have your back to the direction of the wind otherwise you face the risk of having direct contact with the chemical which might be harmful to you.
- Always apply your chemicals in the morning or late afternoon when the weather is clear. Work your way backwards from one end of the field to the other and do not walk back through the farm when you have finished applying the chemicals
- Always have another person close by who can offer assistance in case the chemical gets into your eyes or in case there is an emergency.
- After application, make sure you wash your hands with soap, take a bath and soak your clothes before you touch food or go back home. You should also wash out your knapsack sprayer with clean water and throw away the water at a safe place away from water bodies.

- Break the chemical containers to make them unusable before you bury them in the ground away from common places where they can easily be dug up by others.
- Do not mix weedicides with other chemicals with the mind that it will make it stronger; it will rather make it weaker. As a reminder try and put on protective clothes and properly apply the chemical as shown in Figure 19 below.



Figure 19 Proper dressing and application of agrochemicals

Source: IPA-Ghana, Tamale –Demonstration plot

If you follow the safety instructions mentioned above properly, prepare and apply the chemicals as directed on the label of the container or by your CEA/AEA, you will maximize the benefits of the chemicals as well as protect yourself. Both you and your crops will be healthy and you will enjoy a very good harvest.

Additional Information / Summary Highlights

Improper use of agrochemicals can negatively affect the environment and health of humans. In agriculture, chemicals can either be used on the field to suppress weeds, insects, pests and diseases caused by several pathogens. They can also be used in storage to treat grains for longer storage shelf-life. In the use of these chemicals, however, if proper care is not taken, damage can be caused to the environment and humans. It is therefore very important to follow the recommended guidelines for purchasing, preparing and applying chemicals to fields.

17.2 Steps to take when chemical contact/poisoning occurs

During use of agrochemicals, accidents might happen that will result in harmful exposure to the toxic substances contained in them. Below are a few guidelines or steps that should be taken in such situations:

17.2.1 Contact of chemicals with eyes

Whenever chemicals get into the eyes of the user, you need to rinse with clean water. Rinsing of the eyes should be done gently and eyes should not be rubbed. As you do this, keep the face of the user facing down and to the side to allow for the chemicals to escape. It is therefore very important to always have a container filled with clean water on standby in case this happens and always have someone close by to offer you such assistance if the need arises. As a preventative measure, it is however advisable to always wear goggles when using chemicals.

Note: This is only first aid that should be done while the victim is being transported to a clinic or hospital for treatment.

17.2.2 Chemicals getting inhaled

If chemicals are inhaled during preparation or application, victims should be moved immediately to open areas where they can get fresh air to breath.

17.2.3 Chemicals in contact with the skin

If chemicals pour on the skin, quickly remove all contaminated clothing and wash all contact areas of the skin with soap and clean water.

17.3 Symptoms of chemical poisoning

If you observe the following signs soon after using chemicals on your field, they may be indications of chemical poisoning for which you should immediately seek medical attention at a clinic or hospital.

17.3.1 Mild poisoning

- Headache
- Sweating
- Diarrhoea
- Irritation of Nose and Throat
- Eye Irritation
- Nausea & Fatigue
- Skin Irritation
- Loss Of Appetite
- Weakness
- Restlessness
- Dizziness
- Sore Joints

17.3.2 Severe poisoning

- Vomiting
- Convulsions
- Inability to Breathe
- Fever
- Muscle Twitching
- Constriction of Eye Pupils (Eye Pupils Become Small)

- Increased Rate of Breathing

Note: These signs are symptoms that could indicate poisoning. It does not mean anytime there are these symptoms, there has been a chemical poisoning.

Whenever there is an incident on the farm or in the house involving chemicals, apply the relevant first aid treatment as the first step and then take the victim to a clinic or hospital for early treatment.

CHAPTER EIGHTEEN

CROP ROTATION

18.0 Introduction

Crop rotation is the practice of using the natural biological and physical properties of crops to benefit the growth, health, and competitive advantage of other crops. In this process the soil biodiversity also benefits. The desired result is a farm which is more productive and to a large extent self-reliant in resources.

It can also be defined as a series of different crops planted in the same field following a defined order. Crop rotation with legumes for example has been found to improve soil physical, chemical and biological conditions.

Crop rotation require multidimensional thinking. Rotation management requires understanding both the whole farm and each individual field and balancing field and farm-scale decisions.

Luckily, land in Northern Ghana is suitable for a variety of crops. You can easily grow legumes like soybeans, groundnut or cowpea; cereals like rice, maize or millet; tubers like yam, cassava and even vegetables like cabbage, onion and green pepper. These different kinds of crops have different nutrient requirements and affect the soil balance differently. They are also susceptible to different pests and diseases. To keep your land fertile and strong for a long time, it is important to routinely change the crop you cultivate on particular fields. Crop rotation comes with several benefits. In this message, we are going to discuss some of the benefits you can get from rotating your crops and also how to develop a suitable crop rotation plan specifically for your field.

18.1 Benefits of crop rotation

If you have a recurring problem with some particular pests and diseases on your field, practicing crop rotation can help you eliminate them without using any pesticides or insecticides. This is because some pests and diseases can only infect or

attack specific crops. This means that when you change the crop cultivated on that field, the diseases and pests will not have a susceptible host to attack. Hence they will either migrate to a different area where they can get the types of crops they want or will die off on the field. For example, a very common pest of maize is the stalk borer. This pest feeds on the maize plants and causes a significant reduction in productivity of the crops. Now, if you identify this pest on your field and grow groundnut the following year, you will be eliminating these pests from your field because they do not like groundnut.

The second benefit of crop rotation is that it helps to rejuvenate the soil on your field. Legume cultivation is very vital for this purpose. This is because legumes like groundnuts, cowpea and soybean have the ability to fix atmospheric nitrogen into the soil and feeds mainly on phosphorus and potassium. Such crops are called light feeders because they require less nutrients from the soil. Maize and other cereals rely heavily on nitrogen and less on phosphorus. So by rotating the cultivation of maize and groundnut plus other crops, you ensure a continuous balance of the nutrients in the soil.

To summarize, crop rotation has the following benefits;

- Helps to reduce incidence of certain pests in a particular area
- Helps to reduce incidence of certain diseases in a particular area
- Helps in restoration of lost nutrients from fields
- Helps in fighting certain parasitic weed species from areas where they are dominant
- Farmer gains experience in the cultivation of multiple crop types
- Cultivation of different crop types leads to improved soil properties and fertility.

18.2 Guidelines and principles of crop rotation

The first thing you need to know to enable you draw a good crop rotation plan is to identify the type of soil you have on your field. Knowing the soil type helps you to know exactly which crops can be successfully cultivated on them. You can accurately

do this by getting your soil samples to CSIR-SARI at Nyankpala for testing. However, if you cannot afford to do this, you can refer to the crop history of your community to know exactly which crops have been successfully cultivated. By doing this, you will know which crops to include in your rotation plan (even though you might miss out on some crops that have never been grown there but might perform well if tried).

The second step is to look back on your crop cultivation history on that field for the last 4 or 5 years. If you have only been cultivating one particular crop, then it is time to grow a different crop. For example, if you have been growing maize alone, then it is time to cultivate some light feeders such as vegetables like onion and cabbage or legumes like soybeans and groundnut. Also, if you have only been cultivating legumes, then trying maize will be a good idea as it will make good use of the nitrogen that has been incorporated into the soil by the years of legume cultivation. The third step is to decide on a long term plan for cultivating your field that allows your field to not be burdened. You can decide on any of the following plans based on your main focus crop and how the field has been cultivated in the past:

1. You can grow your legumes for 1 year, maize the following year and repeat the cycle.
2. You can grow your legumes for 2 years, maize for 1 year and then go back to the legumes.
3. Grow legumes, followed by maize and then followed by vegetables.

The good thing about crop rotation is that it is very flexible. You just need to remember one very important principle: do not follow heavy feeders with each other. Always have a light feeder between, otherwise you will not be making good use of your crop rotation. You can also have a plan where shallow feeders like maize are followed by deep feeders like cotton. Occasionally, you can plant a root vegetable to reduce the burden on the land before you go back to interchanging the maize with soybeans, cowpea or groundnut.

Remember to not cultivate cereals after other cereals for extended periods of time. Always make sure you cultivate a legume or a vegetable crop between to reduce

the burden on the soil. If you have more than one piece of land for farming, you can grow maize on one and a legume (e.g. soybeans) on the other land. In the next season, however, you will need to interchange them. This way, you will be able to ensure that your fields are always fertile and able to support your crops every year. Practicing crop rotation will also help to eliminate the diseases and pests that affected your crop in the previous season. However, if you only have one piece of land, you can practice intercropping which will also help you maintain your soil fertility and control weeds and insect infestation.

Below are the specific things you need to know about crop rotation.

- Do not follow cereals with other cereals if you want to maximise the benefits of your crop rotation regimes
- Do not follow legumes with other legumes if you want to maximise the benefits of your crop rotation regimes
- Follow heavy feeders with light feeders
- Follow deep feeders with shallow feeders

18.3 Crop types and examples

Classification by Family

- **Cereals** – maize, rice, sorghum, millet, etc.
- **Legumes** – soybean, cowpea, groundnut, Bambara beans, etc.
- **Vegetables** – Cabbage, Green pepper, tomatoes, onions, etc.
- **Roots and Tubers** – Yam, cassava, potatoes, etc.

Classification by feeding features

- Heavy Feeders
- Light Feeders
- Deep Feeders
- Shallow Feeders
- Givers

CHAPTER NINETEEN

WATER MANAGEMENT

19.0 Introduction

Northern Ghana experiences only one major rainy season in a year. This means that farmers who rely solely on rain for their farming can have only one harvest from their crops in the entire year. In southern Ghana, however, there are two rainy seasons, one major and the other minor which afford farmers there two seasons in a year. This tells us how critical the smaller rain we receive here in the north is and so the better we are able to manage it the better our farming will be. In this message, we will learn about practices that allow you to make the best use of water for your farming.

Good water management is when you are able to balance the effects of water supply from rainfall or irrigation and water loss through evaporation and transpiration (evapotranspiration) or run-off. Good water management begins right from land preparation.

19.1 Role of water in the growth and development of crops

It is important to know that up to 90% of plants is water. This means that water is very critical to the overall growth of crops. Below are some of the roles played by water in the development of your crops:

- **Water is a primary component of photosynthesis**

Photosynthesis is the process plants undergo to produce food. For this process to be complete, the plants need water in addition to sunlight and carbon dioxide. Therefore without water, this process will be incomplete and the food cannot be produced.

- **Water is a primary component of transpiration**

Transpiration is the process by which moisture is carried through plants from the roots to small pores on the underside of leaves where it is changed to vapour and

released into the environment. This process of water loss from the plant is very important because it enables the plant to cool itself and regulate its internal temperatures. This process of water loss to the environment also helps the plant to access CO₂ for photosynthesis.

- **Water enables turgor pressure in plants**

The presence of water in the plant regulates the turgor pressure in the plant. This pressure is what enables the plants to stand erect by inflating the cells.

- **Water serves as a medium of movement of minerals from the soil to the plant**

The nutrients needed for proper growth and development of plants are located within the soil. For these nutrients to be taken up by plants, they need to be dissolved in the water and then taken up by the plants through the roots.

- **Water serves as a medium to move products of photosynthesis through the plant**

All parts of the plant depend on the food produced by the plant through photosynthesis. Water serves as that medium through which the products of photosynthesis are moved to other parts of the plant.

- **Medium for biochemical reactions**

Water serves as the medium where very important reactions within the plant occur. Without sufficient water within the plants, these processes wouldn't happen.

19.2 Common symptoms of water stress

- Decreased growth
- Wilting
- Small, off-coloured leaves

- Reduced xylem growth = long-term growth reduction.

19.3 Impact of water shortage

- Reduced growth and vigour
- Nutrient deficiencies
- Reduced health of roots
- Reduced cooling effect

19.4 Soil water conservation techniques

Before deciding when to plant, you should observe the rainfall pattern in your community and neighbouring communities too. You should not plant immediately after you have recorded the first rain of the season because this rain might not supply the soil with enough moisture needed to sustain germination and early growth. It is therefore advisable to wait for at least three good rains before you plant. This will ensure that your field has sufficient water to aid germination and early growth of your plants. If you are not sure about what time to plant, consult your AEA or CEA but generally you should plant between early June and late July (depending on the crop) to ensure your plants do not face dry spells that will cause failure of your crop.

After clearing your field do not burn the weeds but leave them on the field to become mulch for your crops. This will reduce loss of soil moisture/water through evaporation and make more water available for your crops. Also, you can intercrop your cowpea, groundnut or soybean with vegetables which will cover up bare areas on your field and serve a similar purpose as the mulch. Please refer to the messages on mulching or intercropping to learn how these can be done properly.

Sandy soils have poor water-holding capacity and quickly lose water through evaporation when the weather gets hot. If your soil is sandy you can improve upon it by incorporating manure into it. This improves the soil structure and makes it hold water longer.

If you have a sloping field, it makes it easier for water to run off. This means that even if it rains, the water does not stay on the field long enough for it to be

absorbed by the plants to aid development of the crop and production of food. This can be addressed in two main ways – first, you need to make sure that during land preparation, you plough across the slope. After this you will need to construct contour bunds or ridges on the field. These are walls of earth built on sloping lands to stop the water from rushing down the field and washing away the top soil which contains most of the nutrients needed by your groundnut, cowpea and soybean plants to develop well. A good example of a contour bunds across a slope is shown in Figure 20 below.



Figure 20 Contour bunds across a sloppy field

Another measure you can put in place is to construct mini-dams/reservoirs with your neighbouring farmers. By building a reservoir, you can collect and store rainwater when it rains and use it to manually water your fields during dry periods when your plants are beginning to suffer from drought.

On the other hand, too much water for groundnut, cowpea and soybean arising from flood conditions will negatively affect the crops. On more clayey fields, this might be a problem. If you have a field that is clayey, you can construct drainage

channels, canals or gutters to aid in the outflow of excess water from the field. Even if your field is not clayey and you record very long and intensive rains which cause large pools of water to collect on your field, you should use these canals to drain off the excess water from your field.

In addition to the above water management practices, you can plant drought-tolerant crop varieties. These varieties are able to guarantee some level of yield under dry conditions. Contact your CEA or AEA for information on how to get drought-tolerant varieties of soybean, groundnut and cowpea recommended for your locality.

If you follow these recommendations, you should be able to get enough water on your farm to guarantee better yields.

Additional Information / Summary Highlights

Water/rainfall requirement by crops

Groundnut – 500 to 700 mm

Cowpea – 300 to 400 mm

Soybean – 450 to 650 mm

Water-logged soils

- Root activity slows or shuts down, and plants show symptoms of drought
- Decline in root growth slows plant growth processes
- Leaves may wilt from lack of water uptake
- Root rots are common in some species
- Lower interior leaves may yellow

CHAPTER TWENTY

RECORD KEEPING

20.0 Introduction

Like our elders say “to decide where you are going next, you need to remember where you have been”. In summary, this is what this message is going to talk about. This message is on record keeping and is meant to teach the different types of farming records to be kept and how they can benefit your farming significantly.

Farming, just like any other business, needs a careful management to be successful and one of the tools that can help you to successfully manage your farm is record keeping. Accurate and up-to-date records are essential for successful farm management. Before any financial decision can be made, farm records must be maintained. Farm records are basically kept for income tax purposes, obtaining credit i.e. helps in filling out loan applications and it is a management tool which aid in planning and budgeting your farm business. You can keep records of different kinds on your farming operations such as records on expenditure, income, activity details and relevant contacts.

To start with, you will need to get a note book which will be used only for keeping records related to your farming operations. If you cannot write, get someone within your community who can help you like your CEA/AEA.

20.1 Expenditure records

For your expenditure records page, you should make five columns labeled Date, Description, Quantity, Unit Price and Total Cost. The description column should always state clearly what you are purchasing or spending the money on such as payment for tractor services. Every time you buy something or pay for a service for your farm, you should record it on this page of your notebook. An example is shown in the table below.

<i>Date</i>	<i>Item/Description</i>	<i>Quantity</i>	<i>Unit Cost (GH¢)</i>	<i>Total Cost(GH¢)</i>
<i>June 1, 2014</i>	<i>Certified Seeds</i>	<i>1 Packet</i>	<i>20</i>	<i>20</i>
<i>July 15, 2014</i>	<i>NPK 15-15-15</i>	<i>2 Bags</i>	<i>55</i>	<i>110</i>
<i>Sept.9, 2014</i>	<i>Urea</i>	<i>1 Bag</i>	<i>70</i>	<i>70</i>
<i>June 20, 2014</i>	<i>Labor – Ploughing</i>	<i>5 People</i>	<i>1 Bowl of Maize (5)</i>	<i>5 Bowls of Maize 25</i>
<i>August 12, 2014</i>	<i>Labor – Weeding</i>	<i>4 People</i>	<i>10</i>	<i>40</i>
Total				265

20.2 Revenue record

Similarly, you should have another page for only recording income you get from your farming operations. Like the one for expenditure, this should also have Date, Description, Quantity, Unit Price and Total Amount. Every time you manage to sell some of the produce from your harvest, you should record it on this page at the price at which you sold them. An example of this type of record is shown below.

<i>Date</i>	<i>Item/Description</i>	<i>Quantity</i>	<i>Unit price(GH¢)</i>	<i>Amount (GH¢)</i>
<i>May 12, 2014</i>	<i>Hiring out draught animals</i>	<i>4 Farmers</i>	<i>25</i>	<i>100</i>
<i>Dec15, 2014</i>	<i>Sold maize harvest</i>	<i>10 Bags</i>	<i>55</i>	<i>550</i>
<i>Dec20, 2014</i>	<i>Sold soya harvest</i>	<i>8 bags</i>	<i>80</i>	<i>640</i>
<i>Jan 17, 2014</i>	<i>Sold goats</i>	<i>4</i>	<i>45</i>	<i>180</i>
Total revenue (GH¢)				1,470

20.3 Operational records

The third kind of records you should keep is on the details of your farming activities. These should always include the dates the activities were carried out. For example, if you wanted to record on fertilizer application, you would enter date of application, number of bags and type of fertilizer applied and how the fertilizer was applied. For records on planting, you would enter the variety of seed planted, date of planting and total number of acres planted.

Finally, you can keep records of the contacts of all individuals or companies relevant to your farming operations. Examples of these would be the contacts of your CEA, AEA, Input dealer, buyers of your produce, tractor service provider, etc. In short, anyone you hold transactions with in connection with your farming business should have their contact details and addresses recorded on this page in your notebook.

Finally, you should never forget to take receipts for all purchases you make as they may be useful in subsequent transactions such as dealing with a rural bank or credit institution.

At the end of the season, you can refer to all the entries you have made in this book to correctly calculate your total expenditure and hence the profit. This book should also be consulted when making important decisions such as number of people to contract to work on your field. Perhaps you hired too many this year and had to pay too much or you hired too few and the process took too long which then might have damaged your crops.

20.4 Benefits of proper record keeping

- Helps you track expenditures made on your farm at any given time
- Helps you estimate all pending costs and expenses yet to be made on your farm
- Helps you in planning and making decisions related to your farming for the current and subsequent seasons
- Helps in calculating the profit or loss made during the season
- By keeping proper records, you do not lose contacts of people who play important roles in your farming
- It serves as a management tool: accurate farm record help the farmer to make necessary adjustments to operate more efficiently.
- Farm record is needed for the preparation of tax documents.
- Above all if you have plans to access a loan facility from a bank, the records you have been keeping will become very useful and might help you secure a loan if you are able to provide documents and receipts that track your previous farm income and transactions.

20.5 Recommended record keeping practices

- Keep special book dedicated solely for keeping records related to your farming
- Make entries on days of transactions – do not wait to enter them later. You might forget
- Your records book covers different types of records. Keep different record types on separate pages. Do not mix up different record types on the same page.
- When making calculations in your record book, first do them on rough sheets or jotters. After you have completed the calculations and are sure, you can then transfer them into your records book permanently.
- Always take receipts for the transactions or purchases made for your farm and keep them all together in a safe and protected place.

20.6 Recommended transaction practices

- When making purchases, always get prices from multiple sources. This will help you get the best and most competitive prices for the services or products you want to purchase.
- If you have to travel long distances to purchase inputs for your farm, always announce to your fellow farmers within the community to compile all orders. This way, you will be able to split the transportation costs with them and save some money.
- Always check the expiry date of all inputs you purchase for your fields. By doing this, you will avoid wasting money on damaged products that will not be effective and may end up causing harm to your crops
- Make orders for services ahead of time. Do not wait too long until the service becomes urgent before contacting the service provider. It might be too late to place an order and sometimes might lead to an increase in prices of goods and services.
- If you do not have pre-agreed prices with buyers for your produce, always make sure to have a contact person at market centres to keep you regularly updated

on current market prices of commodities. This will inform you on the best time to sell your produce to make the most of your harvest.

- When transporting produce to market centres, always negotiate to do it together with your fellow farmers to save cost

CHAPTER TWENTY ONE

INTERCROPPING

21.0 Introduction

Although some men grow legumes, cowpea, soybean and groundnut are often considered to be “female” crops in Northern Ghana with most men preferring to cultivate cereals and tubers while women usually go for the leguminous crops.

It is quite common to have same households cultivating all these crops but usually, the fields are separate with one completely dedicated to a particular crop. There is a different way to do this which is more beneficial to the household and also sustainable for the fields cultivated. This is called intercropping.

In this message, we are going to discuss how to develop a good intercropping plan for your field and reap all the benefits that come along with intercropping.

Intercropping is the practice of growing multiple crops on the same piece of land at the same time. There are several intercropping systems you can choose from. With the help of your CEA/AEA, you can decide which variation will be more suitable for the crops you choose and the nature of your field. Because of the special ability of cowpea, groundnuts and soybean to fix nitrogen from the atmosphere into the soil, it makes them a very vital component crop in most effective intercropping systems. Because of this ability, they rely less on the soil for nitrogen as compared to other crops and feed more on phosphorus and potassium from the soil. So the principle would be to intercrop any of these crops with cereals, vegetables or tubers.

21.1 Types of intercropping

Some of the systems of intercropping you can use on your farm are:

Row intercropping: In this system, when planting your field, you will plant one row of either groundnut, soybean or cowpea and then another row of the other crop. You will repeat this pattern throughout the entire field.

Strip intercropping: In this system, when planting your field, you can have three or four rows of either groundnut, soybean or cowpea and then another one or two rows of the other crop being intercropped or vice versa.

Mixed intercropping: In this system, you can grow one or more of the groundnut, cowpea or soybean together with any of the other crops in no distinct row arrangement. Even though this is equally beneficial to the farm, it makes farming operations difficult and more tedious.

Relay intercropping. In this system, you can plant the groundnut, cowpea or soybean into the other crop after the other crop has reached its reproductive stage but before harvesting. Figure 21 is pictorial depiction of the types of intercropping described above.



Row intercropping



Strip intercropping



Relay intercropping



Mixed intercropping

Figure 21 Types of intercropping

Whichever type of intercropping system you choose, you should consider the nature of your field and the crops you want to intercrop with your groundnut, cowpea or soybean. You can decide to intercrop maize, millet, sorghum, yam, cassava, tomatoes, etc. with your cowpea, soya and groundnuts. For subsequent intercropping seasons, you can then interchange rows for the other crop.

Intercropping has several benefits for you and your farm, namely

- Because of the different kinds of crops, you will be able to maintain a standard level of fertility for your field from season to season.
- Intercropping helps to check diseases and pests that would usually affect a single crop stand
- Intercropping helps in weed control as the crops compete for space with the weeds
- Intercropping provides a buffer crop on your field which will provide you with some harvest if your main crop fails

With intercropping, the different kinds of crops grown means that you will have a varied food basket to feed your family.

Practicing intercropping and other sustainable farming systems will make your farming more profitable while making your land more fertile at the same time.

When intercropping, however, care should be taken to not create an environment of competition amongst the different crops.

21.2 Considerations when intercropping

When deciding on an intercropping system, you should consider several factors that will allow you to derive maximum benefits from the system. Some of these considerations are as follows:

- **Adjustments in plant density to avoid overcrowding**

Intercropped farms have more than a single crop growing on the field at a time. Because of this, careful consideration should be given to the planting distances used during planting. If you plan to practice intercropping, recommended planting distances for your crops need to be modified to avoid overcrowding of fields. This usually means adding about 5 to 10 centimetres to the inter-row or intra-row distances depending on the specific type of intercropping system being used. Adding the extra spacing allows space for crops to grow very well. Also, it allows space for movement between crops without causing physical damage to the crops.

Without the additional spacing, it will be very difficult to move on the farm once the crops have reached maturity.

- **Maturity dates or development periods to maximize use of nutrients and other resources**

Crops require different nutrients at the various stages of growth of the plants. E. g. during fruiting, plants may require more of nitrogen as compared to other nutrients. Therefore it is very vital to consider the planting times of the different crop types and their maturity periods. Properly planning this will ensure that the crops reach these stages at different times so as to not create a condition of excessive competition for the same nutrients at a given time. Therefore, based on the maturity period of the two or three crops being intercropped, you can properly time the dates of your planting so that they all don't reach fruiting or vegetative growth at the same time.

- **Utilizing plant structure that provides for a diversity in heights with one plant providing a support for the other to grow**

The key characteristic of a proper intercropping system is to have crops that complement each other in nutrient needs, growth habits and physical attributes. This means that you will not be maximizing the benefits of intercropping if you grow two creeping plants as intercrops. An example of such consideration is to plant corn with climbing beans so that they can use the maize plants as stakes to support their upward growth.

- **Adjustments in nutrient requirements to account for those being supplied by inter cropping system**

For proper intercropping systems, you might have nitrogen fixers intercropped with nitrogen- dependent crops. This allows for the dependent crops to feed on the nutrient supplements supplied by the nutrient givers. Such systems reduce the amount of chemical fertilizers that need to be supplied for good growth of the crops.

CHAPTER TWENTY TWO

TIMELY AND PROPER WEED MANAGEMENT

22.0 Introduction

During the course of the season, your crops will face several challenges before harvest time arrives. How your crops are able to cope with these challenges will determine the kind of yield you get at the end of the season. Among the challenges your groundnut, cowpea and soybean crops can face are pests, drought, diseases, weeds, etc.

A weed is simply any plant that causes nuisance to a crop. It takes advantage of resources available to crops. On a farm, weeds are those plants that negatively affect crop production by competing with crops for resources, such as sunlight, nutrients and water which potentially reduce crop yields. The presence of weeds also increase production cost resulting from the cost of controlling them and the insects and diseases they harbour.

For weeds to establish on your field, they need a few factors to thrive. Like all other crops, they will need space, moisture and nutrients to grow but unlike most cultivated crops, they are much more resilient and tolerant to less favourable conditions. This means that if they are allowed to co-exist with the soybean, cowpea and groundnut crops, your crops will be overcome because weeds compete with crops for nutrients, water, sunlight, and other vital resources necessary for adequate plant growth. Some types of weeds (parasitic weeds) send their roots into the roots of crop plants and siphon their nutrients resulting in very poor growth and development. Weeds may also carry diseases and pests that can cause harm to your plants. It means by properly controlling the weeds on your field, you would have removed one of the challenges faced by your crops in achieving a good yield. This is the reason why weed control measures have to always be timely.

Weeds come in different sizes and types but they all cause harm to crops. It is therefore very important to learn how to effectively control them to ensure that

they do not harm your crops and reduce your harvest. In this message, we are going to focus on weeds and the practices that can help manage them to reduce the negative impact they have on your crops. Other messages will deal with the other challenges and how to address them accordingly.

22.1 Methods of weed control

Weed control activities are very critical in the early stages when your crops have not yet formed a canopy to suppress the growth of the weeds. Groundnut for example cannot compete effectively with weeds particularly in the first 3-6 weeks after sowing. Weeding should therefore be done regularly from the second week after planting until the canopies are formed.

In cultivating groundnut, cowpea or soybean, you have an advantage over other kinds of crops. If you use the recommended planting distances, you will be able to considerably reduce the amount of space available between the crops for weeds to establish. Aside this you can control weeds manually, mulching, proper tillage, use of other plants and chemicals (herbicides). However, the ultimate choice depends on the species of weed involved and the level of infestation. These methods of weed control are briefly discussed in this section.

- ***Proper tillage***

Tilling refers to the practice of preparing the soil on your field for planting. This can either be done mechanically with tractors, manually with hoes and cutlasses or with draught animals. During tilling, the soil is usually turned and this results in weeds being buried, causing them to die. Properly tilled fields take some time before weeds become re-established.



Figure 22 A tractor ploughing field before planting

Source: Archives of

IPA-Ghana, Tamale.

- ***Mulching***

Mulching is the practice of leaving materials (mostly organic) on the soil surface amongst crops. In addition to controlling the loss of water from the soil, these mulch materials also serve to suppress the growth of weeds on the field. Before mulching, however, make sure to kill all the weeds on the field either by hoeing or use of weedicides.



Figure 23 Demonstration of a well-mulched cowpea field with weed growth suppressed

Source: IPA-Ghana, Tamale.

- ***Manual removal***

Manual removal of weeds is by far the most common method of weed control in northern Ghana. Tools usually used are the hoe and cutlass. For manual weed removal, care should be taken so as to not cause physical damage to the crops. Also, weeding should target the roots of the weeds and not only the above-ground growth. If weeds are not removed at the root level, it does not take long for them to re-establish. As in all weed control methods, this should be timely.

It is always good to weed your farm at least twice before the plants form a canopy to suppress the growth of weeds on their own. The first weeding can be done in two or three weeks after sowing with the second one in another two or three weeks after the first weeding.

Remember that all weeding activities must be timely to minimize competition and avoid irreversible damages to your crops.



Farmer using a hoe to control weeds

Figure 24 Manual weed control

- ***Use of chemicals (weedicides/herbicides)***

Another method of controlling weeds on your farm is through the use of chemicals. Chemical weed control saves time and involves less labour cost. However, if you cannot afford weedicides to fight the weeds on your field, make sure you carry out your manual weeding safely without causing any damage to your crops in the process.

You can apply pre-emergence weedicides before planting or immediately after planting before any weeds appear on your field. With pre-emergence weedicides, you may not need to weed your farm because by the time the chemical wears out on your field to allow weeds to germinate, your crops may have established a closed canopy which will make it very difficult for weeds to grow.

You can also decide to use post-emergence weedicides which kill certain target weeds while leaving the desired crop relatively unharmed after application. These kinds of weedicides will kill only the weeds and will not cause any damage to your groundnut, cowpea or soybean plants. E.g. alligator (pedementhalein)

To control weeds using herbicides it is always advisable to ask your CEA, AEA or input dealer for brands of selective weedicides.

To summarize, herbicides are generally classified as follows:

- **Contact herbicides** – these types of chemicals destroy only plant tissue that they come into contact with. Generally, these are the fastest-acting herbicides. They are ineffective on perennial plants that can re-grow from roots or tubers.
- **Systemic herbicides** are foliar-applied and move through the plant where they destroy a greater amount of tissue.
- **Soil-borne herbicides** are applied to the soil and are taken up by the roots of the target plant.
- **Pre-emergence herbicides** are applied to the soil before planted seeds emerge and they prevent germination or early growth of weed seeds.

- ***Using of other plants to fight weeds***

Some plants are able to produce substances from their roots that are harmful to herbaceous weeds. Examples of such crops are marigold plant species. Other plants can also be planted along the sides of your field as border plants to prevent the invasion of certain weed types into your farm.

Remember that if you control weeds properly on your farm you have healthy crops and good harvest in the end. Your cowpea farm for example, should look similar to the picture in Figure 25 below.



Figure 25 A clean cowpea farm
plot

Source: IPA-Ghana, Tamale –demonstration

CHAPTER TWENTY THREE

LABOUR MANAGEMENT

23.0 Introduction

Farmers spend a lot of money on different activities during a growing season. They need to buy fertilizers, seeds, weedicides, pay for tractor services and transportation of harvested produce. Surprising to most people, however, the most expensive cost in farming is not any of these, but labour. Since the majority of our farmers are small-scale farmers who do not practice mechanized farming, farm activities such as planting, weeding and harvesting are all done manually. Farmers may have three different sources of labour –the farm family (family labour), hired labour and labour provided through cooperation between members of the community. Due to the labour-intensive nature of the farm activities, farmers usually engage their children, spouses, neighbours and other family members in carrying them out. A farmer may use any or all sources of labour on the farm depending on the situation. The total effort from labour is made up of people, skill and time available. Figure 26 below is a farmer making use of family labour.



Figure 26 A farmer working in the field with family labour

On big farms, most of this work is either done by machines – which are much faster and efficient - or by hired farm labourers who are paid according to the amount of work they do. Imagine your farming activities were like this, which means you have to pay yourself and all your family members for all the days spent working on the farm. This will constitute your total cost of labour for one season.

In this message, we will learn about how to properly plan the time spent on the farm and how to monitor people who work on your farm in order to be more productive and efficient – this is called labour management.

23.1 Proper labour management tips

The first step in proper labour management is to consider your labour resources when determining your scale of production or farm size. At the start of the season when you are deciding how many acres of your groundnut, cowpea or soybean to cultivate, consider the number of people in your household who can help you to cultivate that size of land and whether or not you can afford to hire the extra labour to make up the difference. **The rule is simple: the bigger your farm, the more labour you need.**



Figure 27 Farm workers preparing ridges

In modern farming, it is not really about how big your farm is but, rather, how well you cultivate the little you have – that is why it is possible that a farmer who cultivates only three acres can harvest the same as another farmer who cultivates five acres. If you cannot afford hired labour, don't cultivate a big field; only cultivate the size of land that you and your family can manage very well. Otherwise, you will be overburdened and cannot provide the care your farm needs to do well.

Whether you are hiring labour or working with your family on your farm, you should always remember to assign roles. For example, if you have three people helping you on your farm with harvesting, you can split the task –you and the next eldest can be responsible for breaking the cobs of the maize plant and piling them in small heaps on the field. The remaining two can be tasked with collecting these small piles from the main field and gathering them into heaps at the side of the field under the shade. If you do this, work will be more efficient.



Figure 28 A household sharing harvesting tasks

In assigning tasks, consider the ability of the individual and always remember to be fair. For example, on a weeding day, you can assign a portion to an individual. If you (an adult) are responsible for 10 rows, your son can be assigned to about four or five rows. This way, you are able to tell who completed their tasks at the end of the day. A clear responsibility also serves as motivation to inspire hard work.

Before you hire people to work on your farm, you should be clear on the task and the number of people you will need. You can now talk to other farmers and get recommendations on the best labourers around. Three hard-working labourers could weed a field in the same amount of time it would take five average labourers to do.

Once you know the hardest working labourers in your community, maintain a good working relationship with them. This ensures that anytime you call on them to work on your farm, they will respond and be committed to getting the work done well and on time. They may even work for you on credit if you do not have money readily available to pay them.

You do not need to be on the farm throughout the day. Farm work is best done early in the morning and early evening after the sun has gone down – it is healthier, and you will spend less energy to do the same amount of work.

Remember not to take your kids to the farm when they are supposed to be in school. You can take them to the farm on weekends or after school when they return home. If you are a pregnant woman, you should have a reduced workload for good health.

Remember that if labour is properly planned and managed, you and your family can cultivate many fields with the same amount of time and resources. You could even engage in other money-making activities with the spared time.

CHAPTER TWENTY FOUR

FALLOWING

24.0 Introduction

In some communities, access to sufficient farming land is a problem. This means that farmers can cultivate a particular field for several years without allowing the field to rest and regain its strength and fertility. The problem becomes even more serious if there is no intercropping or crop rotation plan. This results in the overburdening of the field which causes a gradual decline in productivity.

In this message, we are going to talk about fallowing which is the practice of allowing the field to rest for a period without cultivation. If you have continuously cultivated your field for a very long time without allowing it to fallow, the soil becomes depleted of the nutrients needed to support proper growth of crops.

24.1 When to allow your farmland to fallow

A good way of knowing that your field needs to rest is when you realize a significant reduction in your yields over time even if you continue to apply the same amount of fertilizer. For proper fallowing, there are a few factors you should consider. The longer you cultivate your field continuously, the longer it will need to fallow to regain its fertility for studies have shown that there is a significant positive relationship between length of fallow and crop yield. You can allow two years of fallow period for every 10-15 years of continuous cultivation of your field. Usually, farmers who practice fallowing simply allow the field to stand for some time and go back to cultivate it to their previous crops. However, fallowing can be designed better to gain more out of the time allowed for the field to rest.

24.2 Fallowing practices

The best way a soil is able to regain its strength is through the incorporation of organic materials. These organic materials decompose to become nutrients in the soil. The presence of these organic materials also facilitates the activities of soil organisms which improve upon the structure and texture of the soil. You can therefore help quicken the results of fallowing by periodically adding organic materials to the field. These can be leaves, grasses, tree branches, animal droppings, etc. On the other hand, it is possible to grow specific plants on the field during the fallow period. Know that the purpose of growing these specific plants is not to harvest them but to improve upon the soil. After planting the field with these plants, you wait until the crops have grown to the vegetative stage at which point they have the most leaves and have spread out on the field. At that point, you can slash the plants and allow them to decompose into the soil. This can be done several times in a single year and you would be incorporating so much organic material into the soil that would otherwise have taken several years to achieve. Examples of crops that can be used are *Centrosema*, *Crotalaria*, *Calopogonium* and *Mucuna*. These crops have very high nitrogen content and in addition to the organic materials that they will provide for the soil when they are sprayed and allowed to decompose, they also fix atmospheric nitrogen into the soil. The importance of slashing the plants before fruit formation is to prevent the plants from using up the nitrogen deposits in its matter.

24.3 Characteristics of a good fallow species

Not all plants can be good fallow species. Below are some characteristics of good fallow plants that can help fields regain fertility faster.

- Its growth is quick, closing the canopy quickly, to suppress weeds and control erosion

- It yields much biomass of good quality
- It decomposes fast and becomes organic manure.
- It is deep-rooted so that it picks up well the nutrients that are leached and deep in the soil
- It fixes nitrogen biologically from the atmosphere, building up good nutrients overall
- It is easy to establish and manage
- It supplies extra products such as stakes, grain and fodder that make its use attractive
- It will not spread as a weed into cultivated areas
- It easily produces seeds with long viability
- It is adapted well to resist the pests in the area
- It is adapted well to resist the diseases in the area
- It is well adapted to thrive under not very favourable conditions such as minor droughts, average soils, etc.

24.4 Why fallowing?

The purpose of a fallow period is to allow the field to regain the fertility lost from continuous cultivation.

Proper fallowing of fields allows for sustained cultivation over long periods of time without experiencing reductions in productivity levels attributable to falling levels of fertility.

Remember that with a proper crop rotation or intercropping plan on your field, the need for fallowing is significantly reduced and you will be able to maintain your field for much longer.

All the plants below are examples of good fallow plants that can be grown on a field during the fallow period. Growing such plants can reduce the average time needed for the field to completely revive by more than half. Pictures of some of these plants are shown in Figure 29 below.



Pigeon Pea



Calliandra Species



Sesbania Species



Crotalaria Species



Desmodium Species



Canavalia Species



Mucuna Species

Figure 29 **Examples of plant that can be planted during the following period**

CHAPTER TWENTY FIVE

TIMELY AND PROPER HARVESTING

25.0 Introduction

All the toiling a farmer goes through during the season is geared towards one result – a good harvest at the end of the season. In this message, we are going to learn about the things you should consider and practices you should observe during harvest.

As explained in the message on record keeping, you should always remember to note down the date you planted. Because every variety has its own maturity period, noting down the date of planting will help you calculate the time when your crop will be ready for harvest. You can even count the days and mark them on your calendar as a reminder.

25.1 Time to harvest soybean and cowpea

If you are growing soybean, varieties like Songda and Suong Pungun are early-maturing types and will take between 110-115 and 85 – 92 days, respectively to mature whereas Jenguma, Salintuya 1 & 2 are late-maturing types and will take between 115 – 125 days to reach maturity.

Cowpea on the other hand is generally a short-maturing crop with common varieties like Apagbaala, Marfo Tuya, Padi Tuya, Songotra, Zaayura and Asetenapa all reaching maturity between 65 – 75 days.

With this knowledge, you can begin making the necessary preparations for harvesting when the time is getting closer. The date you set for harvesting should be about a week after the crop has reached (physiological) maturity as this allows for your crop to reach the right moisture content for easy post-harvest handling. Also, the 1-2 week gap allows for all refilled plants (discussed in refilling and

thinning message) to also reach maturity and make harvesting more uniform and easy.

Signs to look out for

On the field, there are signs you should look out for that will confirm that your crops have reached maturity. Soybean and cowpea crops are mature when you observe the leaves becoming yellow and falling off the plants. You can also observe the pods for additional signs that will indicate full maturity --- pods nearing maturity also change from green to yellow. At full maturity, the pods will change from yellow to grey or brown depending on the variety cultivated, i.e. when about 90% of the pods have turned brown for non-shattering varieties (e.g. Jenguma for soybean) and about 80% for shattering varieties (e.g. Salintuya I and Salintuya II for soybean).

Mature pods should feel dried up -- when you press them with your fingers, you should hear a crackling sound and the pods should split exposing the seeds.

Alternatively, you can observe a sample of seeds to test if your crop is due for harvest. At maturity, seeds of cowpea and soybean in the pods become hard. At this stage, the moisture content of seeds would be about 14-16%. Non-mature seeds will still be green and soft – the skin of the bean could easily peel off if squeezed. For soybean, seed colour changes from green to light yellow whereas in cowpea, the colour change will depend on the variety cultivated which might be to brown, dark cream or bright cream. The key thing is to feel for the dryness and hardness.

In order to obtain high quality grain, harvest promptly when the colour changes we mentioned becomes obvious. It is strongly advised that harvesting of varieties prone to shattering are not delayed because dry weather and harmattan speed up shattering. To avoid this, however, talk to your CEA or AEA to advise you on non-shattering varieties suited to your location.

If you timed your date of planting properly according to the weather calendar and maturity period of your variety, harvest should coincide with the end of the rainy season and dry conditions. This will give very high quality grains.

Harvesting techniques

Now that you have determined the time to harvest your crops, let's talk about good harvesting techniques. Harvesting can be done with a sharp cutlass, a hoe, or sickles. To harvest soybean and cowpea properly, you should cut plants at soil/ground level or uproot and heap them at various points on the field. It is advisable to heap them on tarpaulins if available. If you do not have a tarpaulin, you can cut up sacks and stitch them together to form a big surface similar to the tarpaulin.

For a timely and good harvest, remember the signs we talked about and do not delay harvesting. The next messages will talk about proper post-harvest handling to maintain high produce quality and get good market prices.

25.2 Time to harvest your groundnut

A variety like Chinese is an early-maturing type and will take 100 days to reach maturity, Kpanielli and Nkakie-SARI are medium-maturing types and will take about 110 days to mature whereas variety like F-Mix is a late-maturing type and will take about 120 days to reach maturity. With this knowledge, you can begin making the necessary preparations for harvesting when the time is getting closer.

Signs to look out for

On the field, there are signs you should look out for that will confirm that your crops are reaching maturity. It is important to know that flowering in groundnuts is not uniform so it is likely that you will have a mix of mature and immature pods at the end of the cropping cycle. Because groundnuts are formed underground, you need to be very careful in the timing of your harvest to avoid

significant losses. Prior to maturity, the plants start to lose their green colour and the leaves turn yellow and begin to fall because the kernels need the plant's food supply for their own growth. Leaf fall is, however, not the best way to determine maturity.

To be specific, groundnuts are matured when 70-80% of the inside of the shells have dark markings and the kernels are plump with the colour characteristic of that variety. In determining pod maturity, you should verify that the pod is well-filled and the inside wall is dark brown. Matured groundnuts are harvested by pulling or digging out the plant with the nuts attached. Dig a few plants up to see if the nuts are ready. The nuts should be brown on the outside, firm and dry. Usually at maturity the inside of the pods is grey and some rattling occurs when the pods are shaken. If you harvest groundnuts before they are fully mature, the pods will contain shrivelled kernels. If they're harvested too late, many pods will break off in the soil and never be found. Also, late harvesting results in non-dormant varieties sprouting in the field, resulting in yield losses.

Severe diseases affecting the foliage sometimes results in harvesting before seeds are fully mature. Pre-mature harvesting reduces nut and oil quantity/quality while delayed harvesting predisposes seeds to fungal infection (i.e. aflatoxin infection) and also causes kernels to shrink during drying.

Plants should be carefully dug out to avoid nuts breaking off and remaining in the ground. For proper practice, loosen the soil around the plants with a spade or a garden fork before harvesting. Pull up the plants and shake the excess soil from the roots leaving the pods attached. Check the soil to make sure you aren't leaving any pods behind. The plant should be turned upside down to expose the nuts if the pods cannot be stripped immediately. After harvest, dry for 2-3 days, then strip the pods from the pegs and place them on mats to dry for another 7-10 days to about 10% moisture.

If you timed your date of planting properly according to the weather, calendar and maturity period of your variety, harvest should coincide with the end of the

rainy season and dry conditions. This will give you very high quality grains as rainy conditions at harvest cause pod to rot which reduces harvest quality.

Remember, for a timely and good harvest, look for the signs we talked about and do not delay harvesting too long after you have observed these signs on your field. The next message will be on proper post-harvest handling which will talk about things you can do to maintain high produce quality and get good market prices

CHAPTER TWENTY SIX

THRESHING

26.0 Introduction

Threshing is the process of separating the commercially valuable part of the harvest produce from the remainder that cannot be sold. This can be done either manually (Figure 30) or mechanically (Figure 31). Mechanical threshing is usually the better option if you have a considerably huge harvest because manual threshing is very time-consuming and will be more costly if hired labour is to be used.



Figure 30 Manual threshing

Mobile threshers mounted on tractors can move from village to village or farm to farm to carry out threshing of the produce. If you do not have such a thresher operating from your village, you can arrange with other farmers in your village to contact an operator from a nearby village to come and thresh your produce in a

group. It worth to note that combine harvesters can be used for both harvesting and threshing simultaneously.



Figure 31 Examples of threshing machines

26.1 Proper threshing procedure

Before you begin to thresh your produce, make sure that the pods are sufficiently dry to reduce the amount of debris and damage to the grains. Threshing should always be done on a tarpaulin to avoid contamination with stones and loss of grains through spillage. After threshing, make sure you gather all stray grains which did not fall into the sack or onto the tarpaulin. Even if it seems like a small quantity, remember that it can make a meal for your family or can be fed to your farm animals.

To extract the seeds, some farmers spread the pods on a tarpaulin laid over the ground and drive a tractor over it. This is usually done for cowpea and soybean but not for groundnut because groundnut seeds are more delicate and can be easily destroyed. If you decide to do this because you don't have access to a thresher, do not do it on a very hard ground as it can cause more damage to the

seeds. After this, it will take considerably less time in manually threshing the produce.

If threshing is properly done, the quality of the produce can be maintained without losing a significant amount of your harvest in the process. If not done well, grains will be significantly damaged resulting in a significant loss of value of your produce because buyers will not pay full price for them. Physically-damaged grains also suffer pest attack and moulding easily. Because of this, damaged grains cannot be stored for longer periods of time.

After threshing, you should not dispose of the crop residues or leave them to waste. Gather them and move them to your field. At the start of the next farming season when the first rains have arrived, you can then spread the residues on the land to be incorporated into the soil during land preparation. This will serve as organic matter that will improve the structure of your soil as well as improve the fertility of the soil.

Remember to always be careful when threshing your produce because it is one of the most important post-harvest activities in groundnut, cowpea or soybean production as it may result in significant losses in your harvest as well as the amount of money you can make from selling them.

26.2 Manual threshing techniques

Threshing seeds manually involves rubbing, flailing, beating, or otherwise manhandling the seeds until they come loose from their pods or seed heads, but must be done without damaging the seeds. With a bit of practice, you'll learn just how much pressure/force is needed, without using too much. For three out of the four threshing methods described below, it's easiest if the seeds are placed in a cotton flour sack before being worked on.

Threshing can be used for almost any type of seed that is harvested after it has dried on the plant, including legumes, members of the carrot family, most herbs, grasses, grains, etc. The methods of threshing are as follows;

26.2.1 Flailing

With the seed matter (the seed pods, seed heads, etc.) in a cotton flour sack, use a stick, broom handle, to beat the seeds until they are released from the pods or seed heads. A true flail is made up of two sticks, usually about the width of a thumb, with one about 2 ½ feet long and the other 1 ½ feet long, joined at one end with a leather strap or a chain. This tool makes it easy to swing and hit the seeds. Over time, a special box, called a threshing box, has been designed for holding the seeds while being threshed. It has sloping sides and is open at one end, allowing for easier threshing. It's not necessary to use a threshing box especially if you place the seeds in a pillowcase or in a cotton flour sack.

26.2.2 Jogging

With the seed matter in a cotton flour sack, place the bag on a hard surface and then lightly jog on them. Do not wear shoes with hard heels or soles (under) for this. You can do this barefooted. Doing it barefooted can help you gauge better the amount of pressure needed to break seed pods more easily.

26.2.3 Rubbing

Spread the seed matter on a board at least 2 or 3 feet wide. (A piece of plywood works well) Use another board, a rolling pin, or a concrete floater, to crush the seed pods. Another form of rubbing seeds free uses a mesh screen. Pour the seed matter on the screen and gently use your hand (preferably gloved) to rub the seed matter around the screen to release the seeds.

26.2.4 Beating

With the seed matter in a cotton flour sack, bang the sack against something – the wall, the floor, the inside of a bucket, etc. You can also do this while holding on to several stems at a time and beating the seed heads against the inside of a bucket or barrel.

26.2.5 Shaking/tumbling

Shaking or tumbling is best used for seeds that are loosely attached to their seed heads, or for seeds in pods that have naturally split open. Place the seeds in a small bucket with a lid. Seal the container, and then shake it or roll it vigorously to release the seeds.

CHAPTER TWENTY SEVEN

DRYING

27.0 Introduction

Drying is a very important activity that should be taken very seriously. Drying of cowpea and soybean begins on the field after the pods have reached maturity. In some varieties of soybean, excessive drying of the pods results in shattering which causes significant losses in the quantity of the harvest so it is important that this is done on time. For groundnut, because the pods are formed in the soil and not exposed to sunlight, drying will only begin after harvesting has been done. Improper drying can cause significant reduction in the value of your harvest. You might have gotten the optimum yield from your field at harvest but with poor drying, the quality of your produce will be seriously affected because of molding which reduces the prices offered by buyers.

In this message, we are going to discuss how to properly dry your groundnut, cowpea or soybean after harvesting.

27.1 Proper drying procedure

Immediately after harvesting your pods from the field, you should dry them properly before you proceed to thresh. This will reduce the moisture content of the grains significantly so that it can be bagged directly after threshing. Also properly dried pods before threshing significantly reduces damage caused to grains during threshing.

In groundnuts, after stripping the pods, drying should be continued until the moisture content is reduced to about 6-8%. This can be achieved by continuous sun-drying for about six to seven days. While drying, take care to cover them if it is about to rain to prevent damage to the produce. Once they are very well-dried, the shells will look slightly wrinkled and become slightly hard when bitten. Take care to not over-dry them because excessive drying will reduce the physical

quality of the kernel, the nutritional value and also seed germination in case you are planning to recycle them for planting next season.

In soybean and cowpea, drying should be aimed at achieving a moisture content of less than 10%. When this level of drying is achieved, the grains will make cracking sounds when crushed between the teeth.

To dry your grains properly, the following are a few things you will need:

First, you will need a tarpaulin or thick quality polythene sheets to serve as a drying surface for your grains. If you cannot afford to buy a tarpaulin, cut open several sacks and stitch them together to form a large surface on which you can spread and dry your grains. An improved drying method that will ensure that all pests are killed involves drying the cowpea grains on a black polythene sheet and spreading a white or transparent polythene sheet over the grains as shown in Figure 32 below. The sun penetrates the transparent polythene sheet and the heat is stored by the black sheet which generates very high temperature that will kill all pests that infest the grains from the field.



Figure 32 Drying cowpea on black polythene sheet and covering with transparent polythene sheet for effective storage pest control.

Drying your grains on such materials makes it easier for you to collect your grains at night (to protect them from dew) or when it's threatening to rain. If you are using sacks stitched together, you can't simply cover them because they are not water resistant so you would need to always collect them into your store room at night. However, if you managed to purchase the polythene sheets or tarpaulin, simply pulling the corners to the centre to heap the grains in the middle and placing a heavy object at the centre where the corners meet over the grains is enough to protect the grains from getting wet in case it rains.

In the absence of any of the materials we've just mentioned, you can use a concrete floor as a drying surface. A local mixture of dung and water to create a smooth and uniform surface can also be used to dry the grains. The most important thing to remember is that, you should never dry your grains on the bare ground as it will allow your grains to be contaminated by small stones, sand and other debris. It will also make your grains look dirty and less appealing to buyers.

When you do not dry your grains properly, they will suffer from fungal attack and become mouldy and lose value thereby giving you less money for your harvest. If you notice your groundnut, cowpea or soybean produce is becoming moldy after drying or you notice strange smells from your dried grains, make sure you take them out and re-dry them.

27.2 Tools use in drying

- **Tarpaulin:** is a large sheet of strong, flexible, water-resistant or waterproof material, often cloth such as canvas or polyester coated with urethane, or made of plastics such as polyethylene. This is very useful in drying farm produce at home or on the field.
- **Rake/Forks:** these are tools that can be used to turn out harvest grains or pods during drying. This allows for all areas of the produce to be properly

dried. This task can however equally be done with the hand – even though it might be more difficult for harvests of significant quantities.

27.3 Tips for proper drying

- Leave pods on vines of plants until the seeds can be heard rattling in the pods (cowpea & soya)
- At this point, pods should be dried and shrivelled.
- If crops reach maturity at a time when the rains are still coming, harvest pods from the field and dry at home where you can gather them when it is threatening to rain.
- Drying can be done with grains still in the pod or after shelling when grains have been removed from the pods.

27.4 Benefits of proper drying

- Good drying maintains quality of grains over long periods of storage
- Properly dried grains fetch higher market prices compared to improperly dried grains
- Properly dried produce are easier to thresh—resulting in less damage to grains during threshing
- Properly dried grains suffer fewer chances of pest attack as compared to improperly dried grains

Note

The main purpose of drying is for the preservation of the grains and the essential nutrients contained in them. If you dry your grains and store them, you should remember to check on them regularly. Anytime you realize any bad smells coming from your bags of grain, kindly take them out and spread them on your tarpaulin for more drying. If this is not done, your grains will suffer mold and lose quality.

CHAPTER TWENTY EIGHT

WINNOWING AND CLEANING

28.0 Introduction

After your produce has been harvested from the field, it needs to be shelled or threshed and dried to ensure that the quality is maintained and grains do not go bad. Even after shelling/threshing of your pods, the grains might still contain debris which must be removed. The process of removing all the unwanted materials or chaff from the grain is called winnowing and cleaning. In this message, we will talk about the benefits of proper winnowing and cleaning and how it can be done well.

Winnowing should be carried out immediately after threshing or shelling and before bagging/storage. Although it is possible to winnow and attempt cleaning before drying, it is not advisable. This is because the moisture of the pods or grains make it easy for the debris or chaff to stick to the grains thus making it more difficult to separate from the grains. It is therefore more beneficial if the pods and grains to be threshed are sufficiently dried.

28.1 Methods of winnowing

Winnowing and cleaning can be done either mechanically or manually. The two methods are discussed in this section.

- **Mechanical winnowing**

The mechanical cleaner is much faster and does a very good job at separating the debris from the grains. The most important thing to consider when cleaning your grains mechanically is the configuration of the machine to make sure that it is not too tight to cause damage to the grains and not too loose to allow most of the debris to pass through with the grains without being removed. Even though

mechanical cleaning is very efficient and saves cost/time, you might not have access to one and will need to do your winnowing and cleaning manually.

- **Manual winnowing**

For manual winnowing and cleaning, you will need a clear weather and slightly windy conditions. The wind blows out most of the light chaff from the grains as they are being poured from one container into another. After wind-cleaning, you will need to run your grains over a screen or sieve with hole-sizes that are smaller than your grains. This will separate most of the chaff or debris that did not fall out during the wind-cleaning. As you do this, pick out all chaffs that are too big to fall through the sieve holes. In addition, look out for moldy grains and pick them out. Also look out for stones, broken/damaged grains and all grains showing signs of pest damage. All these should be removed from the grains before bagging. Some of these can be processed into feed for your farm animals for better growth.

During winnowing and cleaning, try as much as possible to avoid contact of the grains with the bare floor as this will introduce additional debris or contaminants into the grains. Remember that good quality grains fetch higher prices on the market and are more marketable to commercial feed producers. If you are known for selling very quality and clean produce devoid of any debris and chaff, you gain a good reputation and will always have buyers that want to purchase from you.

For mechanical winnowing you can employ the following techniques.

- ✓ **Moving air**

Moving air can be a very effective way to clean your seed/grain and get rid of the chaff and other debris. It can also end up blowing away a lot of your seed/grain with the chaff. This is the most common method of winnowing used in northern Ghana. Women are usually seen tossing the grains into the air and using the natural power of the wind to winnow the seed. For this method, it is important to monitor the wind speed and direction because they can vary greatly from one

minute to another. They are also likely to be stronger than you probably need. Using the wind to clean your seed will work well if there's a significant difference in weight between your harvested seeds and the chaff you're trying to get rid of. To use this method:

1. Lay out a large plastic sheet or tarpaulin to cover the ground around the area where you will be winnowing the grains.
2. Gauge the direction of the wind and stand across it with your side facing the direction of the wind and get two sizeable pans or basins.
3. Pour the seed from 2 or 3 feet up, slowly, from one basin or pan into the other. Repeat as necessary until seed is sufficiently clean. Figure 33 below shows a woman winnowing manually.



Figure 33 Manual winnowing

Note: This method will work best with seeds that weigh more than the chaff, even if the seeds themselves are still small. For tiny, lightweight seeds, this is not a very good method to use.

✓ **Roll and fly**

This method is best for seeds that are round like balls, such as soya. This method can be used with wind or a fan set on a low setting or set back away from the winnowing area that will produce consistent force and direction that can equally be used to winnow grains and is generally much milder than wind. To use this method:

1. Lay out a sheet or a tarp. Place a large, flat box in the middle. Position the fan nearby, so that it will blow across the box.
2. Pour the seeds and chaff at one end of a plastic sheet, and place the cookie sheet on the box, so the fan will blow across it, with the seeds at the far end away from the fan.
3. Gently lift the far end of the cookie sheet until the seeds begin to roll down. The moving air should be strong enough to continue to make the seeds roll up the plastic sheet a little bit before they begin to roll back down again. It should not be strong enough to make the seeds fly off the plastic sheet.
4. After all the seeds have rolled to the bottom and the chaff has blown away, turn off the fan. If necessary, gather the seeds at one end of the plastic sheet and repeat the process until all the seeds are clean.

✓ **Screening with sieves**

Using a stack of sieves is one of the simplest methods to clean seeds. For this method, you will need a number of sieves with variable hole-sizes. To use this method is very simple. Follow the steps below:

1. Arrange the sieves so the largest screen is at the top and the smallest screen is at the bottom.
2. Pour the grains or seeds on the top of the stack, and shake the sieves back and forth for a minute or two.
3. One of the sieves you have arranged will contain mostly seed and very little chaff. Where the seeds end up will depend on their size.

4. If you need to clean the seeds a bit more, gently blow across them to remove the bits of chaff that ended up on the same sieve tray.

CHAPTER TWENTY NINE

BAGGING AND STORAGE

29.0 Introduction

After harvesting, there are still several stages involved before your produce is ready to be sold to fetch you the income you deserve from your hard work throughout the season. Your harvested produce will still have to go through drying, threshing, winnowing and cleaning. After all these processes, however, there is still one more step to be taken. You will need to bag your produce in preparation for sale.

In bagging, try and get a scale to help you measure the right quantity to put in the bags. Note that if, for example, each bag exceeds by half a kilogram and you bag a total of 20 bags, this means you are giving out 10 kilograms of your hard-earned harvest without receiving payment for them. If you do not have access to a scale to aid you in bagging, make sure you use the right sack size to avoid over-bagging.



Figure 34 Bagging of cowpea for storage

After bagging, you can transport them to the market for sale if the prevailing prices are favourable. However, if the prices are not favourable, you can then decide to store them for a while and wait for better prices when the demand is getting higher and there is little in the system to meet the demand.

Dried groundnut pods can be stored in sacks, clay/mud silos, woven straw baskets and clay pots. For storage of soybean and cowpea, it should be dried to a moisture content of 10% or less and can be put in polythene bags before being put in jute or fertilizer sacks for storage. This prolongs the storage life of the produce. Soybean and cowpea seeds/grains can also be stored in traditional structures like barns, pots and plastic containers and not in the open.

The storage facility always should have a cool and dry environment and be air-tight to prevent the grains from absorbing moisture from the surrounding air. When this happens, the grains will become mouldy and reduce in quality. To prevent grains from getting mouldy, the bags should be brought out for drying every three months.

The area around the storage facility should always be weeded and kept clean. If not, it will attract rodents and other pests that might find their way into the storage house to feed on the stored grains. The roof of the storehouse should also not be leaky to allow rains in as this can also lead to moulding of the grains. In the storage house, make sure you arrange the bags of grains on wooden pallets (Figure 35). Do not keep them on the bare floor. If you plan to store your produce over an extended period of time, you can try fumigation to extend the shelf life and reduce pest infestation. However, if you decide to fumigate your storage house, please make sure you contact your AEA or CEA for advice because if not done properly, it can lead to excessive toxicity (poison) levels in the grains making them harmful for consumption.



Figure 35 Bagged produce arranged on wooden pallets

29.1 Benefits of storing produce

One key benefit of storing your produce is that you are able to hold on for a time until the prices are more favourable before you sell your produce for a very good profit. Always make sure you monitor the market prices of the soybean, cowpea and groundnut to know the right time to sell them. Your AEA or CEA can be a very good source for market price information. You can also talk to any traders within your community or in a nearby community who deal in these produce.

Follow the instructions on proper bagging and storage and your harvest will be able to fetch you the price you deserve for the hard work you put into your farm throughout the season.

For cowpea, a mini bag = 40 kg

For soybean, a mini bag = 45 kg

For maize, a bag maxi = 100 kg

For groundnut (unshelled), a bag maxi = 100 kg

29.2 Improved cowpea storage

One of the main dangers that faces grains of cowpea during storage is pest attack with weevil being the most common pest of cowpea when in storage. Infestation usually starts in the field on pods and the population rapidly grows when eggs are laid directly on the seeds. The adult female lives 5-10 days and lays 40-60 eggs which are glued to the cowpea seeds. These eggs feed and develop inside the seeds and emerge as adults after 3-4 weeks. Because a single female can lay so many eggs, even a small infestation at harvest can lead to almost a total loss of stored cowpea after a few months.

For extended storage periods, farmers usually resort to treating grains with chemicals. Grain treatment with chemicals (discussed in another chapter) is only one option for long storage of grains. It is also possible to store grains for very long periods without treating them with chemicals.

For cowpea, an improved method of bagging for longer storage has been developed. This is called **PICS (Purdue Improved Cowpea Storage)**. A demonstration of this is shown in the picture below.



Source: SARI-Tamale.

For this method of storage, you will need 3 different bags per unit – two polyethylene bags (inner bags) and one woven sack (outer bag). The steps involved in PICS are as follows;

1. Ensure that your cowpea grains are completely dry and clean with all contaminants removed. Drying before storage may help reduce the initial rate of infestation.
2. Take the three PICS bags apart and check the two inner bags for holes and tears. Do not use a bag that has holes or tears.
3. Pour a small amount of cowpea into the inner bag, starting gently. This will help to easily insert the first bag into the second.
4. Insert the first polyethylene bag into the second one. Make sure there are no air pockets at the bottom.
5. Insert the two polyethylene bags into the woven bag.
6. Fold over the top of the woven bag and then do the same for the second polyethylene bag
7. Fill the inner bag with more cowpea. While filling, shake gently from time to time to reduce the pockets of air. Make sure no grain gets between the bags.
8. Do not over-fill the bag. Fill it far enough so that a lip remains for tying. Press down the grains with your hands to remove air.
9. Twist the lip of the first bag tightly shut. Fold it over and tie firmly with a heavy string at the base of the twist and over the folded twist.
10. Pull the middle bag up over the first one so that it completely surrounds it. Twist the lip shut, fold over and tie, as before. Follow the same steps for the outer bag.

Precaution: The triple layer bag is recommended for storing cowpea for a long period (at least 2 months). It is recommended that the bag remains sealed at all times for the duration of the storage. Keep the stored cowpea in a safe and dry

place, and out of reach of rodents. Rodents may make holes in the plastic bags. This method of storage is easy, effective and safe.

For triple storage bags, you can contact IITA for supply.

29.3 Storage of groundnut

Groundnuts are semi-perishable and can undergo loss of quality during storage. The factors responsible for the loss of quality are –

- Insect and rodent infestation
- Fungal development
- Flavour changes
- Rancidity – the development of unpleasant smells or taste
- Viability loss
- Physical changes like shrinkage, weight loss, etc.

High moisture and temperature are the most important factors that determine the quality of kernels in storage. During shelling, serious losses in milling quality may result if the groundnut kernels are dried below 7% moisture content or stored at a temperature less than 7°C. If you decide to store groundnuts over a long period, it is best if they remain unshelled. The best storage conditions for normal dry bulk storage of unshelled groundnuts is about 7.5% kernel moisture content at 10°C and 65% relative humidity. What this means is that the environment of the storage hut where you store your unshelled groundnuts should be very cool and not too dry. If such conditions are maintained, unshelled groundnuts can be stored without significant loss in quality for about 10 months.

29.4 Conditions for good storage of groundnut

- Groundnuts always should be stored as pods
- rather than as kernels

- Pods should be well dried to have not more than 5% moisture – at this moisture content of pods, they easily split along the middle when little pressure is applied
- If storage is done as kernels, pods should be removed carefully to avoid splits and broken kernels. When storing as kernels, storage time should be reduced to the possible minimum.

Note: Groundnuts can be stored as pods in earthen or clay pots and bamboo baskets. These containers can be plastered with mud or cow dung as they help in controlling the temperature around the groundnut pods. For long term storage, you can also seal the containers with mud after adding ashes, ground pepper or dried neem leaves. These materials help to control storage pests and reduce infestation rates and the amount of damage they can cause to the pods and kernels in storage. Do not keep pods stored in such containers for too long as such long periods can increase the relative humidity to about 90% and subsequently increase the pod moisture to about 10 to 15%.

Note: Pod moisture of groundnuts above 10% will affect seed viability and quality.

29.5 Storage of soybean

As with all other grains, spoilage and reduced germination will occur quickly if storage moisture is too high. The high oil content of soybean makes them spoil even faster than other produce such as corn. Soybean can be harvested at moisture levels below 20% but for storage, the moisture content must be at 14% or lower. Normally, natural unheated air from extended periods of drying can achieve this moisture content in soybean.

29.6 Good bagging and storage practices

- Always use the prescribed sack sizes for bagging your produce

- Always check to make sure that your storage bags do not have holes or tears in them
- If available, use scales to check the quantity of grain to put into the bags
- Always make sure that your grains are properly dried before you bag and store them
- Always make sure your grains are winnowed and properly cleaned with all debris or contaminants removed before bagging and storage
- Always keep the environment around your storage huts clean of weeds and animals
- Always check your storage huts and make sure there are no cracks or leakages
- Check your storage huts regularly to clean and check on the state of the stored grains.

CHAPTER THIRTY

FINDING BUYERS AND SELLING YOUR PRODUCE

30.0 Introduction

In Northern Ghana, and Ghana as a whole, farming is often not seen as a business but an activity undertaken to feed one's family. Because of this, our farmers mostly practice subsistence farming and do not put in the measures and structures that will boost their operations and increase the profitability of their farms

In other situations, whiles buyers sometimes complain of inadequate supply of farm produce, farmers on the other hand grumble of lack of market. A clear indication of improper linkages between farmers and market. This undoubtedly underpins the fact that restriction of smallholders from market access locks them into long term poverty for generations. It is therefore anticipated that commercialization would shift the goals of farm households from self-sufficiency to profit and income oriented decision making.

One very important step in making your farming profitable is finding the right buyers who will offer you the right price for your produce. To ensure a reliable market for your cowpea, soybean or groundnut at the end of the season, you should begin looking for buyers at the beginning of the season. Because soybean, groundnut and cowpea have high protein contents, they are highly valued for use in the formulation of feed for farm animals or highly nutritional food for your children. If you cultivate any of these three crops and have quality produce at the end of the season, you will not have trouble trying to sell them because there is a very high demand for them.

30.1 Guide to finding buyers for your produce

The most reliable buyers are poultry farmers, aggregators and companies who are interested in purchasing the cowpea, soybean or groundnut in bulk. The crops can be processed in addition with other crops like maize to make feed used in feeding poultry and other farm animals as well as supplement for your food. However, because your farms are small and individual farmers cannot produce the quantities demanded by these companies, first you will need to meet with your fellow farmers and agree to combine the produce harvested from your separate farms. This way, you will be able to raise the quantities of cowpea, soybean or groundnut these companies will want to purchase at a time.

After agreeing with your fellow farmers to combine your harvest, you can visit a few commercial poultry farms and companies to make arrangements to supply them with cowpea, soybean or groundnut. Before you do this, you need to estimate how much you can produce by considering your harvests in the past and the total number of acres you will be farming in the new season. You can rank the buyers based on the prices they are willing to offer, transportation arrangements and payment schedules. It is also important to find out if they are more interested in certain varieties as this will inform your decision on which cowpea, soya or groundnut varieties to purchase and grow on your farms.

After the harvest season, you need to visit the markets to find out the prevailing market prices of cowpea, soybean or groundnut and compare them to the agreed prices. If there is a significant change in the prices, you can re-negotiate the price with the buyers and make arrangements for them to come for the cowpea, soybean or groundnut.

It is important to ensure that every farmer in the group who has agreed to combine their produce has high quality grains and that everyone's produce is properly weighed and bagged to ensure that there is no cheating and no poor quality cowpea, soybean or groundnut in the group. This way, all your produce will be bought at once and this will save you the time and money you have to

spend transporting your cowpea, soybean or groundnut to the market and the difficulty in finding buyers.

However, if you are not able to find any buyers who are willing to purchase from you in bulk, you can make transportation arrangements with your fellow farmers to transport your produce to the market centres in bulk which will also save you some money on transportation costs.

Always make sure to find out before the beginning of the season which varieties of cowpea, soybean or groundnut are in high demand and cultivate them. This will enable you to have a ready market for your produce at the end of the season. Secondly, always try to do things in partnership with your fellow farmers because this reduces the overall cost of purchasing inputs, transporting your produce, etc. and also increases your marketing power.

CHAPTER THIRTY ONE

RECYCLING SEEDS

31.1 Introduction

As a best farming practice, it is recommended that every season farmers should acquire and plant new certified seeds. However, it costs a bit of money to purchase these seeds and it is understandable that not all farmers can afford to change their seeds every season.

In this message, we are going to discuss the best way to recycle your current crop of seeds if you cannot afford to purchase new seeds for next season.

The first thing you should know about recycling seeds is that it is strongly not recommended for hybrid seeds. A hybrid seed is one that is created from breeding two different varieties together to harness the unique qualities of each. Seeds from such hybrid plants will not be able to provide the same level of yield and in most situations will actually produce woefully lower yields when compared to the original plants produced from the first batch of seeds. So if you know that you cannot purchase seeds for the next season and will be recycling your seeds produced in the current season, do not purchase any hybrid seed. You can talk to your CEA or AEA for information on improved varieties of groundnut, soybean and cowpea that are not hybrids but will perform better than your local seeds.

After you have planted your field, start observing your plants very closely to identify the plants that exhibit very strong traits of the variety you planted. Ideally, these plants from which you select your seeds for recycling should be located in the center of your field. This is because their location in the middle of the field makes contamination from other fields less likely. Also, they are less likely to be attacked by pests and diseases as compared to other plants on the periphery of the field.

During harvesting, separate the harvest from identified plants for recycling from the produce from the other plants. After doing the separation, examine the grain

colour, size and shape and also look out for any physical damage. You should only choose seeds that are clean and devoid of any abnormal signs.

Make sure that these seeds are well-dried and kept away from extreme heat or cold. This will ensure that they stay viable during storage for good germination come next season. Always remember to select and store enough of these seeds. Do not save exactly the amount you will need as some of the seeds may be damaged in storage or refuse to germinate when planted which will need refilling.

Please note, however, that continuous recycling of seeds over a long period of time is not advisable as seeds will lose their vigour which will result in lower yields. Whenever possible, try to set some money aside when you sell your produce to be used for purchasing certified seeds and you will be taking a first step towards a good harvest in the following growing season.

31.1 Steps involved in properly recycling seeds

- Begin observing plants early – to identify plants showing desirable growth characteristics
- Protect the entire field from contamination from other fields – especially the plants you have identified to serve as your parent plants for your seeds. If you notice infection or pest presence on these crops, immediately treat them to limit the damage.
- During harvest, separate pods from these plants or part of the field from the remaining harvest
- After threshing, keep grains from the selected pods separate from remaining grains
- Screen selected grains for seeds very carefully for pest presence or signs, physical damage, off-colour, etc.
- Keep selected seeds stored away in a cool and dry place that is well protected from pests and rain

Before the start of the next season when you decide to use these seeds, make sure to conduct a germination test to confirm the viability of the recycled seeds. The plants from which you got the seeds may have fared well but that is not a definite guarantee that the grains gotten from those plants will be good seeds. If the results of your germination test show that the seeds are not great, please try and purchase a new pack of certified seeds from your input dealer to cultivate. Doing otherwise might result in poor yields from your farm.

Ideally, plants identified for getting the recycled seeds should be located in the middle of your farm where they face reduced risk of contamination from adjoining fields. Plants selected from the centre of the field also face reduced risk of infection from diseases on neighbouring farms.

31.2 Disadvantages of continuous seed recycling

- **It becomes hard to tell exactly which variety of crop you are cultivating.**
This is because from continuous cultivation and recycling, there might be cross breeding of your original variety with different varieties from other fields. That is why you observe that after continuously recycling your seeds for several seasons, you might even get grains of different colours after harvest even though at a point, you only had one colour of grains from your field.
- **Your crops have reduced expression of their key traits**
From continuous recycling of your seeds, the key traits known for your particular variety become greatly reduced. For example, if you recycle a non-shattering variety of soybean continuously for a long time, the variety begins to lose that trait. Therefore after several years of recycling, you observe that your crops will begin to shatter. The same applies to other traits such as drought tolerance, resistance to certain pests and diseases, etc.

- **Your yields will begin to reduce drastically**

For every crop variety cultivated, there is an expected quantity of yield refer to as potential yield. From continuous recycling, you will notice that your yields will begin to reduce gradually over the first few years and then drop drastically, although, you adhere to all production practices amid favourable environmental conditions.

- **Not all varieties can be recycled**

Recycling is only possible for traditional crop varieties. For crop varieties that were produced through hybridization, recycling always results in total crop failure. This means that if you purchase hybrid seeds for your field, you cannot recycle them for the following season. If you do this, you will record complete crop failure regardless of your adherence to good agronomic practices.

CHAPTER THIRTY TWO

PREPARING FOR NEXT SEASON

32.0 Introduction

Farming serves as the main source of income for more than half of the people living in rural communities. However, unlike other people involved in business, most farmers do not take adequate time to plan ahead for the following season. In this message, we will be discussing some very important steps you can take at the end of your current season in preparation for the farming season ahead.

If you practiced the earlier message shared with you on record keeping, then you will also be better equipped to properly prepare for the next season. This is because from your written records, you can calculate exactly the total amount you spent during the entire season. If you compare this figure with the total amount you recorded after selling your produce, you can calculate your profit and decide whether or not you want to expand your farm for the next season or maintain the current size. You should never expand the size of your farm if you are not harvesting the optimum amount for your current field size. For groundnut, you should be getting 10-12 bags/acre, for cowpea you should be getting 20-25 bags/acre, for soybean you should be getting about 16-18 bags/acre and 18-22 bags/acre for maize. If you are not getting these harvests or close to them, you should not expand your farm but invest the extra money on the same field size and practice the messages on best practices. However, if you are getting yields close to these and you have additional money to invest, then you can expand the size of your farm but make sure you make the decision on time before the season begins.

32.1 Some activities to undertake prior to next season

As you already know, cultivating your field this season would have caused your soil to lose some of its fertility. Knowing this, you can begin doing some things to your field during the off-season to begin preparing it for the next year. One very

important thing to consider is the incorporation of organic matter into your soil. Between this season's harvest and land preparation next year, you can gradually be collecting and depositing organic materials on your field when you get the chance. These can be in the form of animal droppings, crop residues, compost, etc. If you do this gradually over the off- season, it will reduce the workload of having to do it all at once when the next season begins.

It is good practice to make arrangement with a tractor operator and to purchase some inputs down in advance before the new season begins. The main inputs you will be needing in the coming season are certified seeds, fertilizers and agrochemicals

32.2 Why prepare in advance?

After selling your produce for the current season when you have cash in hand is the best time to purchase these inputs. This is because there are at least four or five months between the end of this season and the next and it is very possible that you will have used up the money by the time the season begins and moreover prices of the inputs may also rise. So it is good to purchase the needed inputs now to avoid difficulties in finding funds when the time comes. By doing this, you may have also avoided spending more if the prices increase during the following year or when there are shortages.

Since there are very few reliable tractor service providers around, it is very difficult to find a tractor operator at the beginning of the season because they become very busy and you might not find one when you need their service. This might cause a delay in your land preparation and planting and can be very dangerous for your farm because extreme delays can cause your crops to miss the rains and result in total crop failure. As a precautionary measure against such disappointments, you can arrange with your fellow farmers to pre-pay a tractor service provider for their services before the season begins. This serves as an agreement and ensures that they commit to clearing your fields at the right time to avoid delays in planting.

In addition to the above, if you mix your manure into the soil before the new season begins, the organic materials get enough time to properly decompose and blend into the soil thereby making the nutrients more readily available to your crops.

In conclusion, to ensure good profit from your farm, you need to start treating it as a business and one of the most important aspects of business is planning. Preparing towards next season means that you are planning well and this will help you avoid a lot of problems such as shortage of inputs and unavailability of tractor services.