

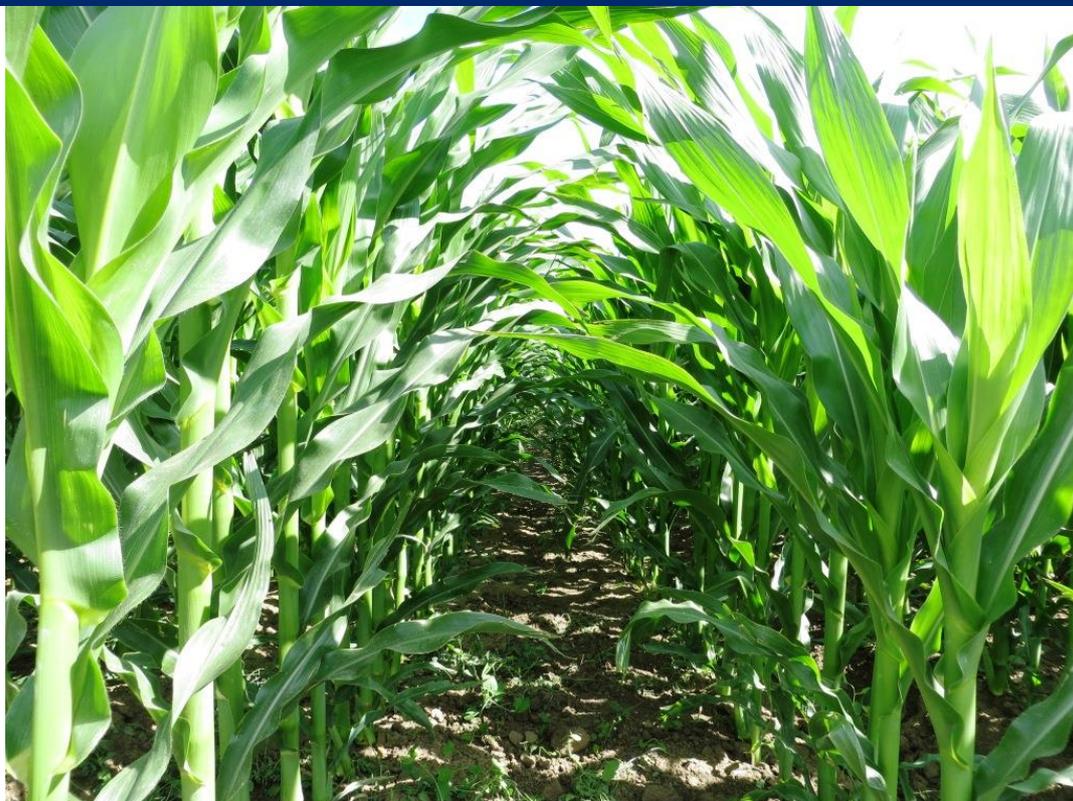


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COMMUNITY EXTENSION AGENT MAIZE HANDBOOK 2015



Extension Agent Handbook for Maize Production in Northern Ghana



Community Extension Agent Handbook for Maize Production, Northern Ghana. Revised Edition, 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



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

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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 continually revised.

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PREFACE

Maize (*Zea mays* L.) is a major food crop for resource poor smallholder farmers in Ghana. It is a monocotyledonous arable crop belonging to the family *Graminaceae* and division *Maydeae*. It is believed to have evolved from the domestication of the wild grass teosante (*Zea Mexicana*) in America which later spread and adapted to varied environmental conditions to the rest of the world.

Maize is a crop having a kernel of hard and one-sided fruit called a caryopsis. The kernel consists of pericarp, endosperm and germ or embryo. The pericarp is a protective outer layer derived from maternal tissue while endosperm constitutes the major portion of the kernel which serves as energy reserve for the growing seedling. It is composed of about 88% starch and 8% protein. As soon as the seed imbibes water, the aleurone layer releases enzymes which digest the endosperm starch into sugar thereby providing energy for seedling growth. The radical develops into roots while the plumel grows to form the vegetative part.

The vegetative growth parameters are the roots, stem and leaves. Maize usually grows to 2-3m high (but can vary from 1-6m depending on variety), with approximately 14 nodes and about 8 nodes and internodes remain condensed underground forming the crown. The lower nodes develop both brace roots and fibrous roots. The fibrous roots may be well developed at 8 weeks after planting and can grow up to 45cm depth but in good soils it can extend to 2.5m. The leaves are the site for photosynthetic activities of crop through which biomass is produced. A single leaf extends from nodes at an alternating pattern. All leaves are initiated within the first 4-5 weeks after planting and as the internodes elongate, new leaves emerge from the whorl once every three days, producing a total of 20-30 leaves depending on the genotype and the climate. The first 5-7 leaves drop off at an early stage while last leaves emerge shortly before tasselling. Leaf area per soil surface area measures leaf area index. For optimum plant growth leaf area index should be greater than 1 indicating that the sun's energy is not wasted to affect photosynthetic activities.

Maize is a monoecious plant bearing both male flowers in the tassel and female flowers on the lateral ear shoots of the same plant. The tassel emerge from the leaf whorl which is initiated approximately 30 days after planting and can grow up to 40cm long. The tassel bears the pollen grain while the ear contains cob and silk enclosed in a husk. The silk is receptive to pollen grain which develops to the grains. Ear shoots are initiated on 6 to 8 nodes below the tassel. At physiological maturity, the husks dry and become papery but it can be harvested fresh at about 3 weeks after flowering.

Maize is ranked as the most important cereal crop in Ghana and it is produced for both human and animal consumption. Every part of the maize plant has economic value. The grain, leaves, stalk, tassel and cob can be used to produce a large variety of food, non-food products and industrial products. The grain is the main source of calories and protein as well as the primary weaning food for babies. It is therefore cultivated by majority of people in all the five agro-ecological zones in the country. It is prepared and consumed in different ways by a multitude of people. It is eaten in the raw state, as cooked and roasted corn or ground and pounded when dried to prepare various food items like *Kenkey*, *tuo-saafi*, *koko* (porridge), *banku* and *Akpele*.

Whereas the area under cultivation of maize has considerably increased, maize yields in Ghana are still low. Maize yields in Ghana have been growing by only 1.1 percent per annum. In 2012 for example, maize yields in the country averaged 1.2-1.8 metric tons per hectare, which is far below the potential yield of 4-6 metric tons per hectare obtained from on-station trials.

It has been estimated that without productivity improvements, particularly for yellow maize, Ghana will need to import 267,000 metric tons of maize in 2015 to meet domestic demand. This implies a threat to food security and requires the need to improve the performance of maize production in Ghana.

The main factors found to have impeding effect on maize production in Ghana include declining soil fertility, little or inadequate use of fertilisers, poor weed and pest controls, and inappropriate tillage practices. It is in the light of these issues that this handbook was compiled to equip AEAs and CEAs to better guide maize farmers on all the agronomic practices necessary to ensure adequate yield.

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

RECORD KEEPING AND FINANCIAL LITERACY

1.0 Introduction

Wealth is created by putting resources together. Just like any other business, the farm has to be managed. How farmers use their resources affect how much wealth they can create. Farm management is about making decisions regarding use of the resources available to a farmer. In other words **Managing a farm means planning activities well and making the right decisions on what to do, how to do it and when to do it.** The main objective of farm management is therefore to maximize returns on the scarce resources available to the farmer.

In this chapter, you will learn more about the importance of keeping records and how this will help improve the way you manage your farm.

1.1 Record Keeping

The first and most important step in taking control of your farm operation's financial well-being is to keep good and accurate financial records. Record keeping simply put means, noting down all the important activities that happen during the season as well as all the money you spend and make from your farm. Doing so will help you make better farming decisions. Three main importance of record keeping have been identified;

- **Income tax reporting:** A good set of records is required for the preparation of complete and accurate tax documents. Poor records often lead to preparing income tax returns that result in either underpayment or overpayment of taxes. This might get the tax reporter into trouble if there is an unexpected IRS audit of records
- **Obtaining credit:** If you decide to borrow money for your farm business operation, the loan officer or bank will ask to see your financial records including a balance sheet, an income statement and a cash flow statement. The creditor will require these statements in order to determine your repayment capacity.
- **Management tool:** Accurate financial records, along with production data, will help the farm business operator analyse the information and make the necessary adjustments to operate more efficiently, thus increasing profitability. Such analysis will help you plan for the future, and it will pinpoint the weaknesses of your farm business and allow you to act accordingly.

There are two very simple types of records every farmer should keep. These are **financial records** and **operational/production record**. Both records are important for efficient management of today's farm business.

1.1.1 Financial Records

Financial records relate primarily to money transactions on the farm. It justifies or proves farm income or expense transactions. Examples include; sales, operating expenses, equipment purchases, account payable, account receivable, inventories, depreciation records, loan balances and price information.

We recommend that you use a book in which you will write down all the expenses you incur during the season and all the income you get from your harvest. In this book you should make two tables with five columns each and label them as shown below.

Table of Costs/Table of cash outflow Fill this table anytime you buy anything or pay for any service to your farm. By adding all the expenses you will know how much money you spent on your farming business.

Remember to keep records of all farm-related activities and expenses. This will help make your farming more profitable.

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

Table of Income/Revenue/Cash inflow: Fill this table anytime you make any money from your farm. By adding the income from all your sales you will know the total income from your farm.

<i>Date</i>	<i>Item/Description</i>	<i>Quantity</i>	<i>Unit Cost/unit price</i>	<i>Total Cost</i>
<i>May 12, 2014</i>	<i>Hiring out draught animals</i>	<i>4 Farmers</i>	<i>GHC 25</i>	<i>GHC 100</i>
<i>Dec15, 2014</i>	<i>Sold maize harvest</i>	<i>10 Bags</i>	<i>GHC 55</i>	<i>GHC 550</i>
<i>Dec20, 2014</i>	<i>Sold soya harvest</i>	<i>8 bags</i>	<i>GHC 80</i>	<i>GHC 640</i>
<i>Jan 17, 2014</i>	<i>Sold goats</i>	<i>4</i>	<i>45</i>	<i>GHC 180</i>
Total				<i>GHC 1470</i>

At the end of the season you will be able to calculate your farm profit:

Total Profit = Total Income/Revenue/Cash inflow - Total Cost

Using the examples in the tables above, total profit = GHC (1470 – 265) = GHC 1205

You must keep this book in a safe and clean place and fill it out every time you spend money and or make money related to the farm. If you cannot write, get your children or someone in your community who has been to school to help you write them down. Your CEA can even help you write them down. Make sure the writings in the book are always neat.

1.1.2 Operational/production Records

These records are items that relate to quantities of inputs and levels of production by enterprise and/or by resource type. These consist of crop yield, spacing, fertilizer application date etc. We recommend you use a book in which you record all information related to farm activities. Below is a table showing how this book can be used. This information will be very useful, for example when you want to call your input dealer again, or recommend a good tractor service.

Activity	Date	Details	Comments/Extra
<i>Land Preparation</i>	<i>15/07/2013</i>	<i>Tractor Service</i>	<i>Tractor contact – 0245757575</i>
<i>Buy Certified Seeds</i>	<i>20/08/2013</i>	<i>Obatanpa</i>	<i>Input Dealer contact- 0207222222</i>
<i>Fertilizer Application</i>	<i>05/02/2013</i>	<i>NPK 23-10-5</i>	<i>Input Dealer contact- 0543555555</i>
<i>Maize Marketing</i>		<i>Wants 10 bags of yellow maize</i>	<i>Contact- 0203101010</i>
<i>Transportation</i>		<i>GHC 1 for 1 bag</i>	<i>Driver Contact- 0266666666</i>

1.2 Management and Making Decisions

Managing your farm well means making the right decisions that will benefit your farm. There are a few things you should always consider when making a decision about your farm:

- Before you purchase any item or pay for any service, make sure to get the prices from more than one shop or provider. If you do this always, you can compare the different prices and go for the least expensive option at the same quality. This will help you spend less and save money.
- Before deciding on the crops or varieties to cultivate, always get information from your AEA or check from the market about the most marketable variety for that year. Cultivate the crop or variety that is recommended by the AEA or in high demand on the market. If you do this, you will always produce crops that are in high demand and you will get ready market for your harvest at good prices.
- When deciding on whether or not to adopt a new technology, don't only consider the cost of that technology. You should also consider the end benefit you will get if you bear the initial cost, e.g. certified seeds require more money in the beginning of the

. Two heads are always better than one.

So anytime you have to make a decision about your farm, discuss with your wife, family members or even your CEA/AEA.

You will get additional suggestions that may help you make the right decision

season but will give better yield and more money at the end of the season. This is called an investment.

- If you have more activities to carry out than you have money to cater for, you should consider which of these activities will have the most impact on your farm or yield if not done. For example buying wellington boots and fertilizers are both important for your farm activities. But if you can only afford one, you should go for the fertilizer because you could borrow boots from a neighbour or use your old shoes in place of the wellington boots. Always weigh options carefully before you make a choice.

Why is Record Keeping important?

- It helps you make better farming and business decisions in the future.
- This will allow you to save money and make more money.

CHAPTER TWO

SITE SELECTION FOR MAIZE PRODUCTION

2.0 Introduction

If this is your first season of farming, or you have moved to a new area and want to continue farming or just planning to get an additional field to your existing one to farm more, **proper site selection is a very important step in ensuring a successful season and must be taken very seriously**

The first rule of site selection is to know your crop first, and select your land next! With your intended crop in mind, you can now proceed to select your site based on the soil and climatic requirements of that particular crop.

It will be difficult to know for sure whether or not the soil on a particular field will be suited for cultivating your intended crop without having the soil tested in the laboratory for pH, organic matter content, total N, available P, exchangeable K etc. (which you can read about in the chapter on Soil Testing). However, there are some things you can still look out for that will give a general idea about the fertility levels of a field.

Soils with high organic matter content tend to be darker in **color** and you can see a lot of decaying plant parts such as leaves or plant roots when you dig with a hoe and fetch a sample of the soil in your hands – usually, the darker the soil the richer it is, so you should look out for the darkest soils.

Soils with high organic matter content tend to be darker in color.

You should also look out for the kind of **weeds** that grow on the land. Weeds, just like your maize plants, need nutrients to grow. Without enough nutrients, weeds do not also grow well. Examine the distribution and nature of the weeds on the field – if weeds are spread out evenly across the field, it suggests a more uniform nutrient distribution on the land. You should also look closely at the color of the weeds – deep green weeds suggest high levels of nitrogen and other nutrients and this is good. Now pay attention to the different kinds of weeds on the land and how they look– some weeds are adapted to low nutrient land and

can grow relatively well even if the nutrient level in the field is not so high. These weeds may deceive you into thinking that the field is fertile--the more different kinds of plants you see on the land, the richer the soil might be because not all plants are adapted to doing well in low fertility soils.

You should also consider the **rainfall pattern** of the area. If this is a totally new area, you should ask people within the community to know about the amount of rain they usually receive. If you realize that the area where you plan to site your farm does not receive enough rain for the selected crop, change to a different crop to avoid your crops suffering from drought or plant drought-resistant variety of the selected crops.

Places with a long history of **pests and diseases**, **herding activities** and high **cost of labour** should be avoided if possible. You should also look out for areas **close to a road** for easy movement of your harvest from the field and tractors/equipment to your field. But be careful because being too close to a road may be a bad environment to grow crops. If possible, choose sites that are **close to a water source** and have **good drainage**. Avoid sites on the **slope** of hills as water and nutrients will flow downhill away from your crops.

2.1 What to consider when selecting a site for maize production

Maize adapts well to different soil types with a pH range of 5.0 -7.0. However, higher yields are obtained from maize planted on deep, fine structured, well aerated, well drained loamy soils that are rich in organic matter. Shallow sandy or gravelly soils should be avoided whenever possible as they are more affected by drought and reduced response to fertilizer application. Maize does not perform well in waterlogged soils. Therefore, all sites prone to water logging should be avoided. The best soil for maize is deep, loose, fresh, fairly light, well drained fertile and rich in organic matter.

Use of miles and meters shows inconsistency. Use miles and feet or kilometers and meters.

Site Selection – From the MoFA Agricultural Extension Handbook 2006, page 96

In selecting the site for production, consideration must be given to the soil type, topography, and accessibility among others. Gardens or farms located several miles from home will surely involve more transportation costs and time consumption. A watchman may be needed and watering times may not be properly followed. It is advisable that every gardener should live near his or her garden. Gardens located several miles from the compound are likely to be neglected. In northern Ghana, fencing is always necessary to guard against stray animals destroying the gardens. The cheapest and easiest fence is made out of sticks straight up from the ground with cross sticks to give a firm structure. If the farmer can afford, he could use barbed wire spaced 5 cm apart or wire mesh with strong post spaced 2.5-3 m apart. The posts should be set 45 cm into the ground and the soil packed hard around them. Other convenient fencing materials include wooden posts, guinea corn stalks and piled thorn bushes. In some parts of the UER, mud walls are built around dry season gardens. The soil should have a good structure and should not be acidic or alkaline in reaction.

Poor drainage and water logging can significantly reduce yield. If such fields cannot be avoided then drain any areas where there is standing water by digging channels to direct water away from the field. Proper drainage allows for early cultivation, better weed control, and reduces the likelihood of nutrient leaching. Finally avoid planting maize in shady areas since the crop requires enough sunlight for efficient photosynthesis.

Why is Site Selection important?

- You can choose better land so that your yield will be good.
- You can cut down on transportation time and costs which will save you money.

CHAPTER THREE

SOIL TESTING FOR A GOOD FERTILIZER APPLICATION

3. 0. Introduction

A soil test chemically extracts and measures most of the elements essential to plant nutrient such as N, P, K, Ca, Mg etc. It also measures soil acidity and alkalinity or pH. These parameters are indicators of lime requirement, nutrient availability, and the potential of the soil to produce crops.

3.1 Recommended practices

The fertilizer recommendation for maize is 3 bags of fertilizer per acre of maize. This application rate is considered to be effective in most fields in assuring improved soil fertility and good yield.

- 1) Two bags of NPK 15-15-15 applied at planting or after 2 weeks.



- 2) And 1 bag of sulphate of ammonia or half a bag of urea at 6 weeks after planting.



The best approach is testing soil samples which can better guarantee your soil is getting the right nutrients it needs or the right nutrients it is lacking in order to better meet the

nutritional needs of your plants and guarantee close to the optimum yield of your crop variety.

A good soil test will help you make a good decision on the right type of fertilizer to apply and also the right amount or quantity to apply.

The NPK fertilizers contain N (Nitrogen), P (Phosphorus) as well as K (potassium). As you already know, there are different kinds of nitrogen-fertilizers that are sold on the market. The different numbers you see on the sack means that some have more nitrogen in them than others while others have more phosphorus in them than the other types. For example;

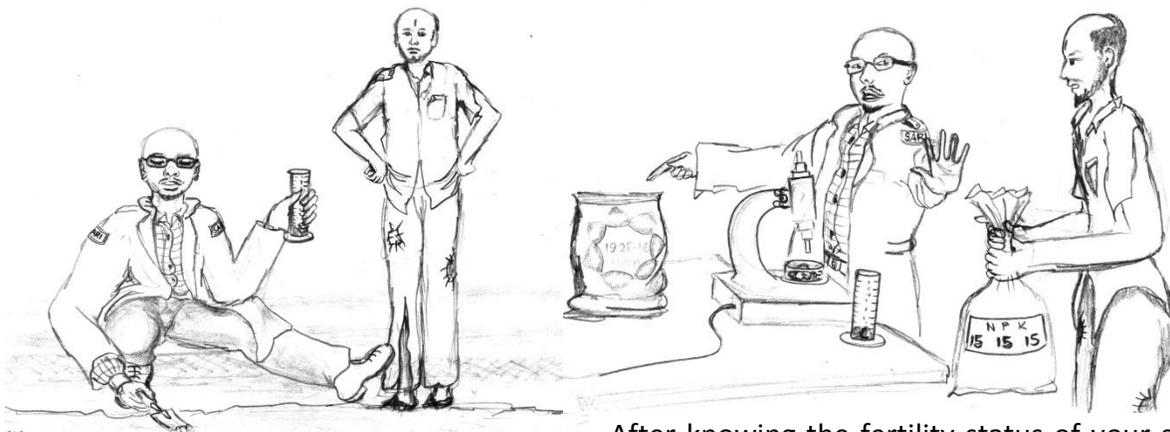
- N-P-K 15-15-15 contains 15% nitrogen, 15% phosphorus and 15% potassium.
- Sulfate of ammonia contains 21% nitrogen and
- Urea contains 46% nitrogen.

This is because the fertilizer blenders know that some soils will need a lot of N (nitrogen) and less P (phosphorus) while other soils will need more K (potassium) compared to the P (phosphorus) or vice versa.

Remember that if you test your soil, it will help you make the best decisions about which fertilizer to buy and how to apply them.

You can talk to your AEA for advice on what to do after you have tested your soil. Your AEA can also help you find a lab where your soil can be tested.

Soil tests can be done either on the field or in detail at the soil chemistry laboratories. A good soil test will help you know the fertility status of the soil on your farm.



After knowing the fertility status of your soil, you can decide the best fertilizer to choose that will make your soil rich and in what quantities to apply them to ensure that you have the best possible yield from your farm.

Why is Soil Testing important?

- You will find out how good your soil is and the type of fertilizer your soil needs MOST– making the fertilizer more effective, making yields bigger, and reducing the money you spend on nutrients your soil does not need.

CHAPTER FOUR

LABOUR MANAGEMENT

4.0 Introduction

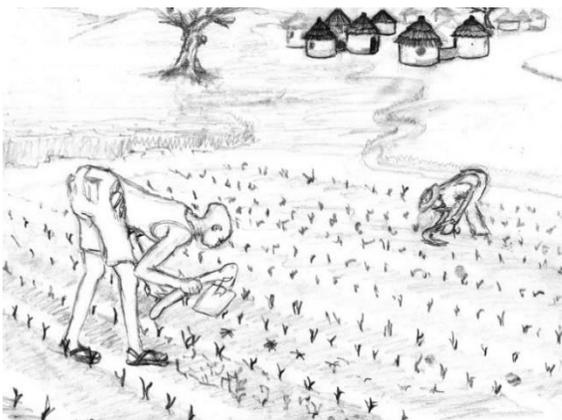
Labour is the work of farmers, their families and hired labourers. This is human effort and it is needed on all farms. Farmers may have three sources of labour; the farm family (family labour), hired labour and labour provided through cooperation between members of the community. A farmer may use any or all sources of labour on the farm depending on the situation.

You may not have expected this, but the most expensive input in farming is labour. Most farmers engage their children, spouses, neighbours and other family members in farm activities such as land preparation, weeding, fertilizer application, harvesting, etc. Imagine you had to pay yourself and all your family members for all the days spent working on the farm; that is the value of the total cost of labour for one season. Therefore, if labour is properly planned and managed, it means you and your family will spend less time on one farm and can have more time and human resource to invest in another farm or other income-generating activities that may not be farming.

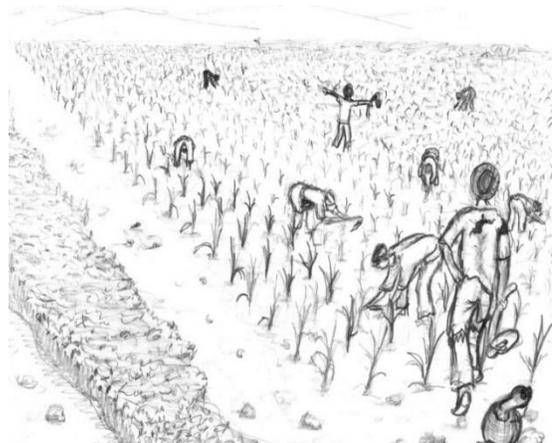
4.1 Effective labour management

You can ensure proper labour management by doing the following;

- **Farm size should be commensurate with available labour.** If you cannot afford hired labour, don't cultivate a huge field; only cultivate the size of land that can be adequately catered for by you and your family. Otherwise, you will be overburdened and cannot provide the adequate care needed for your farm.

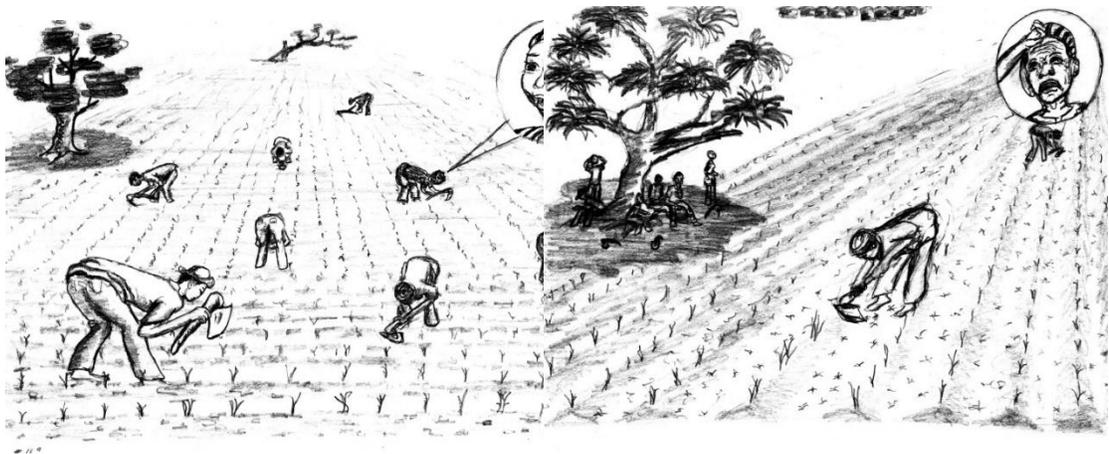


Small Farm: Few Workers



Large Farm: Many Workers

- **Have good working relationship with your labourers.** This ensures that anytime you call on them to work on your field, they will respond and be committed to getting the work done well and also on time. With a good working relationship you could even get them to work for you on credit if you do not have the money readily available to pay them for their services.
- **Hire quality farm labour and not quantity.** Whenever you need people to work on your farm, consider the best workers or farm hands and estimate the optimum number you will need for each activity. When you hire too many people than is required for a particular activity, you waste money and the work might also not get properly done.



Good, Hard-working Workers

Expensive, Lazy Workers

- **Work only during the cooler hours of the day.** You do not need to be on the farm throughout the day. Farm work is best done early in the morning and early evenings around sunset. During these periods, the sun is less harsh and you use less energy on activities.



Hot, mid-day hours

Cooler, morning hours

Why is Labour Management Important?

- You will utilize the right amount of workers and the right kind of workers. This will save you money, time, and stress.

CHAPTER FIVE

FARM SANITATION

5.0 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 how it causes harm if ignored. Farm sanitation will make your farm operations more effective, efficient and productive.

5.1 How to ensure a clean farm

The first thing you can do is to **create a good path/road to your field** from the main road or your community. This makes it easier for you to get to your farm or give other people directions to your farm. Also, it is safer if you have a cleared path because it will reduce the chances of getting injured by thorny bushes or animals (snakes, scorpions, etc.) that could be hiding in the bushes.

Having a cleared path to your field also **minimizes contact with other weed species** thus reducing the chances of you transferring spores or seeds of weeds and other pathogens to your farm from other farms.

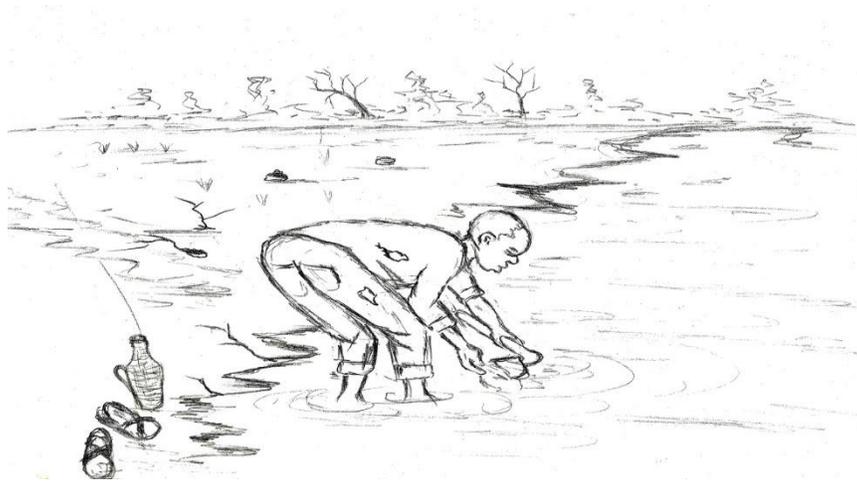
After clearing a good path to your farm, you should also create clear and good paths within your farm. Usually, if you plant correctly in rows and use the right planting distances between your rows, you might not need to create any special paths through your field. The most important thing is to have good passageways or paths through your field that will make your movement through the field easy and prevent damage to your crops.



You can also create a path around your field so that passers-by or neighbouring farmers do not have to pass through your farm to get to theirs but around it thereby reducing possible physical damage to your crops. This is very critical at the early stages of your farm as crops could be easily stepped on if care is not taken.

Studies have shown that lodging increases with higher plant density and greater interplant competition. It is therefore recommended that depending on the germination test, planting two seeds per hill is recommended for those with 85 to 100% germination rate and three seeds per hill for a 70 to 84% germination rate; it is recommended to get better seeds if the germination rate is lower than 70 percent. In addition to this it is recommended that farmers plant their maize in rows to help them calibrate plant population densities and achieve plant spatial arrangements that facilitate subsequent crop management operations, such as weeding and applying fertilizer.

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. Usually, the **best control measure is to identify, isolate and destroy all the diseased or infested plants**. If you are able to identify and remove all affected plants on time, you could avoid a total crop failure. It might also be necessary to apply other chemicals to prevent the development of diseases in other plants on your field. But make sure you consult your AEA or CEA when you detect such things on your farm.



On the farm, other farmers might come to borrow your tools such as hoes and cutlasses to work on their farms. After they are returned, make sure you **wash and clean them carefully to avoid transferring pathogens and other contaminants unto your farm**.

Finally, weeding is a very important sanitation practice that helps keeps your farm clean and eliminates hiding places for pests and hosts of disease pathogens.

Why is Farm Sanitation important?

- It will decrease the amount of destruction by trampling, diseases and pests and therefore will increase your yield and money.

CHAPTER SIX

LAND PREPARATION

6.0 Introduction

In Ghana, traditionally, different land preparation methods are employed in the production of different crops including maize. Some of the land preparation methods include disc ploughing without disc harrowing before planting, disc ploughing and disc harrowing before planting, disc harrowing without disc ploughing before planting, and no tillage.

Land preparation methods for maize production include: slashing and burning, slashing, hand hoeing, herbicides application and tractor ploughing and harrowing. These methods open-up the soil surface for seed sowing and vegetative growth. Although no tillage practices accumulate soil surface organic matter and improve soil biochemical properties, the ploughing and harrowing rather facilitate root penetration, seed sowing and organic matter incorporation into the soil and improve soil structure.

In no tilled soils, yield is usually low due to decreased aeration, soil water storage, crop water use efficiency and reduced penetrability of roots. Since the use of herbicides destabilizes soil biochemical properties, the adoption of a land preparation method that provides suitable conditions for maize production should be encouraged. The use of methods that incorporates organic matter into the soil increases aeration through burrowing and decomposition activities of organisms.

6.1 Some good land preparation practices in maize production

In order to ensure optimum crop yield in maize production, the following practices should be adhered to:

- You need to make sure your land is properly cleared and ready for ploughing. Clear the land by removing plants, stones, felled trees and other materials so as to make it easier for the use of tractors and bullocks. After clearing the land, do not burn the weeds but leave them to dry on the land as this can form a good ground cover.
- Now that our land is properly cleared you can go ahead to plough. Prepare your plots of land with the first rains. That is usually from the beginning of May to early June. Plough your land to loosen the top soil and incorporate the crop residue or vegetation cover. This improves soil fertility and helps in seed germination and rainwater

- retention, and reduces soil erosion. For farmers in Northern Ghana, it is recommended to plough once and supplement it by harrowing once before planting.
- **Do not burn the slashed weeds as this will kill beneficial microorganisms including those that can improve the quality of soil.**
 - Planting on ridges is highly recommended on shallow soils.
 - It is best to plant soon after harrowing.

6.2 Types of tillage

There are four main types of land preparation, which are available to most farmers in northern Ghana:

6.2.1 Zero/No Tillage

Clear the area of weeds using a cutlass. Leave the cleared weeds on the land to serve as mulch. After 7 days, a re-growth of the weeds will occur. Plant your maize on that 7th day. Do not plant when soils are too wet or very dry. Chemical spraying should be done a day after planting using a recommended herbicide to kill all the new emerging weeds. You can also kill the weeds with a non-selective herbicide such as glyphosate followed by direct planting into the standing mulch.

6.2.2 Manual Ploughing

In this method, the farmer needs a hoe and a cutlass. This involves the use of human labour to till the land. Use your hoe to turn and loosen the soil; it will help kill the grass. Where the weeds stand tall, use the cutlass to slash them to enable the hoe turn the soil and bury them. The use of the hoe is not enough in all cases to provide the best depth of tillage for good growth. For example, a good tillage depth for maize should be about 30 cm. Using man power with a hoe can only get to about 10 cm. To achieve the required depth of 30 cm using hoe, ridging is one easy way. Always make your ridges across the slope to check erosion.

6.2.3 Animal Ploughing

Another method by which we can till our maize fields is using an animal- drawn plough. Good tillage requires good animals and selecting an animal is very important. On the

following pages more information is given on the benefits of animal ploughing and also tips on how to select a good bullock for ploughing.

Animal Traction – From the MoFA Agricultural Extension Handbook 2006, page 281

Animal traction is a system in agriculture whereby animals are used for soil tillage, carting, inter-row cultivation, seeding, and water lifting. Most farmers in the Northern Region use hoes to cultivate their land. This makes the work tedious and less productive. This is why our farmers must be convinced to use this source of energy. Draught animals, i.e. bullocks, cows, donkeys, and horses are excellent source of energy for any farmer using just a hoe.

Draught animals can be trained for land preparation and transportation (carting manure, firewood, agricultural produce etc). Due to the high cost of tractors, only a few farmers can afford to buy them. Tractor hiring services are often unreliable, costly, and quality of service is sometimes very poor. Therefore the use of draught animals and traction equipment by farmers is on the increase every season. The advantages of using draught animals for farming are many:

- 1. The initial cost as well as the maintenance cost of draught animals and equipment are low and within the financial means of most small-scale farmers.*
- 2. Draught animals do not have to be imported and therefore no foreign exchange is needed to buy them. Tractors and their implements must be imported. On the other hand animal-drawn equipment can easily be manufactured in Ghana.*
- 3. Draught animals can help farmers to make their work easier and more productive - i.e. soil preparation is easier and faster with animal drawn implements than with a hoe.*
- 4. Animal feeds are available or can be produced in desirable quantities in Ghana but fuel for tractors must be imported.*
- 5. Draught animals, unlike tractors can reproduce themselves.*
- 6. Draught animals, unlike tractors, need no spare parts.*
- 7. The farmer using draught animals, unlike the hoe farmer can easily expand his farm if the land is available.*
- 8. Draught animals give the farmer valuable manure, which is extremely important for the maintenance of soil fertility. The combined use of manure and inorganic/mineral fertilizers is more efficient in crop production than using one type alone.*
- 9. Draught animals can be used safely on steep slopes and on wet fields where a tractor may be useless*
- 10. The farmer using draught animals can cultivate more forage crops for his animals but this is usually impossible for the hoe farmer*
- 11. When the farmer uses draught animals for non-agricultural purposes (carting firewood, water, stones) he can increase his income during the dry season.*
- 12. When the draught animals are old they are not useless like tractors but can be sold for meat at a good price.*

Selection Criteria of Bullocks for Traction – From the MoFA Agricultural Extension Handbook 2006, p283

Before selecting a bullock, the farmer must know the following:

- *The body form of the animal*
- *Hardiness of the animal (ability of the animal to tolerate unfavourable conditions)*
- *Economic use of the animal*
- *Productivity of the animal*
- *Bullocks suitable for draught purposes should be about 3-4 years old and have a minimum weight of 250 kg.*
- *The two bullocks forming the team should be of the same size and weight to have equal share of the traction power.*
- *If possible breeds resistant to sleeping sickness should be chosen {i.e. Ndama, West Africa Shorn Horn (WASH)}*
- *Other characteristics to consider: Strong powerful neck, Direct horns, Straight back, Visible eyes, Good temperament (i.e. not attacking), Good gait (walking well at least 2.5-3 kph or the animal should cover a distance of 100 m in 2 minutes), and Straight power legs with broad hoof*

Also note:

1. *A healthy animal walks well on sound feet, feeds readily, breathes regularly*
2. *On rising, it stretches itself and often passes dung **which is firm in consistency** (dung piles up and not liquid faeces, dung is normal and not discoloured or blood-stained).*
3. *Have a nose and mouth clear and free from discharges, the muzzle is usually cool and moist.*
4. *Has a smooth coat, shiny tail and flanks free from faeces.*
5. *Healthy animals tend to flock together, feed together and rest together.*
6. *Have a good appetite, no rapid loss of condition. No swellings, ticks, or lice.*
7. *Have ears alert (moving to and fro) eyes bright and clear and not running.*

NB. For more information on Bullock Care, please visit the chapter on Mixed Farming. You can also ask your AEA.

6.2.4 Tractor Ploughing

We also use tractors to plough our maize fields. This method is the fastest. Good tillage reduces the time spent in non-productive work. Try and make sure to schedule a reliable tractor operator. The tractor operator should plan the ploughing in such a way as to minimize the number of turns and maximize 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 level 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.

Fields ploughed by animals or tractor sometimes have soils in large clods. This will not favour good maize germination. There is the need to harrow your field when this situation arises. We can harrow manually using hoe or with a tractor.



6.3 Training bullocks

Re-training the bullocks before the first rains is very important 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. Give your draught animals extra feed to make them strong for tillage work. A bull should be three years old to start ploughing.

Aside the above it is worthy to note that 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. This means that you must choose a blade that is not too damaged.

What type of Ploughing is Right for YOU?

- Manual Ploughing – Not a lot of money. Last minute ploughing.
- Animal Ploughing – Some money to rent a bullock OR more money to invest in a bullock and take advantage of mixed farming (dry season business operations, meat sales, etc.). Keep in mind the animal will need to be fed and taken care of.
- Tractor Ploughing – Some money to rent a trusted tractor operator. No interest in owning a draught animal.

CHAPTER SEVEN

CERTIFIED AND LOCAL SEEDS

7.0 Introduction

Seed is an important resource in crop production. One of the major causes of low maize productivity in West Africa is insufficient use of certified seeds of improved maize varieties. Seed quality is most important in crop production, as high quality seed is essential for good crop yields and good returns, and minimizes the likelihood of crop failure. Your harvest at the end of the season therefore depends largely on the type of seed sown at the beginning of the season.

7.1 Local seeds

Farmer saved seeds preserved from varieties best adapted to the environment, are the main planting materials used by smallholder farmers. The limitation of this traditional source of seed are low yield and lack of guaranteed seed quality after a short period of cultivation; mix up of varieties of seed occurs leading to loss of desirable characteristics.

7.2 Certified seeds

Seed certification is a quality assurance system whereby seed intended for marketing is subject to official control and inspection. At its simplest, the system endorses that a sack, packet or box of seed contains what it says on the label and that the seed was produced with the requirements of certification scheme. The seed certification system is an official system supported by national legislation and international protocols to ensure that seed is produced, multiplied and marketed according to predetermined standards and systems while maintaining the genetic integrity of the product.

The central idea behind seed certification is to supply high quality seed to farmers and other growers which are true to identity, high in purity and germination capacity and free from pests and disease. It is known that certified seed has high germination percentage,

Certified Seeds will produce higher yields. If you take good care of them and follow best practices such as planting in rows, weeding, and adding fertilizers. Without these management practices, even certified seeds will not give high yields!

suits your farming conditions and guarantees a good harvest if properly cultivated. Therefore using quality seeds is a very important step for a successful season.

7.3 Factors to consider when choosing a variety of seed

There are different seed varieties available so it is important that you choose your variety wisely as all varieties have their unique characteristics. When choosing a variety, you should consult your AEA and take into consideration the following factors:

7.3.1 Amount of rainfall you get in your community

If you don't get a lot of rainfall in your community, you should choose the varieties below that are drought-tolerant such as **Omankwa, Akposoe** or **Aburohemaa**. Drought-tolerance means that the plants can withstand low rainfall periods and still give you a good harvest at the end of the season. On the other hand, if you live in communities where you receive good amounts of rainfall, you can plant high-yielding varieties such as **Obatanpa, Mamaba, Enibi** or **Etubi** and enjoy very high harvests at the end of the season.

7.3.2 Prevalence of maize pests and diseases in your farming area

If your farm or community is located in an area where your crops get infested with pests such as insects, attacked by pests such as rats, infected by diseases such as maize streak virus disease, rust and smut, you should choose the varieties below that are pest/disease-tolerant or you can choose early-maturing ones such as **Dorke, Dodzi and Abontem**. Because they are early-maturing, they have less time on the field and so are less exposed to incidences of pests and diseases. Also, because they are disease-tolerant, diseases that easily affect other maize varieties cannot infect them nor have a serious effect on them.

7.3.3 Market demand

Even before you begin your season, you should know who you are planning to sell to when you harvest. It is important to ask your buyers what type of maize they will want so that you can produce that type. If your buyer is a poultry farmer, he might prefer varieties with a good protein content such as **Golden Crystal** or **Obatanpa**.

In the table below, different certified seed varieties are listed together with their unique characteristics.

Maize Varieties	Type	Maturity Period	Potential Yield	Characteristics
Okomasa	OPV	120 days	22 bags/acre	Disease-tolerant
Golden Crystal	OPV	110 days	18 bags/acre	Quality protein maize, Yellow grain, High-yielding
Obatanpa	QPM-OPV	110 days	18 bags/acre	Quality protein maize, Disease-tolerant
Mamaba	Hybrid	110 days	26 bags/acre	High-yielding
Abeleehi	OPV	110 days	18 bags/acre	Disease-tolerant
Dodzi	OPV	85 days	14 bags/acre	Drought-tolerant
Dorke SR	OPV	95 days	15 bags/acre	Disease-tolerant
Omankwa	DTM-OPV	90 days	19 bags/acre	Drought-tolerant
Aburohema	DTM-OPV	90 days	20 bags/acre	Drought-tolerant
Abontem	OPV	80 days	20 bags/acre	Drought-tolerant
Enibi	Hybrid	110 days	26 bags/acre	High-yielding
Akposoe	OPV	85 days	14 bags/acre	Drought-tolerant
Etubi	Hybrid	110 days	27 bags/acre	High-yielding

OPV =Open pollinated variety; DTM = Drought tolerant maize; QPM = Quality protein maize

After choosing the variety to cultivate, get directions to certified input dealers (Turn to the appendix at the back of this book for a list of input dealers) from your CEA/AEA and make arrangements with fellow farmers to go and buy the seeds. If you buy in bulk, you will get them at cheaper prices. Your CEA can also contact your AEA to discuss buying seeds in bulk from the Seed and Inspection Unit of MoFA, which you can be sure will give you certified seeds. When buying the seeds, do not buy more than what you need for your current season. The seeds might either get damaged in storage or become waste if you decide to change varieties for the next season. However, make sure you buy slightly more than the exact amount you will need on your field just in case some seeds do not germinate and you need to refill. It is important to know the name of the variety you purchase.

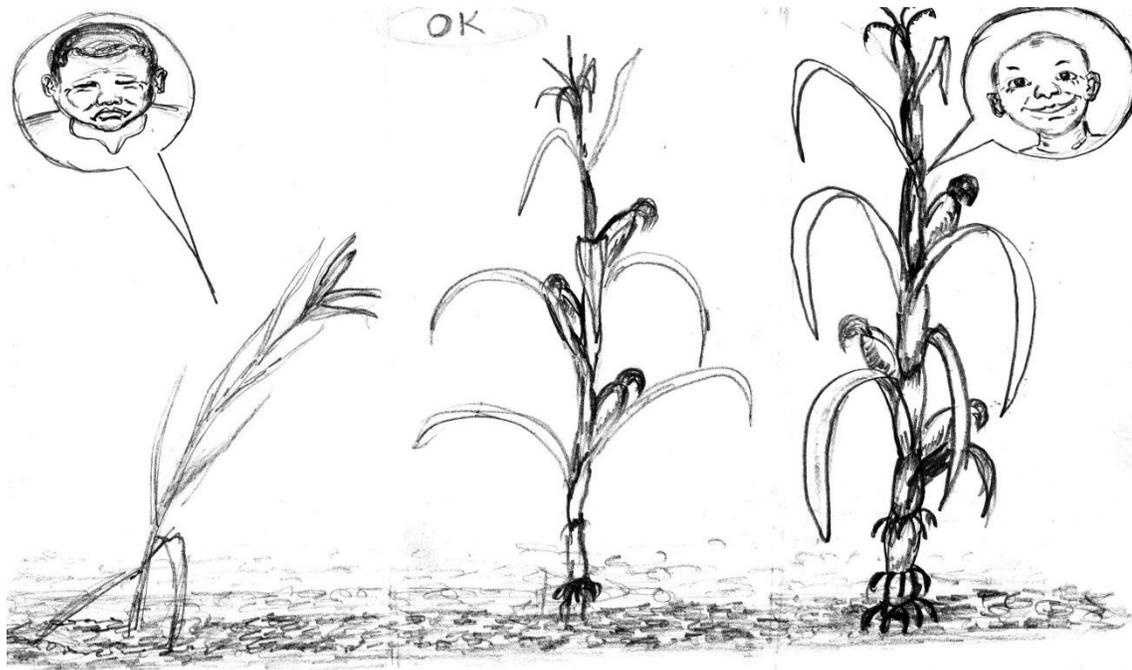
7.4 Seed Saving

Among the inputs used by farmers, seed is the cheapest, however, without good seed the investment on other resources including fertilizer, water, pesticides and other input will not pay the required dividends.

In maize production, seed selection is a very common traditional practice. Some farmers have always selected largest and most healthy-looking and best filled cobs and handled them separately for seed. The best practice is to purchase new certified seeds for each season but if you cannot buy seeds you can recycle seeds from the previous harvest. You should not save seeds of hybrid varieties as they will not do well in the following year.

When saving seeds for the next season, keep the following in mind:

- 1) Start observing your plants closely and identify the ones with desirable features such as deep-green leaves, tall, thick stems, big cobs, etc. Ideally, the plants from which you select your seeds for recycling should be located in the centre of your field because such plants are less likely to be contaminated by pollen from neighbouring fields.
- 2) During harvesting, separate cobs of potential seeds from the remaining harvest.
- 3) Examine grain colour and size. Also look out for any signs of pest infestation, disease or physical damage. Only cobs or grains that meet these quality checks should be considered for seeds for the next season.



7.5 Seed treatment

Another useful thing you can do to ensure good quality maize is to treat the seeds using recommended chemicals in order to protect them against soil-borne pests, diseases and bird attacks before and after germination. Recommended chemicals include Marshal 2% dust, Apron star, Allstar, Dressforce and others. Always read label to know what quantity of chemical to use for dressing a certain quantity of seeds

WARNING: Do not consume seeds that have been treated by yourself or certified seeds that have been treated. These can be very deadly for humans and animals!

Why Buy Certified Seeds?

- Certified seeds are bred to be higher-yielding or drought-tolerant or pest-resistant. It is like they have special characteristics which can lead to much higher yields.
- If you re-use seeds for a long time you won't have those special abilities.
- Certified seeds, when used and cared for properly, will result in a better yield – AND are worth the investment!

CHAPTER EIGHT

TESTING SEED QUALITY: GERMINATION TESTS

8.0. Introduction

Germination test is basically performed to determine what proportion of seeds in an accession 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. It is a good practice to conduct a germination test for seed purchased for the season or stored for more than one year. If germination is poor, discard and buy fresh seeds.

Buying certified seed is the first step in ensuring that you have a good harvest because they perform better than uncertified seeds. Germination tests are the second step as they give you a measure of the quality of the seeds even before you sow them.

Results of germination tests will inform the following key decisions:

- Whether or not you need to go in for different seeds other than what you plan to plant
- How many seeds to place per hole (during actual field planting) to guarantee above-minimum germination percentage

*Even if you have
bought certified
seeds you
should still do*

Because of the time-sensitivity of these decisions, it is advised that you **conduct the germination tests about two weeks before the date you have scheduled to plant**. This gives you enough time to get new seeds if your current seeds fail the germination test and possibly conduct another germination test on your newly-purchased seeds too.

8.1 Conducting a germination test

Follow these instructions carefully to conduct a successful germination test:

1. Get a small plot of land very close to your house that is, as much as possible, **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 is because **the germination test plot will need close care** and attention to ensure that the result is reliable.

2. Now that you have acquired your germination test plot, mark out an area of about 7 feet by 7 feet (2m x 2m) with wooden pegs at all four corners. This plot size is big enough to contain the 100 seeds or young plants you will use for the test but also small enough for easy care and management.
3. Clear all the weeds on the marked-out area of the plot but **do not burn them or collect them from the plot**. Leave them on the plot – this will help the soil retain more water and make it available for your seeds to aid in germination. Also, it protects your seeds from easily being picked up by chickens and other pests.
4. Make sure that you use your hoe to till the soil to make it loose – just like you do on your real farm during land preparation before you plant. This will make it easier for your young plants to sprout.
5. Now count 100 seeds from the package of certified seeds you have purchased or from the recycled seeds you have selected to plant this season. Make small holes the size of your thumb in the soil and place your seeds in them. Gently cover every seed with soil. **Do not press down hard on the soil after you have placed the seed**. Place only ten seeds in a row – to do this, measure about 21 cm for both inter-row and intra-row. If you plant this way, you will be able to fit all the 100 seeds on the plot and also have uniform distances between young plants for easy counting.
6. Watering the plot at this stage is very important. Because seeds have already stored the food they need to support germination, they **DO NOT NEED** nutrients from the soil to germinate; what they need is sufficient water. You can water the plot right before you plant or immediately after you have planted. Whichever you decide on, just make sure that you water the plot sufficiently (without logging it) on the day of planting.
7. Now that your plot has been planted, you have to protect and take good care of it to ensure that your results are reliable. Water them every two days and keep away fowls and other pests that may pick seeds or feed on the young plants.

From the 5th day, seeds should have begun sprouting but you should wait for at least six or seven days to take the results of the test because some seeds might germinate later than others even if they are also good. **If a seed has not germinated after seven days, it means there is a problem**. Now that your seeds have germinated, you should count the number of seeds that emerged and calculate the number that did not.

After counting your seeds, 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 (usually stated on the pack) if they are all the same variety. Some brands also guarantee germination rates and allow customers to return the product if they experience germination rates lower than what is guaranteed on the pack. So make sure you talk with your input dealer in detail before you make a 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 one or more different varieties.

To ensure that the results from your germination tests are reliable, you need to follow the instructions and processes listed above very carefully. If you do not conduct the test well, you will not have a good germination result even if the seeds are of very high quality.

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. This is not good because your plants will not grow uniformly on your field and some will reach harvest before others. Also, conducting germination tests helps you to estimate more correctly the number of seeds to place per hole. You will therefore spend less time on thinning your plant stands if the seeds are of very high quality.

Why is a Germination Test Important?

- If your seeds are bad, it can save you and your family from a total crop failure.
- You will know for sure that your seeds are good and will produce a good yield if other conditions are correct
- It is the first indicator of your yield.

CHAPTER NINE

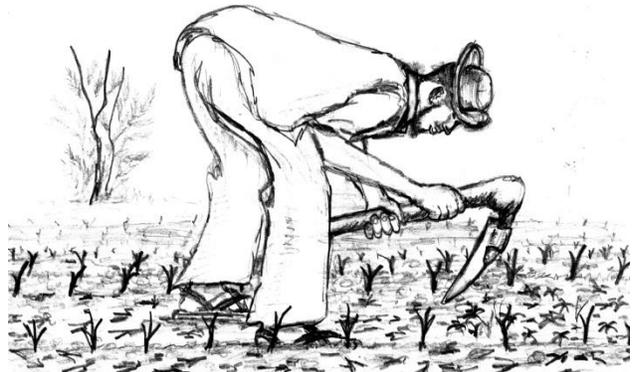
TIMELY AND PROPER PLANTING OF QUALITY SEEDS

9.0 Introduction

Planting is one of the most important farming activities or perhaps the most important one. This is because without planting, you will never have a crop. Planting also requires you to plan ahead in terms of ploughing and germination tests. Even with quality seeds, **if you do not plant them well**, you will have non-uniform crop establishment, poor germination, plant overcrowding/over-spacing, etc. and **you will not get the good harvest** that the seed can give you.

Maize seeds are sown at stake usually in rows for maximum plant population density. The inter-rows range from 60-90 cm apart while intra-rows range 30-60cm depending on the variety. The seeds are sown at 2 seeds per hill but it could be sown up to 3 or 4 and later thinned to 2 seedlings per hill. The intra-row spacing can be halved and one seedling per stand maintained in this case. The population then varies from 15,000 to 90,000 plants per hectare. Sowing can be done with a planter, machete or dibber. To obtain uniform germination, sowing depth of maize varies from 5 to 10 cm, depending on the soil type.

Early planting has been found to be associated with higher yields because the crop is able to utilize the entire growing season and consequently maximize yield. The recommended planting calendar for the various agro-ecological zone is given in the table below. However, the experience of farmers in each area is the best guide.



Suggested planting dates for maize in Ghana

Agro-ecological zone	Major season	Minor season
Sudan Savannah	End-May to Early-July	
Guinea Savannah	End-May to - Mid July	
Transition	Mid-March to End-April	Mid-July to Early-September
Forest	Early-March to End-April	Mid-July to Early September
Coastal Savannah		

Source: CSIR-Savannah Agricultural Research Institute, 2014. Note: Shifts in the onset of the rains have shifted the planting dates 2-4 weeks forward especially in the Sudan and Guinea savannahs

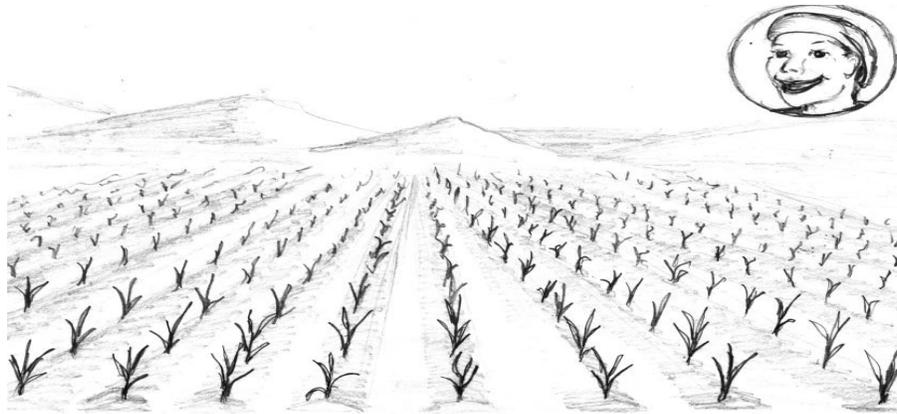
9.1 What to consider before planting

- First look at seed for signs of weathering, disease or physical damage. Seed should be plumb and free from damage e.g. broken seed coats and chipped crown.
- It is a good practice to always conduct germination test ten days before planting to prevent poor stand likely to result from low quality seed.
- Thirdly you must consider timing. Planting must always be done after at least three good rains – this ensures that your plants have enough water to support germination and early growth. This should also be around the time the rains came in over the last three years - usually between May and July.
- The forth thing you must consider is the layout of the crops on your field. Planting in rows has several benefits for your crops:
 - ✓ Facilitates farm operations such as weed control, fertilizer application, watering and harvesting.
 - ✓ Provides fewer hiding places for dangerous animals such as snakes and other pests.
 - ✓ Makes it easy to abide by the correct planting distances for your selected maize variety.
 - ✓ Above all it ensures bigger and better yield.

9.2 Planting in rows

To plant in rows, follow the instructions below:

- 1) Get at least three other people to help you on the day you plan to plant – these could be your family members or neighbours. You could also help out on their farms when it is time for them to plant to repay them for their help. With this arrangement, you don't have to get hired labour to help you plant your field.
- 2) Cut small tree branches and make two wooden pegs. Place the wooden pegs at opposite ends of the field – begin at the far edge or side of your field.
- 3) Now you will need a rope. On this rope, you should mark out the planting distance of your maize variety - these marks will guide you when you are making holes on the field for the placement of the seeds. Tie the marked rope or string to the first peg and take it around the placed pegs for as far as the rope will reach.
- 4) With a long stick in hand and your helper right behind you, move along the laid rope on the field and make small holes in the ground at the marked points on the rope. Have your helper place the right number of seeds (*from the results of your germination test*) in the holes you have made and gently cover them with soil to protect them from pests/birds and from direct heat of the sun. Do not press down the soil too hard on them as this will make it difficult for the seeds to sprout. Also, do not plant in soils that are too wet or too dry.
- 5) Next, place the pegs for the next row. Use your measuring tape to mark the exact points depending on the recommended inter-row distances of your maize variety. After you have done this with one of your pegs, repeat the same for the peg on the other end of the field.
- 6) Continue until planting is complete.
- 7) Remember that it is very important to use the right planting distances for your crop variety when you are planting. This ensures good crop distribution and the right plant population on your farm. You should therefore ask for the correct planting distance for the variety you choose to cultivate.



A traditional but scientific way to train yourself to achieve similar results is muscle memory. To do this, mark out the recommended planting distance of your maize variety (with the measuring tape) on the ground the same length as your field.

Using the same stick you'll use to make holes on the day you'll plant, aim for these marked points on the ground: practice this aiming activity for about 30 minutes each day when you are less busy. After about one week of this activity, you will get used to that action and the recommended distance.

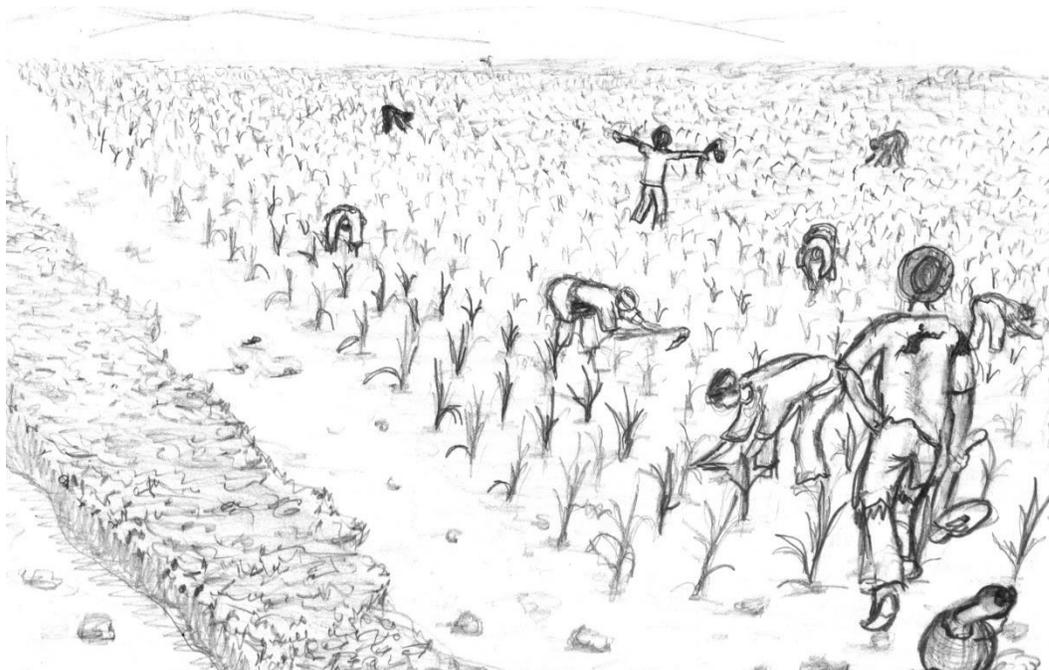
If you do this, you might not need to mark out the distances on the rope and this will save more time compared to aiming for marks on the ropes

Refer to the table below for the recommended planting distances of some common maize varieties.

Recommended planting distances based on maize variety

Recommended Maize Variety	Planting Distance	Resultant Plant Population
Okomasa	90 x 40 cm	22,222 per acre
Golden Crystal	90 x 40 cm	22,222 per acre
Obatanpa	80 x 40 cm	25,000 per acre
Mamaba	80 x 40 cm	25,000 per acre
Abeleehi	80 x 40 cm	25,000 per acre
Dodzi	75 x 40 cm	26,666 per acre
Dorke SR	75 x 40 cm	26,666 per acre

Source: CSIR-Savannah Agricultural Research Institute, 2014.



Why Plant in Rows and Using Correct Spacing?

- Each variety needs a certain amount of space to be as big as possible.
- Using that spacing means your yield will be as big as possible

CHAPTER TEN

REFILLING AND THINNING

10.0 Introduction

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. To achieve the best yield, you need to have the optimum plant population and density for your particular variety because your yield is determined by the number of healthy crops you have on your field and how they interact with other environmental and nutrient characteristics of your field. Some few days after planting, you will notice that certain seeds have not germinated. Depending on the number of seeds you placed per hole, you will also notice that many of the stands have more than one germinated young plant. There is therefore the need to either refill or thin out or do both.

10.1 Procedure for refilling and thinning

In the following subsections we have explained how to refill and thin your crops.

10.1.1 Refilling

As recommended in the previous chapter on seeds, make sure you have extra seeds (of the same variety you planted) left after planting. In the 5 to 7 days following planting, if you notice that some seeds have not germinated, it means that there is a problem and you need to begin preparations for refilling. Follow the following steps when refilling your field;

- Move through your entire farm and count the number of seeds or spots that failed to germinate.
- In addition to non-germinated spots, you should also closely observe germinated seedlings. Some seeds may have germinated but look diseased (refer to the table below for signs of disease) – these kinds of plants might either die soon or not grow into healthy plants. You should pull these seedlings out and count them as you plan to refill those stands too.
- Add these two totals to see how many seeds you need to refill (**non-germinated spots + diseased or weak-looking plants**). Remember to utilize your germination test as well - above 85%, select two seeds times the number of spots counted; between 70-84%, select three times the number of spots counted.

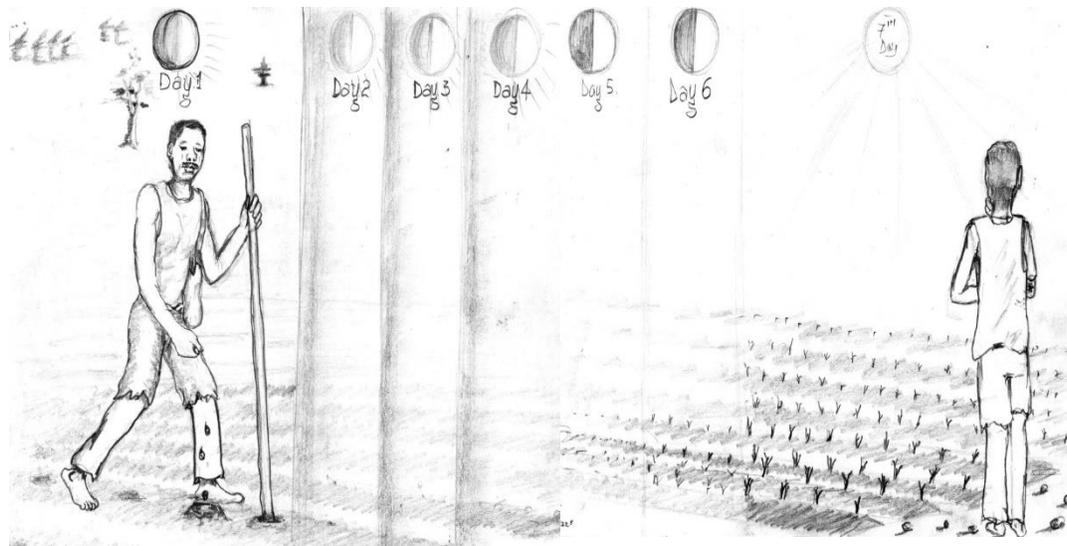
- Now that you have the amount of seeds needed to fully refill your field, soak them in water for 1 day – this reduces the number of days before they germinate. After soaking for a day, dry them for a few hours in the shade before refilling your field with them. If you do this, your plants would have germinated 2 to 3 days after.
- After doing this, dig up and stir soils thoroughly around all spots that need to be refilled and treat them if you can. This will expose any ants or soil pests that may have eaten or destroyed the seeds you planted causing them not to germinate and also make it easier for seeds to sprout. Another benefit of doing this is that it will disturb the environmental stability of any pathogens in the soil that may be causing your young plants to look diseased.



Remember

All this should happen within the first 10 days after your original planting date. If the period is prolonged, your crops will not be uniform and some of your crops will reach maturity significantly earlier than your refilled crops.
THIS IS NOT GOOD FOR YOUR CROPS!

- You can now go ahead and refill all the spots on your field. When placing your seeds, make sure to place them as close to the original spot as possible to reduce chances of overcrowding or over-spacing in those areas of your field as this may lead to increased competition.



10.1.2 Thinning

From scanning your field, you would have also noticed spots that have about three plants. This creates serious competition for space, nutrients, water and even sunlight. These conditions are not good for healthy crop development. **This is when you carry out thinning to remove the extra plants per stand.**

If possible, you should do this after it has rained and the ground is soft. If it has not rained, you will need a watering can filled with water. Water the soil around the base of any stand with three or more young plants to make it loose.

Observe all three or more young plants and look out for signs of disease or weakness in any of them. You should either select the one (or more) that look(s) diseased, the smallest or the palest and uproot gently. If this is not done gently, you might end up disturbing or damaging the roots or leaves of the bother two plants you intend to keep in that stand.



Thinning to two plants per stand should also be done 7 to 10 days after planting - this ensures that plants do not suffer from unnecessary competition before the extra plants are removed. Further thinning to one plant can be done when crops are grown and well-established. When doing this round of thinning, the features to look out for to select the plant to uproot are the same.

It is important to know that both refilling and thinning can be carried out on the same field. All spots that do not germinate as well as stands that only have diseased-looking plants need to be refilled while stands that have three or more plants need to be thinned out.

Why is Refilling and Thinning important?

- Refilling makes sure you have as many healthy plants as possible.
- Thinning makes sure you don't have too many plants.
- Together they ensure the highest yield and more money!

CHAPTER ELEVEN

PROPER AND SAFE USE OF AGROCHEMICALS

11.0 Introduction

Agrochemicals are used world-wide to improve or protect crops and livestock. The word 'agrochemical' simply put means all chemicals products which are manufactured or processed for use at work in agriculture and allied industries.

Some 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.
- **Human health protection:** Pesticides are the most effective substances to eliminate Insects that cause human diseases such as Malaria, Dengue fever, Lyme disease, and West Nile virus loom large. Also, human health is supported against insect and fungi borne carcinogens, like aflatoxins, which is proceeding to hepatic and other cancers.

The use of agrochemicals have their shortcomings in crop production in that food is the basic necessity of life and food contaminated with toxic pesticides is associated with severe effects on the human health. Over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species, including non-target species, air, water and soil. They are one of the causes of water pollution, and some are persistent organic pollutants and contribute to soil contamination. As a result, we are closely exposed to harmful chemicals in the food and water we consume and in the air we breathe. Unfortunately these chemicals are non-biodegradable, persistent and get accumulated in the environment and thus into the human food chain.

In addition, pesticide use for example, reduces biodiversity, reduces nitrogen fixation contributes to pollinator decline destroys habitat (especially for birds), and threatens

endangered species. It has also been noted that some of the pest adapt to the pesticide and don't die.

We can say that although agrochemicals have immense benefit in agricultural production, there are evidences of its negative effect on humans, animals and the entire biosphere. It therefore means that there should be moderation in the use of these agrochemicals. This chapter is therefore devoted to expose readers to the types of agrochemicals available on the market and the proper procedure to adopt when using them.

11.1 Types of agrochemicals

There are several types of agrochemicals on the market today, these are:

- 1) **Insecticides** such as Actellic 25 EC, Karate;
- 2) **Fungicides and bactericides** such as Kocide, Nordox;
- 3) **Weedicides** such as Atrazine; and also
- 4) **Mineral fertilizers** such as NPK & Sulphate of ammonia.

All these chemicals have special uses and instructions that have to be followed strictly to assure results on the field and also safety of the user.



11.1.1 Insecticides

These chemicals are used to kill insects that cause physical harm to our crops. Because these creatures usually cause harm by feeding on the leaves, roots, cobs or grains and stems of the plant, these chemicals also work by making the plant inedible to the pests and insects they are made for. These chemicals are therefore either systemic or contact. The kind you choose (systemic or contact) will depend on the pest/insect you are trying to control so it is therefore important to contact your AEA through your CEA to advise on which kind to get for your pest. It is also important for your application to be timely; if you over-delay, the extent of damage will be so much that even if you apply the chemicals to kill the pests/insects, you can't save your crop.

NOTE: Insecticides do not turn into nutrients for the crops.

11.1.2 Fungicides

These chemicals are used to protect crops from being attacked by diseases caused by fungi or preventing the spread of the diseases after they have infected our crops. Just like human beings, it is important to know which disease has infected the crop before you know which chemical will treat it. It is therefore important to get your AEA to identify the disease and recommend a particular chemical for its control. Once again, application should be timely to avoid irreversible damage to the crops.

11.1.3 Weedicides or herbicides

Hand weeding is the most commonly used method of weed control among farmers but weedicides are catching up fast because it requires less labour and is also cost effective. Weedicides, just like other agrochemicals can be very toxic and if not used properly can cause harm to you, your crops, your field and the environment. To avoid wasting weedicides and causing harm to unintended target crops and yourself, do not spray when it is windy.

Note:

- PRE-EMERGENCE weedicides must be applied immediately after planting or 2-3 days after planting
- POST-EMERGENCE weedicides should be applied 3 weeks onwards after planting or as directed by the manufacturer. Always read the manufacturer's instructions

11.1.4 Mineral fertilizers

The most common mineral fertilizers are NPK compound fertilizers (in different combinations), Sulphate of Ammonia and Urea. These fertilizers are used to enrich the soil and give our plants the nutrients they need to grow healthy and produce good yields. During application, follow the instructions in the Fertilizer Application message to get the most out of your fertilizers.

11.2 General guidelines for agrochemical use

To use all the above mentioned types of agrochemicals, there are some guidelines you should follow. These are listed below;

- Before you decide to use any agrochemical on your farm, please **discuss with your AEA** to help you decide where to find reliable dealers, which type to use and how to properly use them. Do not forget to buy your **gloves and face masks** when you visit your dealer to buy the chemicals. They are very important.
- Although the safety instructions on all chemicals may be the same, their preparation and application may vary so it is important to always find someone to help you **read the label of the chemical container on the preparation and application instructions**. If you use your knowledge of another chemical's preparation and application for all chemicals, they will not work well and the problem you are trying to solve might remain.
- When you are ready to mix your chemicals according to the instructions on the chemical container, make sure there are no kids, animals or other unprotected people around. **Mixing chemicals should always be done on the field**. Wear overalls if available. If not, wear shirts with long sleeves, thick trousers or jeans and boots (not sandals) before you begin working with the chemicals.
- **Only mix the amounts you can use at a time**. Don't mix in excess and store - the chemical might become less potent and also pose danger to others. Follow mixture ratios accurately and avoid using too little water or too much water than what is described on the container. Too little water makes the chemical hazardous to crops and the environment and too much water makes the chemical weak.
- During application, **always have your back to the direction of the wind**. Otherwise, the wind might blow the chemical onto your body. 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



Remember

Although chemicals can be very beneficial for your crops, they can also be VERY harmful for humans and animals.

Before you start using chemicals ask your AEA for a training on how to apply them safely.

ALWAYS use protective clothing

NEVER re-use chemical containers

- 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 your knapsack sprayer with clean water and throw the water away 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 idea that it will make them stronger; it will rather make them weaker.**

Why Safely Use of Agrochemicals?

- Using chemicals makes our crops more productive by adding nutrients or fighting pests and diseases making our yields higher.
- However, they are **POISONOUS** and must be used carefully in order to get their benefit.

Symptoms of Poisoning by Pesticides – From the MoFA Agricultural Extension Handbook 2006, p 357

Pesticides can poison people and animals in the following ways:

1. By direct contact through the skin
2. By inhaling, and
3. By swallowing.

Symptoms of **mild poisoning** by pesticides are headache, fatigue, weakness, dizziness, nausea, vomiting, excessive sweating, anxiety, loss of appetite, and tightness in the chest.

Symptoms of **moderate poisoning** are: rapid pulse rate, vomiting stomach cramps, fatigue, blurred vision, diarrhoea, excessive salivation, watering of the eyes, hyper-excitability, twitching of the muscles of the eyelids, constrictions of the pupils and beginning of mental confusion.

Symptoms of **severe poisoning** are: fluid in the chest, tremors, convulsions, coma, loss of urinary and bowel control, respiratory failure.

First Aid

- If a person suddenly feels sick while using a pesticide, he should stop working immediately and leave the spraying or contaminated area and seek help.
- If a child or an irresponsible adult swallowed a pesticide solution, give him quickly a tablespoon of salt dissolved in half a glass of warm water to induce vomiting. Give the victim plenty of water or milk.
- When excessive amounts of pesticide have come into contact with the skin, remove immediately all clothing and clean the contaminated parts of the body thoroughly with soap and water.
- If the eyes of the patient have been contaminated with spray or dust, wash them carefully with flowing water or ask the patient to blink the eyes under water.
- If breathing of the patient ceases or weakens, give him artificial respiration until the doctor arrives
- Never try to give anything to an unconscious patient. Take the patient immediately to the nearest hospital or clinic and take along the label of the pesticide or the whole container for the doctor's inspection.
- **When you suspect a moderate or severe pesticide poisoning, IMMEDIATELY seek medical care!**

Precautions for Safe Chemical Use – From the MoFA Agricultural Extension Handbook 2006, page 355

1. Pesticides such as insecticides are very useful chemicals used in agriculture but they are poisons and must be handled with caution.
2. Read the safety precautions on the label before buying and using a pesticide. If the label calls for the use of protective clothing and equipment, make sure to use them.
3. Use a carefully locked room or box placed away from food, drink and especially children and irresponsible people for safe storage of pesticides.
4. Mix pesticides in the open air or in a box in well-ventilated rooms and avoid inhaling sprays or dust.
5. When opening or filling the sprayers, avoid splashing and spilling pesticide solution on yourself and others.
6. Do not smoke, eat or drink while mixing or applying pesticides or while your hands are still contaminated with such materials.
7. Use protective clothing and gloves because toxic pesticides can be absorbed into the body through your skin.
8. Never measure pesticides in a container which is used for eating.
9. Prepare pesticide concentrations exactly according to the stated recommendations
10. Never spray against the wind in order to protect the body against pesticides.
11. After applying a pesticide, the operator should wash the sprayer and then himself and change into clean clothes. Never remove the filler cup of a pneumatic knapsack when the cylinder is under pressure.
12. Wash contaminated clothing before wearing it again.
13. Do not use empty pesticide containers for feeding or watering animals or for fetching water for human consumption. Empty containers should be destroyed and dumped in disposal pits of at least 1.5 to 2 meters deep. Do not fill the pits up to more than 30 cm to the top.
14. Do not prepare pesticide solutions more than what can be used in a day. Any pesticide solution which was not used during the day should be poured out in an isolated area where it will not contaminate crops, water, or injure domesticated or wild animals.
15. Avoid any application of pesticides at least 10-14 days before harvesting edible crops.

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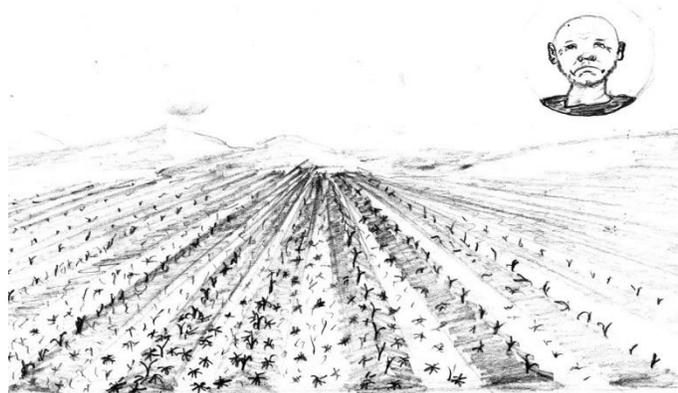
CHAPTER TWELVE

WEED MANAGEMENT

12.0 Introduction

A weed is simply any plant that causes nuisance to a crop. It takes advantage of unused resources made available by cropping system. In other words, 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. Weeds also lead to increase production cost resulting from the cost of controlling them and the insects and diseases they harbour.

*In Africa, farmers lose up to 35% of their maize harvest as a result of weeds!
This means that if your crop would have given you 10 bags at harvest, not controlling weeds might reduce your harvest to only 6.5 bags.*



Weeds also compete with maize for light, nutrients, soil water, space, resulting in yield losses, low grain quality. Weeds must never be allowed to outgrow maize plants before they are controlled. Note that weeding during the critical 2-4 weeks after planting will greatly enhance grain production.

Even though there are many types of weeds, the common feature of all weeds is that they compete with our crops for nutrients, space and water and eventually cause harm to our plants resulting in reduced potential yields of our crop. It is therefore very important to learn how to effectively control them to ensure that they do not harm our crops and reduce our harvest. That is what you will be taught in this message.

Weed control may be expensive but it is very necessary. Also, the difficulty of weed management usually results in either poorly carried out control or bad timing of control activities.

In Ghana, it is estimated that about 45% of farm labour of the smallholder farmer is dedicated to weed management. A common method of weed management that requires less labour is using chemicals. Even though this method of control requires money to buy the chemical and might also be environmentally harmful if not regulated, it is very effective in controlling most weeds that occur on our maize farms. Below are the different kinds of chemical control and how these can be applied.

12.1 Methods of weed control

One key thing to know is that the type of weed determines which method of control is the best. This section briefly describes the different weed control measures which include, manual, biological control and use of weedicides or herbicides.

12.1.1 Manual control

Manual and mechanical techniques such as pulling, cutting, and otherwise damaging plants, may be used to control some invasive plants, particularly if the population is relatively small. These techniques can be extremely specific, minimizing damage to desirable plants, but they are generally labour and time intensive.

Timely Manual or Hand Weeding: You can manually control weeds in your farm by using your hoe to clear them from your field – this is however very labour- intensive. Manual weeding should be carried out throughout the field at least two or three times between planting and harvesting. The first weeding should be done at most 3 weeks after planting. After this, weeding should be done anytime weeds appear on the farm in substantial numbers.

12.1.2 Herbicide control measures

Herbicide is a chemical used to kill or inhibit the growth of weeds and other unwanted plant pest. Contact herbicides kill only the plant parts in contact with the chemical, whereas systemic herbicides are absorbed by the roots or foliage and translocated throughout the plant. Herbicide activity can be either selective or nonselective. Selective herbicides are used to kill weeds without significant damage to desirable plants. Nonselective herbicides kill or injure all plants present if applied at an adequate rate. To be effective, herbicides must adequately be in contact with plants, be absorbed by plants, move within the plants to the site of action without being deactivated, and reach to toxic levels at the site of their action.

12.2 Types of herbicides

There myriad of herbicides on the shelves all over the world. Herbicides can be classified in several ways including weed control spectrum, labelled crop usage, chemical families, mode of action, application timing/method. The subsections below briefly describe some of these herbicide based on application timing.

12.2.1 Pre-emergence herbicides

These types of herbicides are applied to the soil soon after planting or before the maize seeds emerge. Pre-emergence herbicides kill weeds even before they get the chance to compete with your crops because they prevent weed seeds from germinating or they kill sprouting weed seeds before they have the chance to emerge.

To use pre-emergence herbicides, note the following;

- It is best done after it has rained and the ground is moist
- If you will apply organic manure to your field, do this before you apply the herbicide
- Clear your field and plant before you apply, but leave the plant residues to serve as mulch and organic matter
- Planting should also follow immediately after harrowing

Pre-emergence herbicides are best for the control of annual grasses. **Pendimethaline (Stomp or Alligator),, Atrazine** and **Galex** are all examples of pre-emergence herbicides that are available in your input dealer's shop. Some herbicides may be applied before planting. They are referred to as **Pre-plant herbicides**. In Ghana the herbicides that may be termed **pre-plant** are those used for killing weed before planting. Examples are Paraquat (Gramozone or Gramoquat) and Glyphosate (which has many trade names such as Sarosate, Sunphosate, Nwura wura, Glycel, Kalach, Tackle, Odeneho, Glyking 480, Kabasate, Glycol)



12.2.2 Post-emergence herbicides

Post-emergence herbicides are those herbicides that are applied after the seeds emerge, usually 3 -4 weeks after planting or later.

For post-emergence control, note the following:

- Always apply chemicals between early or when the weeds are young, about 3 weeks after planting and always about 1 week before fertilizer application
- Application might be multiple times during the season depending on how well you applied the chemicals the first time
- **Keep strictly to the manufacturer's recommendations as the chemical can kill your crops when not properly applied or the dosage is exceeded**



Currently there are only few post-emergence herbicides on sale for use in maize. The common ones are for rice. Atrazine powder may be used as post emergence herbicide in maize but you must seek the advice of your AEA before using it this way.

NB: Remember to always consult your AEA before you purchase or use any chemical on your farm.

12.3 Good cultural practices for effective weed management

Another effective method of weed management is through **good cultural practices**. Below are the list of some cultural practices that may help in the control of weeds and how they work.

12.3.1 Good land preparation

If you prepare your field very well with a tractor and harrow or with a good draught animal, it will help in reducing the development of weeds on your farm. This is because good land preparation gives your field a good tilth which does not favour weed settlement and also destroys weeds and their seeds in the process.

12.3.2 Seed treatment

The special mechanism weeds have that makes them fight with your crop is that their seeds germinate and develop very quickly. To make sure that your maize plants get a head

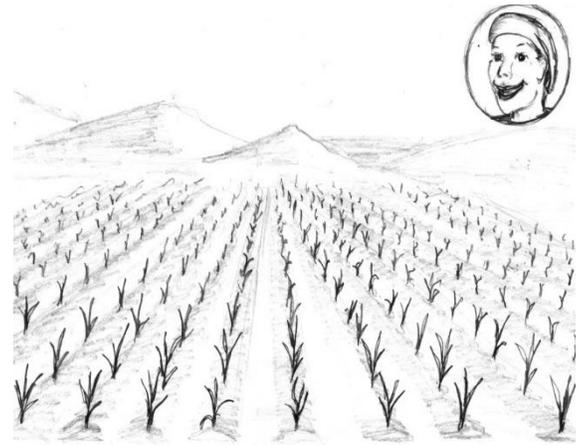
start, you should soak seeds in water for 1 day and dry them in the shade for a few hours (to prevent rotting) before you plant them. When you do this, your seeds will germinate quicker and stand a better chance in competing with newly growing weeds without causing harm to your crops.

12.3.3 Proper planting

If you plant in rows, it is easier to see your crops and get rid of the weeds because all of your crops are in rows, spaced evenly.

12.3.4 Improved fertilizer application

At the first fertilizer application, when your maize is less than 2 weeks old, you should apply fertilizer at about 5 cm (use a measuring tape) away from the base of your plant. For the second application at 6 weeks after planting, apply the fertilizer at 15 – 20 cm (use a measuring tape) from the base of your plant. If you do this, it makes the food from the fertilizer more available to your crops and less to the weeds. **Broadcasting is not advised!** But even before you apply fertilizer, always make sure you weed your farm with a hoe to kill all weeds.



12.3.5 Inter-cropping, crop rotation and farm Sanitation

If you use these farming systems and management practices, you will reduce the physical space available for weed establishment, increase resistance to weeds and create a clean environment that reduces the spread and development of weeds on your farm.

12.3.6 Cover crop

This means planting a leguminous crop like *mucuna*, *calopogonium* or *centrosema* which will suppress the weeds and not allow them to grow. They also serve as good sources of nitrogen for your crops. Always incorporate the cover crops into the soil before you plant or kill them with pre-plant herbicides such as glyphosate and plant directly into the dry standing mulch. Consult your AEA for more information.

Even though after 8 weeks your maize crop can compete with weeds, it is still advised that you clear all weeds on your farm to keep it clean and avoid diseases or pests that they may be harbouring. All these methods of weed control are good but your choice of weed control method may depend on your farm size, the money you have and the type of weeds present on your farm. What is most critical in weed control however, is proper timing because **maize is most vulnerable to weed attack in the first six weeks** and any damage caused by weeds in this stage of plant growth will be irreversible.

What Type of Weeding is Right for You?

- **Chemical Weeding**
 - You can afford to buy chemicals
 - You know how to use them safely
 - You have many farm plots
- **Hand/Manual Weeding**
 - You want to save money by not buying chemicals
 - You do not know how to use chemicals safely
 - You are concerned about health and environmental effects of chemicals
 - You have access to many good workers who can help you weed

No matter what type of weeding, remember the more weeds you have the lower the yield you will have!

CHAPTER THIRTEEN

FERTILIZER APPLICATION

13.0 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 use of fertilizers is the most effective and 2 convenient way to improve soil fertility.

Maize is a crop that takes a lot of nutrients from the soil. Without adding nutrients, the maize plant will not do well and you will end up with a poor harvest. To ensure a good harvest, apply fertilizer.

13.1 Types of fertilizers

We have two kinds of fertilizers that can put nutrients in the soil for the maize.

- 1) One type is called **Organic Fertilizer** which includes animal droppings such as cow dung and chicken droppings. Another example of organic manure is compost - we will talk about organic fertilizer in the next chapter.
- 2) The other type of fertilizer is called **Mineral Fertilizer**. This is usually sold in bags. Examples are NPK and Sulfate of Ammonia.

Higher yield can be obtained by combining both organic and inorganic fertilizers.

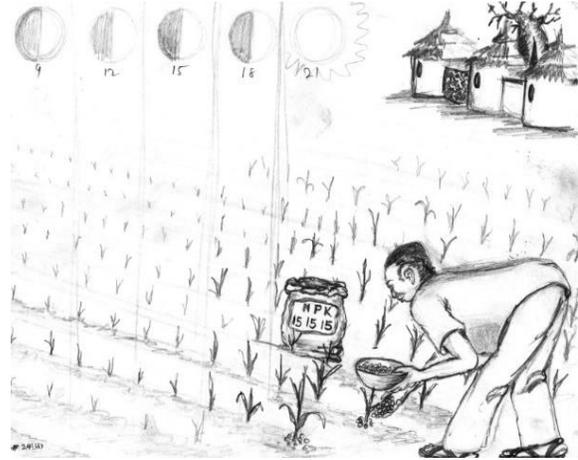
Mineral fertilizers are usually sold in 50-kg bags. In northern Ghana, the mineral fertilizer that is commonly used is NPK 15:15:15. Recently, there have been introduction of other blends on the market. An example is **Actyva** which is NPK **23:10:5+3S+2Mg+0.3Zn**. It is also good for maize. There are other formulations of NPK on the market, e.g. NPK 16-16-16. The other types of mineral fertilizer recommended for maize is Sulphate of Ammonia and Urea. When applied into the soil, mineral fertilizers become available to the plant immediately. If not taken up by the plant soon enough, it

*Standard fertilizer recommendation for northern Ghana
For one acre of maize:
- 2 bags of NPK and
- 1 bag of Sulphate of Ammonia, or half of 50 kg bag of Urea*

is easily lost. For this reason, the following times are the best for applying mineral fertilizers to maize:

- 1) The first application is done **at planting or when the maize is 2 weeks old with 4 to 5 leaves**. At this stage, apply NPK at two bags to an acre. Apply a handful of fertilizer to 4 maize stands. The fertilizer should be placed in a hole at the base of the plant and covered. It is always important to dig a hole about 5 cm away from the maize plant and bury the fertilizer just like the way planting was done. The roots of the maize plant that take up the fertilizer extend beyond the 5 cm from the maize plant itself.

When you bury the fertilizer, it cannot be washed away by heavy rains that may fall immediately after fertilizer application. It is also more available to the maize plant. Fertilizers should always be applied on moist soil.



- 2) At **6 weeks after planting**, when the maize plants are about knee-high or taller, they will be looking green, strong and healthy. But that's not enough. The first fertilizer is almost finished because the maize plants have used it all up. Therefore it is time to give our maize some fertilizer again.



time, don't bother applying fertilizer.

This time, because the maize will soon tassel and produce seeds, they will need Sulfate of Ammonia at 1 bag per acre. Give a handful of fertilizer to 6 maize plants. Once again, place the fertilizer at the base of the plant and bury it.

NOTE: After the stated time periods it is not helpful to apply fertilizer – if you missed the

It is true that chemical fertilizers are costly and organic fertilizers take time to prepare but when you do use fertilizers, your yields will be higher and so will your income from farming. **Fertilizer is an investment and not a cost.**

Fertilizer measurement tools

Measuring device	Kilograms	Grams
1 milo tin (level)	0.82	820
1 handful (approximately)	0.40	400
1 ideal milk tin	0.17	170
1 mackerel fish tin	0.16	160
1 tablespoon (heaped)	0.025	25
1 teaspoon (heaped)	0.01	10
1 bag of fertilizer	50	50,000

Source: MoFA, 2006, Agricultural Extension Handbook.

Any fertilizer application after tasseling is not effectively used by the plant. For this reason all fertilizer applications should be done before the plant tassels.

Why Should You Utilize Fertilizer Correctly?

- Fertilizers provide nutrients your maize NEEDS, which will increase your yield
- But only if you apply them correctly – at the right times, the right amount, and the right places

CHAPTER FOURTEEN

MULCHING, COMPOSTING, AND ORGANIC FERTILIZER/MANURE APPLICATION

14.0 Introduction

Maize is called a heavy feeder because it needs a lot of nutrients to grow. Because our soils are not very fertile and either lack the nutrients needed or only have them in small quantities, they cannot support the maize and provide a good harvest without the addition of supplementary nutrients.

Most farmers supply these additional nutrients by applying inorganic fertilizers but it is not the only way – you can also apply organic fertilizers. Organic fertilizers refer to all plant and animal products that can be added or incorporated into the soil to provide nutrients and make the soil rich. These materials can be added to the soil in decomposed or un-decomposed form. When un-decomposed materials are added to the soil, they undergo decomposition to become humus. In this chapter we are going to delve into mulching, composting and organic fertilizer application.

14.1 Mulching

Mulch is simply a protective layer of material that is spread on top of the soil. There are basically two types of mulch; inorganic and organic.

Inorganic mulches include various types of stone, lava rock, pulverized rubber, geotextile fabrics, and other materials. Inorganic mulches do not decompose and do not need to be replenished often. On the other hand, they do not improve soil structure.

Organic mulches include materials derived from plants that are spread evenly on the soil surface. Their main purpose is to retain soil moisture, reduce runoff and erosion, reduce weed infestation, increase water infiltration and regulate soil temperature that is very desirable for seed germination. Organic mulches decompose in the landscape at different rates depending on the material, climate, and soil microorganisms present. Those that decompose faster must be replenished more often.

Soil moisture reserves are mostly higher on plots with mulch than those without mulch and weed infestation at unmulched plots are usually higher by as much as 11 times more than those that are mulched. Also grain yield obtained from mulched plots can be higher than those from unmulched plots. You are encouraged to apply mulch on your farms whenever you can. Basically, after weeding your field, do not collect and burn the weeds

from your field. Leave them on the field to serve as soil cover. In addition to maintaining the moisture content of the soil by reducing evaporation, these plants will also decompose and increase the organic matter content of your soil.

14.1.1 Benefits of mulching

Mulch has many benefits for both your maize plants and for the humans working on the farm. Some of the benefits of mulching include;

Weed control: Prevent weeds from germinating and smother existing weeds.

Moisture conservation and drought resistance: Mulches can reduce soil evaporation, and increase the amount of water absorbed by a bed by holding water on the surface until the soil is able to absorb it.

Soil temperature: Mulches generally regulate soil temperature keeping it cooler than bare soil.

Nutrient content: mulches add nutrients and organic matter to soils. By “composting in place” sheet mulches add organic matter and humus to the soil.

Soil pH: Depending on the mulch you choose, you can make your soil more or less acidic.

Encourage and protect earthworm activity by providing a cool damp environment for earthworms and providing more food for them.

Encourage and protect soil microbial populations in similar ways as for earthworms.

Keeping dirt from splashing on plants, which can help with disease prevention as many diseases are soil borne and can be transferred by splashing dirt in heavy rains.

Erosion control: Mulch helps prevent erosion in heavy rains, from gravity in sloped beds and in the case of wind.

14.1.2 What to use as mulch

Mulches can be made up of dead and decomposing organic matter, or growing plants. The table below is a list of mulching of material and sources from which they can be obtain. Also found in this table is the thickness of the mulch to be applied and some general comments to guide you.

Mulch materials and sources

Mulch material	Where to find	Thickness on soil surface (inch)
Straw	Farms, garden centers	4-6
Grass chipping	Land scapping companies, the fields around you.	2-3
Tree barks or wood chips	Saw mills, felled trees on farms	2-4
Dry leaves	Farms, bushes around, school grounds	6
Newspapers, shredded or in sheets	Recycling bins, families and friends	2-3
Standing Hay	Farms, grow your own cover crops	4-6

14.1.3 How to use mulch

Begin by asking yourself the following questions:

What do I hope to achieve by mulching? e. g. weed control, moisture retention, soil improvement.

How large is the area to be mulched?

How much mulch will I need to cover the area?

Having answered these questions, obtain your mulch material and spread on soil surface using the recommended thickness shown in the table above.

14.2 Composting

Decomposition of plant parts under natural conditions might take a long time before they are converted into humus that releases plant nutrients. **Composting** is a method you can use to make this process of decomposition faster. The two main types of ingredients you will need to make good compost are dry organic matter such as dried leaves or maize stover for carbon addition and green organic matter such as grass and legume cuttings for nitrogen addition. The green material should be allowed to wilt before use in order to prevent rotting rather than decomposition. After a few months of regular watering and turning of the mixture, your compost will be ready for application on your field when your next season begins and will contain all the nutrients your crop will need.

14.2.1 What is needed to prepare compost?

1. Weeds, grasses and any other plant materials cut from inside and around fields, in clearing paths, in weeding, etc.
2. Wastes from cleaning grain, cooking and cleaning the house and compound, making food and different drinks, particularly local beer.
3. Crop residues: stems, leaves, straw and chaff of all field crops – both big and small – cereals, pulses, oil crops, horticultural crops and spices, from threshing grounds and from fields after harvesting.
4. Garden wastes – old leaves, dead flowers, hedge trimmings, grass cuttings, etc.
5. Dry grass, hay and straw left over from feeding and bedding animals. Animal bedding is very useful because it has been mixed with the urine and droppings of the animals.
6. Dropped leaves and stems from almost any tree and bush except plants which have tough leaves, or leaves and stems with a strong smell or liquid when crushed.
7. Dung and droppings from all types of domestic animals including horses, mules, and donkeys can be used
8. Urine from cattle and humans

14.2.2 Making compost

The Indore Pit Method is the most commonly used method of compost preparation in Ghana. This is described below.

- A. Select and prepare the site. Site should be accessible for receiving the composting materials. The site should also be protected from strong sunlight and wind.
- B. Dig the pit using a minimum of 1 metre deep, 1-1.5 metres wide and 1.5-2 metres or longer.
- C. Fill the pit. Before the pit is filled, the bottom and sides should be covered with a mixture of animal dung and water. If animal dung is not available, a mixture of top soil and water can be used. The pit should be filled in the following order:
 - i. Dry plant materials, e.g. strong straw and stalks of maize and sorghum, which are thick and long, are used for the foundation. These need to be broken into short lengths (about 10–15 cm long). The stalks can be crushed, and then chopped. If possible let cattle lie down or sleep on them for one or two nights. Spread the dry materials evenly over the bottom of the pit to make a layer 20–

25 cm thick. Then sprinkle water with a watering can or scatter water evenly by hand over the dry plant materials so they are moist, but not wet.

- ii. Layer 2: A layer of moist (green leguminous) plant materials, wilted, e.g. groundnut haulms, cowpea stover, stems and leaves left over from harvesting vegetables, damaged fruits and vegetables. Leafy branches from leguminous woody plants can also be used as long as the materials are chopped up. The layer should be 20–25 cm thick at the sides. Water should NOT be sprinkled or scattered over this layer.
- iii. Layer 3: A layer of animal manure collected from r dried cow dung, horse, mule or donkey manure, sheep, goat or chicken droppings. The animal manure can be mixed with soil, old compost and some ashes to make a layer 5–10 cm thick. If there is only a small quantity of animal manure, it is best to make slurry by mixing the dung in water, and then spread it over as a thin layer 1–2 cm thick.

The layers are added to the pit in the sequence, Layer 1, Layer 2, Layer 3, until the pit is full to the top with the middle about 30–50 cm higher than the sides. The layers should be thicker in the middle than at the sides so the top becomes dome-shaped.

Place one or more ventilation and/or testing sticks vertically in the compost pit remembering to have the stick long enough to stick out of the top of the pit. Ventilation and testing sticks are used to check if the decomposition process is going well, or not.

- D. After the pit is full of compost making materials, the top should be covered with wet mud mixed with grass and/or cow dung, and/or wide leaves such as those of banana, pumpkin and/or plastic so the moisture stays inside the pit, and rain does not get in to damage the decomposition process.
- E. Turn the compost pit every 2 weeks.
- F. After a third or fourth month, it should be possible to find fully matured compost
The mature compost can be taken out and put on the field just before ploughing, or mixed into the soil immediately by hand hoe.

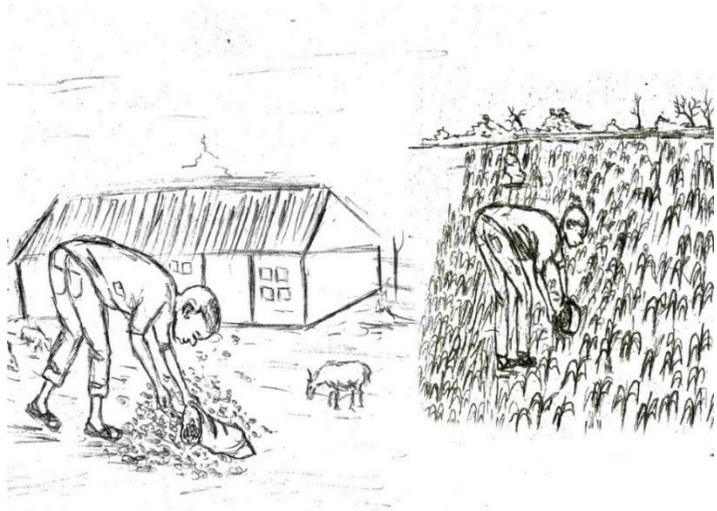
14.3 Organic fertilizer/manure

Animal droppings such as cow dung and chicken droppings and compost are examples of materials that can be used as organic fertilizers. When using manure, it should be mixed with the soil during ploughing or after ploughing.

At least 15 donkey truck loads (2-3 tons) per acre should be mixed thoroughly with the soil about **one week before planting**. This is very important because if you plant too soon

after applying the animal droppings, you might end up scorching your young plants. Application is best done in the morning or late in the afternoon when it is not windy.

In Burkina Faso, Mali and Niger, the compost or manure is not applied on the entire field. Instead it is applied in pits called **Zai** . These pits are made in line at a distance equal to the planting distance of the crop. For this method is known as the Zai method and requires early land preparation.



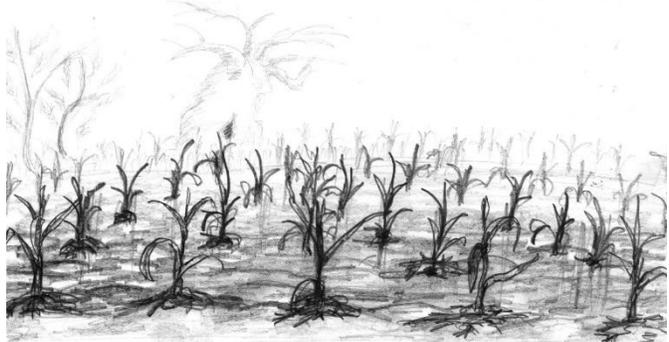
The Zai method



- After preparing your field, you will need to mark out the entire field for the planting distances of your maize variety.
- You will then need to dig holes of about 1 foot deep and 2 feet wide at your marked spots over the entire field.
- Collect and fill holes with your organic fertilizer or animal droppings as you move around the field until all the holes are filled.

- After this, you should apply water to help dissolve the nutrients into the soil and wait at least a week before you plant.

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 method of organic fertilizer application is very labour-intensive but it is very effective in rejuvenating fields. The amount of energy and time needed to transport and apply organic



fertilizers on the farm is great so you will need to make preparations for farm labour. For more information, refer to the next chapter on soil conservation!

Why Should You Use Organic Fertilizer?

- Using materials that are found around your farm and home is **FREE**.
- Using organic material is better for the environment and less likely to cause health problems.

CHAPTER FIFTEEN

SOIL CONSERVATION AND MANAGEMENT

15.0 Introduction

Subsistence agriculture forces farmers to use extractive practices on small size farm (0.5–2 ha) year after year for food production, delaying or completely excluding the adoption of conservation practices that reduce soil erosion risks. Managing soils under intensive use and restoring eroded/degraded soils are top priorities for sustainable agricultural production. Management and conservation of soil and water resources are thus critical to human well-being.

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 maize farming are nitrogen (N), phosphorus (P) and potassium (K). These nutrients can be added to the soil in the form of inorganic fertilizers. This, however, needs to be managed because over-application leads to leaching of soil nutrients to lower levels of the soil and an over-concentration of certain nutrients might also lead to scorching of plants.

15.1 Soil structure and texture

This refers to the form and arrangement of the soil particles on your field. Soil structure and texture has a direct effect 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 or texture of the soil. This is why you need to add organic matter to your soil regularly to improve upon the structure and texture of the soil. Maintaining good soil structure and texture on your field is important because it helps in water retention capacity of your soil as well as helps in easy root development and penetration for good nutrient uptake.

15.2 Preservation and conservation

Preservation and conservation is another important thing you should consider in soil management. The vegetation in northern Ghana is mostly Guinea Savanna which is characterized by short trees that are widely dispersed and grasses. What this means is that, the land is not properly protected and is exposed to wind and water erosion which results in the loss of top soil from the field. **Erosion can be controlled by creating stone bonds, ploughing across slopes and green manuring.**

15.3 Fallowing

Another good soil conservation and management practice is **fallowing**. With fallowing, you leave your fields for a few years without cultivating any crop on it. In this period, the field is allowed to regain the nutrients it has lost due to several years of cultivation. Whenever you plough your field at the beginning of the season, you lose your soil through erosion because it has been exposed. Through fallowing, top soils that would have been lost when the land is prepared will be conserved.

15.4 Contour bunding

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 bundles and arrange them along the contour lines of the field. These will serve as barriers that will block the washing away of top soil off 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.

15.5 Green manuring

It is a two-step process. First, you will have to plant the field with leguminous cover crops, such as *mucuna*, *centrosema*, *crotonaria* after the earliest rains. This could be in April or May – these plants can survive on very little rain. After three to four weeks, when it is time for planting your maize, you plough these crops into the soil. This practice is very beneficial because during the stage when they are growing, the plants serve as ground cover that protects your top soil from wind and water erosion. The ploughing of the plants into the soil also incorporates organic matter into the soil that improves the fertility of the soil. You should not wait until the plants flower as you will not get the full benefit. After ploughing the green manure crops into the soils, you should wait for about two weeks before you do your planting.

Why conserve your soil?

- Having healthy soil means your crops will have the nutrients they need, meaning good yields.
- Doing some of the above practices ensures the land will be productive for years to come – even for your children.
- This means you won't have to look for new lands.

Land Degradation – From the MoFA Agricultural Extension Handbook 2006, page 345

Land Degradation signifies the temporary or permanent decline in the productive capacity of the land. Land here refers to all natural resources such as vegetation, water, and landforms. The advanced stage of land degradation is desertification. Northern Ghana is one area most prone to land degradation. Soils of northern Ghana are generally poor, with about 1% or less organic matter content. Generally, where the organic matter content of the soil falls below 2% the soils are more prone to erosion.

Causes of Land Degradation

- Bushfires are one of the most important land degradation factors in the region. Annually, these are used to generate fuel-wood, for charcoal production, to hunt for game and prepare the land for farming. This gradually and continually strips the soil of any protective cover resulting in soil erosion.
- Poor land management practice turns large tracts of land into wasteland.
- Inappropriate farming methods: continuous cropping that does not incorporate appropriate crop rotation systems does not allow a build-up of nutrients; over-use of chemical fertilizers and pesticides disrupt the soil ecosystem.
- Pollution of the land through indiscriminate dumping of solid and liquid wastes, scrap metal, plastic/polythene, building rubble.
- Overgrazing: continuous grazing by farm animals till the complete destruction of all the vegetation
- Indiscriminate mining (including sand and gravel winning): this causes damage to the soil and the substructure, and pollution of water and soil by chemicals.
- Deforestation: removal of trees and other vegetation for farming, lumber, and domestic use.

Effects of Land Degradation

- Destroys the productivity of the land leading to reduced crop yield
- Leads to erosion and siltation of dams and waterways. This may also affect irrigation schemes.
- Increased spread of iron pan formation
- Destroys the ability of the land to restore its productive state to sustain plant and animals life.
- Increase the cost of farming through the use of inputs like mineral fertilizers to replace nutrients lost to erosion
- Loss of biodiversity as the land loses its ability to sustain life.

Bushfire/Wildfire - From the MoFA Agricultural Extension Handbook 2006, page 352

Wildfire can be understood as any uncontrolled burning of vegetation that destroys farm produce, the forest, grassland and any agricultural resource that affects the social and economic wellbeing of an individual and the community. During the last three decades, the most significant cause of forest loss and degradation in Ghana has been wildfires. Large tracts of vegetative cover are destroyed annually with its consequent high negative economic implications.

Wildfires have become endemic in northern Ghana because the rural economy relies heavily on agriculture, where fire has been incorporated as a tool. As long as the rural economy thrives, fire will be used and wildfires will persist. Northern Ghana has been identified as highly vulnerable to fire and annually an average of 65% of vegetation cover is destroyed by bushfires. Wildfire can be categorized into two groups: early fires and late fires, either of which has its advantages and disadvantages.

Early fires refer to the burning of the bush at the onset of the dry season when there is substantial amounts of moisture in plants to limit the amount of vegetative matter that would be consumed by the fire. Supporters of this practice believe that it minimizes the extent of damage caused to the environment by fire. However others believe that this practice leaves a lot of stubble behind which generates late fires with disastrous consequences.

Late fires refer to the setting of the bush to fire during the dry season or at the beginning of the rainy season. This type of fire is very devastating as the vegetation, especially the grass, usually lose almost all the water in them during the dry season.

Causes

Most of the time, bushfires are started intentionally as a tool to clear the land for crop production, in a communal game hunting, honey tapping, or pasture management. Also, livestock farmers, especially nomads, often set the bush on fire to stimulate the growth of fresh succulent grasses to provide fodder for livestock at the time of the year when there is serious scarcity of forage. Occasionally, accidental fires do occur through some form of carelessness and negligence.

Bushfire / Wildfire (continued)

Effects

Bushfires have wide ranging ecological, economic, and social impacts including the following:

- Loss of valuable timber resources and depletion of carbon sinks.
- Degradation of water catchments areas resulting in siltation and drying up of water bodies
- Loss of biodiversity and extinction of plants and animal species
- Loss of wildlife habitat and depletion of wildlife.
- Loss of natural regeneration and reduction of vegetation cover
- Global warming resulting in rising temperatures.
- Increased percentage of carbon dioxide in the atmosphere due to the loss of carbon sink resources
- Depletion of soil micro-biota resulting in loss of soil fertility.
- Ozone layer depletion

Control and Prevention

Bushfire prevention and control activities are intended to decrease the number, size, and intensity of unwanted fires and the damage they cause. The prevention and control measures that can be directed to bushfires in northern Ghana include the following:

- Conduct a participatory analysis on the causes and effects of bushfires at the community level
- Formulation of annual bushfire prevention programmes in the regions.
- Launching annual regional anti-bush fire campaigns and education on radio, in schools and public places.
- Formation and training of fire volunteer squads in communities
- Organizing refresher courses for fire volunteers and providing them with adequate logistics to function effectively.
- Intensification of extension education on non-burning
- Promotion of strong inter-agency coordination and cooperation at the regional and district levels.
- Encouraging basic schools and agricultural institutions to incorporate bushfire management into their curricula.
- Establishment of bushfire management fund in the regions to ensure sustainable funding at all levels.
- Promotion of rural enterprises such as apiculture, grasscutter farming and eco-tourism.
- Promotion of award days in line with the National Farmers' Day Celebrations where deserving communities will be rewarded.
- Assisting research institutions in the regions to carry out adaptive research on bushfire management.
- Dissemination of relevant research findings on bush fires to appropriate institutions for adoption.

Deforestation - From the MoFA Agricultural Extension Handbook 2006, page 350

Deforestation refers to the indiscriminate felling of trees and shrubs. This has the tendency of turning a forest into savanna and savanna into desert. Over the years, deforestation has been on the increase in northern Ghana. It is estimated that 14.7 million hectares of woodlots in the savannah zone of northern Ghana is lost through traditional farming practices. In simple mathematical terms, 20,000 hectares of woodland are destroyed each year in northern Ghana through local farming activities.

Causes

The main causes of deforestation in the northern part of Ghana include the traditional farming practices of shifting cultivation, slash and burn method of land clearing and reduced fallow periods due to high demand placed on land as a result of high population growth. These traditional farming practices coupled with improperly managed mechanized farming, bush burning, wood cutting for firewood and electrical poles have exposed the soil surface to erosion and drastically reduced the soil's agricultural productive capacity.

Effects

Deforestation affects all forms of life on earth due to consequences such as:

- Reduction in soil fertility
- Interruption in the rainfall pattern
- Global warming and greenhouse effects
- Interruption of various biological cycles
- Loss of important medicinal plants
- Death of soil micro-organisms due to high temperatures

Management Options

- Establishment of community woodlots where community members can draw their fuel wood, rafters for rooms, and poles for electricity.
- Encouraging the use of alternative fuel sources such as cow dung, guinea corn and maize stalks, wood shavings etc.
- Promotion of micro-enterprises such as groundnut oil and shea butter production, dry season vegetable farming through small irrigation schemes, as steps to address the poverty situation in the regions.

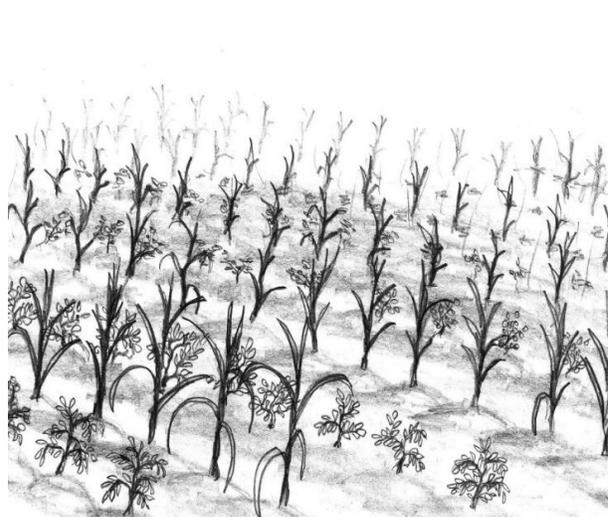
CHAPTER SIXTEEN

INTERCROPPING

16.0 Introduction

In most households, male farmers only grow maize or rice on their fields while the women only grow beans and other legumes. These fields are usually separate with one completely dedicated to maize and the other dedicated to the legumes. Because different crops are harvested from these fields, the household enjoys a food basket that is varied and most of the nutritional needs of the family are catered for.

However, there is a different way of creating variety in the food basket through the cultivation of these same two types of crops on the same field. This is more beneficial to the fields we harvest and also increases the individual harvests of these crops. This system is called intercropping.



Intercropping is the practice of growing multiple crops on the same piece of land at a time. It is the practical application of ecological principles such as diversity, crop interaction and other natural regulation mechanisms. Intercropping has many advantages, mainly related to the complementary use of environmental resources by the component crops which results in increased and more stable yields, better nutrient recycling in the soil, better control of weeds, pests and diseases and an increased biodiversity.

16.1 Methods of intercropping

There are several intercropping systems you can choose from. With the help of your AEA, you can decide which variation will be more suitable for the crops you choose and the nature of your field. There are different ways to intercrop, which we will describe here.

Row Intercropping: In this system, the farmer grows two or more crops at the same time with the crops planted in different rows.



Strip Intercropping: In this system, the farmer grows two or more crops together in strips wide enough to permit separate crop production using machines but close enough for the crops to interact.



Mixed Intercropping: In this system, the farmer grows two or more crops together in no distinct row arrangement.

Relay Intercropping: In this system, the farmer plants a second crop into a standing crop at a time when the standing crop is at its reproductive stage but before harvesting. There should be a leguminous crop involved.



Remember that the type of intercropping system you choose should depend on the nature of your field and the crops you want to intercrop.

16.2 Principles of intercropping

To reap the full benefits of intercropping, there are a few principles you will need to follow.

1) Do not intercrop two or more plants from the same family. For example,

Cereals should not be intercropped with other cereals. If you grow maize as your primary crop, you should not intercrop with crops such as millet, sorghum or upland rice. Because most cereals are heavy feeders, intercropping two cereals will result in increased competition for limited soil nutrients and will result in crop failure of both plants. This will also highly deplete the fertility of the soil making it more difficult to grow crops in subsequent seasons without high input of fertilizers. **Legumes should also not be intercropped with other legumes.** Legumes such as soya and cowpea help the soil by converting nitrogen (what you get from Ammonia or Urea) in the atmosphere into a form that can be used in the soil. This means that, these legumes do not really need that much nitrogen from the soil – they need other nutrients such as potassium and phosphorus. Therefore when you intercrop two legumes, they will both fix nitrogen in the soil but compete for these two major nutrients (P & K) from the soil and result in underdevelopment of the crops which will lead to low harvests. Examples of legumes are groundnut, soya and cowpea. You should avoid intercropping any two of these crops!

Did you know?
The advantage of intercropping a cereal and a legume is that the legume fixes nitrogen in the air for use by the cereal while the maize does not compete for P & K with the legume because they both require them at different stages of growth.

2) Do not plant the same areas of the field with the same crop the next season.

The rows you plant with cereals this season should be planted with legumes the following season to ensure uniform nutrient addition and rejuvenation to all parts of the field. It is therefore important to note the exact areas of the field that were planted with which crop because during land preparation for the next season, all the rows and strips will be destroyed.

16.3 Benefits of intercropping

Some of the benefits of intercropping are;

- **Legumes fix nitrogen** from the air. When the plants are ploughed into the soil they provide nitrogen needed by cereals and this reduces the amount of ammonia or urea you will need to apply to your maize and other cereals.
- **Most pests and diseases are crop-specific.** This is because other crops can withstand them without being infected (diseases), produce biological compounds that are

harmful to them (pathogens & pests) or are not feed for them (pests). Therefore planting two crops from different families together on the same field serves as a biological control mechanism against pests and diseases. Examples of cereal pests and diseases that do not attack legumes and therefore whose activities are hindered through intercropping are earworm, army worm, and rust disease. Examples of legume pests and diseases that do not attack cereals and therefore whose activities are hindered through intercropping are thrips, aphids, and rosette.

- Weeds need space to establish and germinate. Technically, if you are able to cover the entire surface of your land without a single inch of free space available, your farm would be free of weeds. Through intercropping, we are able to reduce the space on our fields that remain bare by planting in a secondary crop and thus **reduce the space available for weeds to establish themselves.**
- A crop might fail because of several reasons. It might be because of disease or pest infestation, unfavourable climatic conditions, or even bad seed. Because different crops have different tolerance and resistance levels to these causes of crop failure mentioned above, it means that **intercropped fields will more likely harvest at least one crop at the end of the season.** Farmers in your area who do not intercrop their fields would have suffered total crop losses.
- You also get a **varied food basket** that caters for the nutritional needs of 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!

Why is Intercropping important?

- It is better for the soil, meaning your crops will be healthier and bigger for years to come.
- It is an insurance against risky farming – in bad farming conditions, it is more likely one crop will be harvested.

CHAPTER SEVENTEEN

CROP ROTATION

17.0 Introduction

Crop rotation is defined as a series of different crops planted in the same field following a defined order. Crop rotation with legumes has been found to improve soil physical, chemical and biological conditions. Fortunately, land in northern Ghana is suitable for a variety of crops ranging from cereals like rice, maize and millet; legumes like soybeans, cowpea and groundnut; vegetables like onions, tomatoes and green pepper as well as tubers like yam, etc. These different kinds of crops have different nutrient requirements and affect the soils on which they are cultivated very differently. An effective crop rotation scheme by farmers therefore will ensure efficient use of land while conserving the soil for sustainable crop production.

Not to be confused with intercropping, crop rotation means that you do not repeat a particular crop too many times subsequently on the same field.

If you are a farmer who has access to different fields for farming, there is a way you can take advantage of the wide variety of crops that can be cultivated in the Northern Region to develop a very effective crop rotation system that holds a lot of benefits both for your family and for your field. Crop rotation is simply the practice of alternating the crops you grow on a particular field. Usually people think that with crop rotation, you need to change the crop grown every season but this is not strictly the case. You can design your own crop rotation scheme. Note, however, that you should not rotate crops that are in the same family – this will not yield the beneficial results of crop rotation.

17.1 How to rotate your crops

Here are a few suggestions of how you could rotate your crops:

- You grow one crop for two successive seasons and then switch to another crop for two years before returning to cultivate the original crop
- You grow one crop for two seasons successively and then switch to another crop for only one year and return to cultivate the original crop
- Alternate crops every season i.e. you grow one crop for one season and switch to another crop also for one year and repeat the cycle

- You alternate three or four different crops on the same field based on intervals you have developed for each crop. Whichever schedule you choose for rotating your crops, you should always consider the characteristics of the crops you will be rotating and how they complement each other in terms of nutrient consumption and requirement. Another important factor you should consider is the desired results you want to achieve after each cycle of rotation.

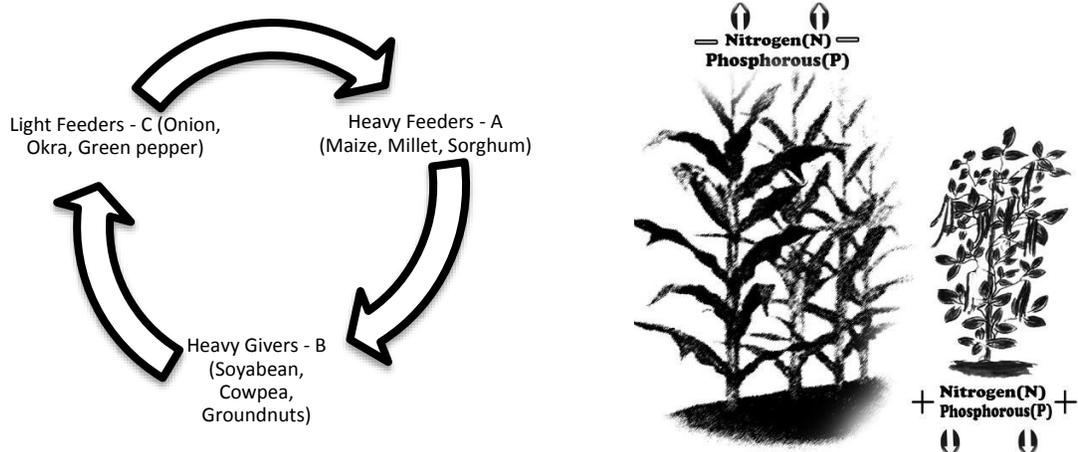
The table below shows the different kinds of crops grown in northern Ghana and their characteristics. In designing your crop rotation plan, refer to this table to decide on how crops should follow each other.

Nutrients requirements of various crops in Northern Ghana.

CROP	TYPE / CODE	NUTRIENT CHARACTERISTICS
Maize	Cereal (A)	Heavy Feeder; Consumes Nitrogen, Phosphorus & Potassium
Rice (Upland)	Cereal (A)	Heavy Feeder
Millet	Cereal (A)	Heavy Feeder
Sorghum	Cereal (A)	Heavy Feeder
Soya	Legume (B)	Heavy Giver; Nitrogen Fixer
Cowpea	Legume (B)	Heavy Giver; Nitrogen Fixer
Groundnut	Legume (B)	Heavy Giver; Nitrogen Fixer
Onion	Vegetable (C)	Light Feeder
Okra	Vegetable (C)	Light Feeder
Green pepper	Vegetable (C)	Light Feeder
Yam	Tuber (D)	Medium Feeder
Cocoyam	Tuber (D)	Medium Feeder

Source: CSIR Archives.

With the information in the table above, you can now develop a crop rotation scheme based on the following diagram:



Remember to use the information from the table (on the different types of crops) and diagram (on the sequence of crop types) to help you decide the best crop rotation schedule and regime for your field.

17.2 Why practice crop rotation?

Looking at all the information needed and the planning you need to put into developing a good crop rotation system, it is easy to abandon the idea and stick to growing the same crops year after year on the same field. However, below is a list of the benefits you will be getting if you decide to rotate your crops.

- **Rotating crops on your field helps to maintain the fertility of your soil.** This means that through crop rotation, your field will remain fertile and is able to support the cultivation of crops for a very long time without losing its strength
- **Crop rotation also serves as a means of pest and disease management on your field.** For the control of pests and diseases, crop rotation is one of the most effective means. Because most pests or diseases are crop-specific, it means that if your farm is infected by a particular disease this season and you grow the same crops next season, your crops will suffer again from that disease. However, if you practice crop rotation, the disease will not get a susceptible host the following season and will be deprived of what it needs to survive and spread. This will result in the death of the pathogens/diseases from your field.
- You get to build your skill and experience in the cultivation of various crop types. You are able to easily switch to a different crop for the next season if the market for your current crop has reduced or if the demand for another crop has increased significantly or if you move to a different area that only grows a crop different from the types you are used to.

Note that if you only have one piece of land you can still practice crop rotation or incorporate the principles of crop rotation in your farm through intercropping.

Why is Crop Rotation Important?

- It is better for the soil, meaning your crops will be healthier and bigger for years to come.
- It also helps fight off disease and pests, making farming easier and more profitable.

CHAPTER EIGHTEEN

MIXED FARMING

18.0 Introduction

In addition to growing crops, most farmers in northern Ghana also rear farm animals. This practice of growing crops and raising farm animals 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. If this practice is done properly, it can be very beneficial to both the family and the farming system. In this chapter, we will learn about how to effectively combine these two activities (crop cultivation and animal rearing) into one for maximum benefits to both.

18.1 Farm animals of Northern Ghana

Let's begin with the farm animals. The most common farm animals raised in northern Ghana are cattle, sheep, goats, ducks, chicken, guinea fowls and in fewer places, donkeys. To fully appreciate the importance of these farm animals to your crops, below are the various ways they can contribute to their cultivation.

Draught and traction: cattle and donkeys

During the rainy season, there is usually a very high demand for tractor services but there are only very few tractor operators to meet this demand. This almost always results in delayed land preparation by most farmers who rely solely on tractors to clear their fields. Cattle and donkeys can be trained into strong and good draught animals that can equally prepare your field as the tractor would have done. Therefore, as a farmer who owns cattle and or donkeys, you will never suffer delayed land preparation as a result of untimely provision of tractor services which will adversely affect your cropping schedule and hence your productivity because you can always rely on the cattle and or the donkeys you have to prepare your field for timely planting. In addition to using them to prepare your own field, you can also rent them out to other farmers to prepare their fields.

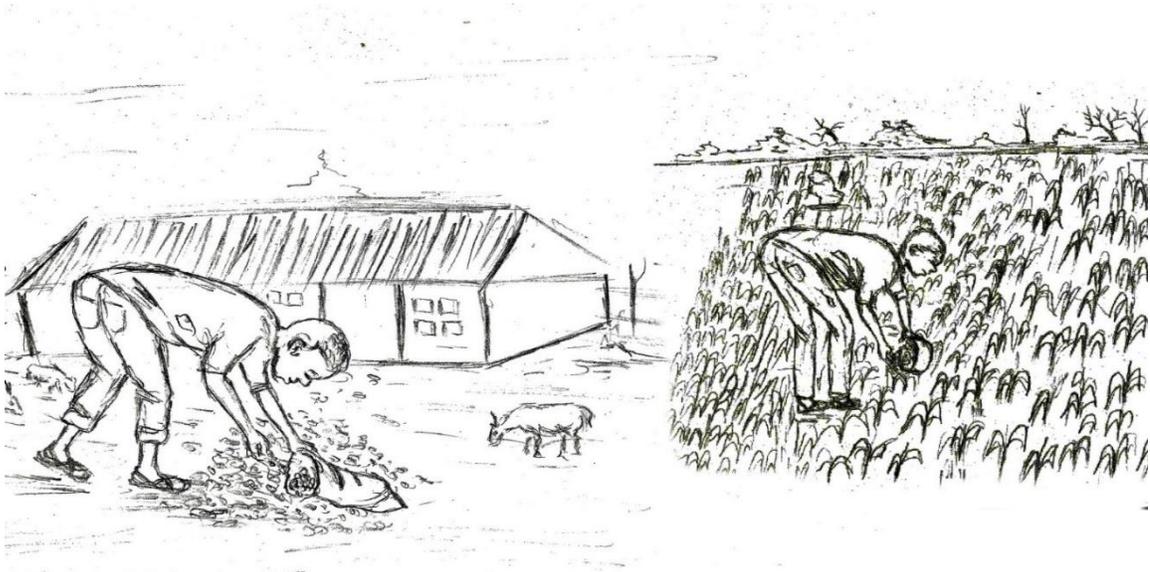
One of the most important things to note in rearing of any animal is proper housing. You need to be able to protect your animals from the environment and it will also help you collect their droppings.

This will generate additional income for you that can be invested in the crops you will be cultivating.

Ruminants: Cattle, Donkeys, Goat & Sheep

Ruminants are animals that have a complex stomach which helps them to digest food that would be impossible for us humans to digest. Most ruminants feed on a wide variety of food including many of the grasses and weeds that grow on our farms. During land preparation, we first have to clear all the weeds or grasses on our field before we can get better access to the soil for tractor ploughing, bullock ploughing or hoeing. More often than not, farmers hire farm labour to do this job or personally spend at least a day clearing the weeds to a height or level that allows for easy ploughing. The good news is that with ruminant farm animals, this is no longer necessary. If you have enough farm animals, you can send them to the field to feed on the grasses and weeds. This is very helpful because it saves you the money and energy you would have spent to achieve similar results. Another advantage of this method is that, the animals convert the grass into ready manure for your soil by excreting their droppings onto the field as they feed. Without this almost instant conversion of plant matter into manure, decomposition to achieve the same result would have taken a long time and nutrients might not be available for your young crops when they are needed most.

Manure providers: All Farm Animals: All farm animals produce droppings that can serve as organic matter for your field and add nutrients to your soil, increase soil fertility and thus boost your harvest. If you do this over time, it will reduce the amount of chemical fertilizers you have to apply to your field to provide the nutrients your crops need. This



will also reduce the cost of production you will incur on your crops.

Grains: Some amount of the grains harvested from the field can be used to feed farm animals. Large poultry farms purchase maize and soya in large quantities for the sole purpose of feeding animals. By mixing the soya with the maize, they are able to meet the nutritional needs of the animals by catering for both the carbohydrate and proteins they need to grow well and produce milk and eggs

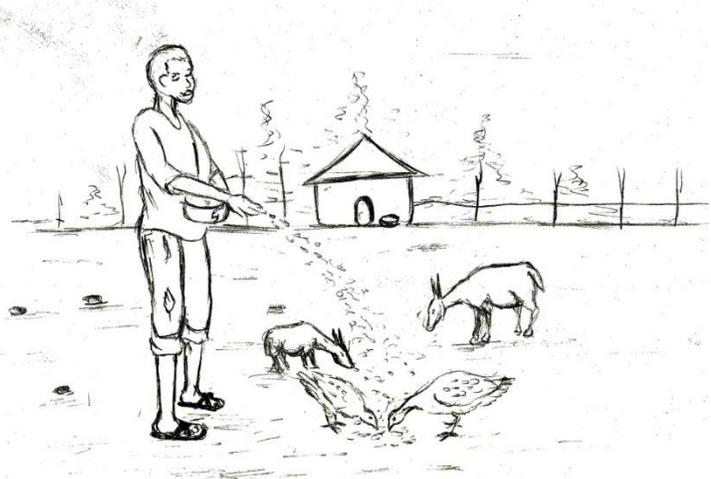


Note that the above-mentioned benefits are only the ones that are directly linked to the production of crops. In addition to these, raising animals provides you with other benefits such as milk, meat and eggs which provide protein and enrich the nutrition of your family or can also be sold for additional income. Lastly, if you raise animals, you wouldn't need to spend money to buy animals during festivals. You can kill one and have enough meat for you and your family and also have the hide to decorate your houses.

18.2 The role of crops in mixed farming

We have talked about the ways your farm animals can boost your crop production. Now, let's talk about the ways growing crops can also help in your animal rearing.

Crop residues: Ruminant farm animals feed on a variety of crop residues. After harvesting, you don't need to burn the stover/biomass from your maize farm. You can separate the parts that are easily degradable to become organic matter that will enrich the soil and take all other parts home to feed your animals. This reduces the distance your animals would have to travel to get feed and the energy or money you would have spent looking for feed.



During your post-harvest processes such as threshing, winnowing and cleaning, the broken grains and organic debris you find in your produce can be processed together with other non-cereal produce or waste domestic food into healthy feed for your farm animals.

If you do this, you will not need to spend money on buying feed supplements for your animals.

Raising farm animals in addition to the cultivation of crops is a very wise venture. If you are not yet 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 the next few years, they would have reproduced and multiplied in number, 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.

Why Should You both Raise Animals and Farm Crops?

- If your animal is big enough it can be trained to plough your field (saving you money) and your neighbour's fields (making you money).
- It can be sold to make money.
- The droppings can be used to fertilize your field.
- Or you can slaughter it when it is big and healthy for your own consumption.

Animal Husbandry - From the MoFA Agricultural Extension Handbook 2006, page 136

1. Cattle

In Ghana, we can find only a few indigenous breeds of cattle. Some foreign breeds have been imported to help improve the local stock. All the breeds in the country are of the beef type and also used for draught purposes. The most common breeds are the following.

The African Humpless (Taurine)

West African Short-Horn (WASH)

This is an indigenous breed and its size varies from place to place in West African countries. It is the most common breed in northern Ghana but is only suitable for beef production or draught purposes. The first calving is between 2.5-4 years. The average calf may weigh between 18-20kg.

N'dama

The N'dama breed is somewhat small in conformation but is of importance for certain areas in West Africa because of its natural resistance to trypanosomiasis. However, extensive tests carried out in Ghana have shown that the immunity decreases when these animals are removed from their place of origin. The N'dama is a group bred for draught and beef production.

Zebu Type Cattle (Hump)

Gudali

This breed is a type of the short horn zebu primarily raised in Sokoto and other parts of northern Nigeria. It has spread to other countries in West Africa. This breed is a good beef cow with a daily weight gain of as much as 0.45-0.68 kg and more if good feeding conditions exist.

Sanga

This is a breed obtained by crossing a white Fulani bull with a West African Shorn Horn cow. However, the term 'Sanga' may be equally applied to any F1 animal coming from a cross between zebu and any humpless cattle. In Ghana there are various types of Sanga breeds. Notably among these are the White Sanga, the N'Dama Sanga and the Gudali Sanga. The first calving occurs approximately between 3 and 3.5 years. The sanga has a heavier build and is good for beef production, traction, and milk.

Management

To ensure good management, the personnel assigned should possess practical know-how and a theoretical background. The housing of cattle should be appropriate and suitably sited. In addition, water facilities should be available. The area should be free of trees. Bushy undergrowth should be avoided. Measures should be taken to improve grazing pastures with desired grasses and legumes.

If financial help is needed financial institutions could be contacted. Two of such institutions are the Agricultural Development Bank (ADB) and National Investment Bank (NIB).

Diseases

While most tropical cattle diseases are present in Ghana, the biggest handicap to the industry is malnutrition. A long dry season means a marked decrease in the quality and quantity of available forage. Consequently cattle lose weight and suffer nutritional deficiencies which make them susceptible to parasitic and other diseases. Young weaned stock should be vaccinated against Rinderpest. In addition, they should be vaccinated annually against Anthrax and Blackleg. Since cattle are attacked by ticks, dipping or spraying should be done once a week during the rainy season and twice a month during the dry season. Other dangerous diseases include Contagious Bovine Pleuropneumonia (CBPP), foot and mouth diseases, tick fever, trypanosomiasis, heart-water, parasitic nematode, and worm burdens for which veterinary advice should be sought.

2. Sheep

Sheep are easier to herd than goats and are generally considered to be more profitable. However, they are more delicate in breeding and are prone to die quickly.

Breeds

The most common breed in northern Ghana is the Fellata or Djalonke. Fully grown, it weighs about 20 to 27 kg. The height is about 63 to 68 cm. Another breed is the Black head. This breed is slightly lighter and smaller than the Fellata. Several breeds from the Sahelian countries have been imported for crossbreeding, but this has not been encouraging since the offspring suffer heavily from tick infestation and eventually die from heart-water.

Management and Disease

Sheep need constant attention especially during the breeding season to ensure a high rate of production. From December to March the ewes should be given supplementary feed to maintain a healthy condition during the dry season and lambing time. At this point the ewes should be confined and a thorough examination performed on the feet, ears, and other parts for parasites.

By the onset of the rains, great care should be given to the hoofs of the flock. The hoofs should be trimmed and a solution of 10% formalin applied. A pen with a dried floor should be provided. If sheep are kept in a pen with a moist or muddy floor they are likely to get foot rot. Due to their habit of close cropping (grazing close to the ground), they can rapidly acquire larger parasitic burdens, especially in the rainy season. They should be dewormed regularly, preferably at the end and beginning of the rainy season. During the rainy season, deworming could be done monthly. In addition to intestinal parasitism, they are susceptible to pneumonia and lip and mouth ulcerations. Sheep can flourish on the short spare grass cover but not on long coarse grasses and need to be watered regularly.

3. Goats

The much maligned goat is one of the most tasteful animals in the arid and semi-arid countries. They can survive and flourish where cattle can barely exist. This has often caused the goat to be unjustly blamed for vegetative destruction caused by bad husbandry and cultivation practices.

Breeds

The major breed is the West African Dwarf Goat. Other breeds like the Arabic or Sudanese types have been tried in Ghana but are not yet common.

Management and Diseases

Goats are well-known for their high potency in feeding on all types of vegetation and roughage. This gives them the credit of survival under very adverse conditions. In general, goats, being mainly browsers, have feeding habits that cause less damage to vital grass cover. After a long dry season, they are the first animals to breed. After a gestation period of five months, they kid and produce milk, long before cows with a gestation period of nine months. The milking of goats should be encouraged since the fat is more digestible than the fat in cow milk. Goat milk is recommended for those convalescing (people regaining health after illness). Goats are hardier than sheep, suffer less from parasitism and succumb to fewer diseases. Young weaned stock should be vaccinated against Rinderpest. In addition they should be vaccinated annually.

4. Pigs

Pig production has increased appreciably in northern Ghana over the last decade. The prolificacy of the species as well as the fact that they are not commonly used in most cultural practices and can therefore be raised mainly for cash purposes has led to an increase in pig rearing.

Breeds

The main breeds of pigs found in northern Ghana are the indigenous Ashanti Black and the exotic Large White and Landrace breeds. The indigenous Ashanti Black is black or brownish-black in colour and normally has a small body size. Under improved methods of rearing pigs, this breed is able to grow to full market rate of 50 to 60 kg. They are early sexually-maturing although initial litter size is low, peaking to a maximum with the 3rd or 4th litter. The degree of hairiness varies and both the hairless and relatively long haired types can be found. The indigenous breed is relatively hardy and resistant to diseases.

Housing

Housing can be built using cement blocks or locally-made mud bricks. Walls should be plastered. Floors should be concreted as pounded laterite floors are dug up as the pig matures. If pounded laterite is to be used, stones should be packed underneath to prevent digging of the floor. Drainage is essential and flooring must slope slightly to allow for runoffs. The floor must be rough to prevent slipping as the pigs gain weight. However, care should be taken not to make the floor so rough that the hoofs and udders are injured. A concrete wallow is needed to serve as a water bath for cooling off. The roof of the piggery should extend beyond the walls so that the rainwater drains onto the grounds outside and not onto the walls of the piggery. Provision of an exercise lot attached to the piggery will improve animal condition. It is very useful to plant shade trees around the piggery.

Feeding

Pigs should never be fed on the ground in order to cut down internal parasites. Each pen should have feeding and drinking troughs which should be kept clean. In order to survive, maintain itself, grow and reproduce, the pig requires a regular supply of essential nutrients. Grains such as maize provide the best source of carbohydrates (energy) for pigs while fishmeal is the most excellent protein source available. However, because of the cost and competition with humans very little of these foods are given to pigs in Ghana. Locally available by products are therefore used. These tend to provide nutrients but by virtue of their fibrous nature the nutrients are less readily available. 'Pito' mash (a by-product of the local sorghum beer industry) is the mainstay of the pig industry in much of northern Ghana and provides energy and protein as well as high level of fiber. Other feeds in use are mill flour, rice bran and chaff, dawada pulp, kitchen waste, yam and cassava peels and green leaves. The source of fat in the pigs ration is obtained from shea butter residue, palm oil, groundnut cake, soybean cake and cotton seed cake.

Health

Three to seven days after delivery, piglets must receive an injection of iron (Fe). Without it, piglets raised on concrete floors will die. However, it is advisable to still give the Fe injection to piglets raised on earthen floors.

African Swine Fever

African Swine fever is a highly contagious viral disease which can cause up to 100% mortality. Typical symptoms include loss of appetite, pigs huddling together, small purplish blotches on the skin, lack of coordination and laboured breathing. There is no effective vaccine or treatment and control is normally by mass slaughter of pigs in the affected area. There is a ban on movement of pigs in affected regions.

Anthrax

Anthrax is an endemic disease in northern Ghana. The disease, which is acute and frequently fatal, is caused by bacteria. It also causes mortality in humans. Symptoms are often seen as sudden death with blood oozing from the body orifice. Such carcasses should not be opened but should be buried at least 1.8 m deep in the ground.

Internal Parasites

These are a problem especially when pigs are free-ranging or not kept on concrete floors. The most frequently required health care is that of deworming. Piglets should be dewormed soon after weaning and sows prior to being moved into their farrowing (delivery) pen. Of particular importance is the common tape worm, *Taenia solium*, which has the pig as an intermediate host and the adult worm lives in man. Picking up eggs from human feces infects pigs. The larvae then encyst in the pig's muscle. If the infected pork is then eaten by man, the larvae hatch out and the cycle is completed. Carcasses affected (measly pork) are to be destroyed at slaughter. By preventing pigs from having access to human feces, the parasite can be eliminated.

Bullock Care – From the MoFA Agricultural Extension Handbook 2006, page 290

Feeding

As bullocks are expected to do hard work, they have to be fed well. Rice straw, sorghum/maize stalks, groundnut/ cowpea vines could be collected from the field and stored. This makes good feed for the bullocks. In addition they should be given one double-handful of concentrate which may be a combination of *pito* mash, rice bran and maize or sorghum in the ratio of 1:1:1. If the bullocks are in good condition during the dry season, they will be able to work hard in the rainy season.

During the rainy season, the concentrate ration has to be increased to three double handfuls. Salt has to be included to replace the salt lost by evaporation while working.

Some farmers use leaves from various fodder trees as feed during the ploughing season. It is very important to feed the bullocks every morning before they start ploughing. To rely on grazing after ploughing put extra stress on the animals and they may not have enough to graze on in order to replenish their lost energy.

Shelter

To protect the bullocks against rain and sun as well as to maintain close check on them they should be provided with a shelter and fenced enclosure. Both can be made from teak poles. However, the roof of the shelter may be constructed with grass. The measurements of the shelter for one pair of bullocks should be 6 m x 3 m (20 ft by 10 ft). In order to reduce the amount of sun and rain under the shelter it must be constructed in the north-south direction. The floor of the shelter must be raised to avoid wet feet and health problems. It has to be cleaned regularly.

Health

The health of the bullocks must be observed continuously. If any symptoms of sickness or disease appear or if the animals are behaving strangely, the nearest Animal Health Worker should be contacted.

Maintenance of Equipment

Cleaning and greasing of the plough wheel after a day's work is important to keep the plough in good condition for a long time. Proper fitting spanners must be used when **changing shares or making adjustments**. The transportation of implements to the field on the platform, as described before, should be used to prevent excessive wear on the implements.

Storage of Equipment

At the end of the season, the implement should be cleaned and exposed parts of the implements oiled or greased. Worn-out parts must be replaced at the same time in order to have the implements ready for next season. Keep spare parts handy for replacement when faults develop. Store the implements/equipment in a well-protected shady place to save it from the rain and the sun. Ensure that the harrow teeth are straight and the nuts are well-tightened. In storage, never turn the teeth of the harrow upward to avoid the danger of someone stepping on them. Check frequently the tire pressure of the bullock cart, keep them well-inflated and never move on flat tires. Put oil regularly on the wheel-nuts so that they do not become rusty. Take care of the wooden boards. They can be painted with diesel when they are new so that they do not rot. It is best if you keep the cart under a shelter to protect it from the sun and rain.

CHAPTER NINETEEN

WATER MANAGEMENT AND APPLICATION

19.0 Introduction

In northern Ghana under rain-fed conditions, maize farmers only have one farming season in a year whereas in southern Ghana, farmers can enjoy two seasons in a year -the major season and the minor season. This difference is because southern Ghana experiences two rainy seasons in a year and therefore enjoys more rains than northern Ghana. This goes to enforce how critical the rain northern Ghana receives is and so the better farmers in northern Ghana are able to manage it, the better their farming will be.

Even though the maize plant make efficient use of water it is considered more susceptible to water stress than other crops because of its unusual floral structure with separate male and female floral organs and the near-synchronous development of florets on a (usually) single ear borne on each stem.

Maize plant has different response to water deficit according to development stages. Drought stress is particularly damaging to grain yield if it occurs early in the growing season (when plant stands are establishing), at flowering, and during mid to late grain filling.

19.1 Water management strategies in maize production

To mitigate any shortfall in water supply to maize plants during the cropping season, which could adversely affect your yield, the following agronomic practices should be adopted.

19.1.1 Selection of crop variety

Even within Northern Ghana, the average amount of rainfall received varies from community to community. This means that you need to take this into consideration when deciding which maize variety you want to plant. As discussed in an earlier chapter (on seeds), different maize varieties have their special characteristics. Some varieties are more drought-tolerant than others. This means under low rainfall conditions, they will still provide you with a good harvest. If you live in a community that does not record high rainfall, it is advised that you select a drought- tolerant variety. This way you will be better managing the small amount of water/rainfall available to your crops for good production.

19.1.2 Water harvesting practices

The problem with the kind of erratic rainfall we experience in the north is not necessarily about not receiving enough rainfall but rather the inconsistencies in rainfall patterns which means that there might be several downpours within a short period and dry spells for another several weeks. This bad distribution of rainfall during the cropping season means that water might not be available to the plant when it is most needed.

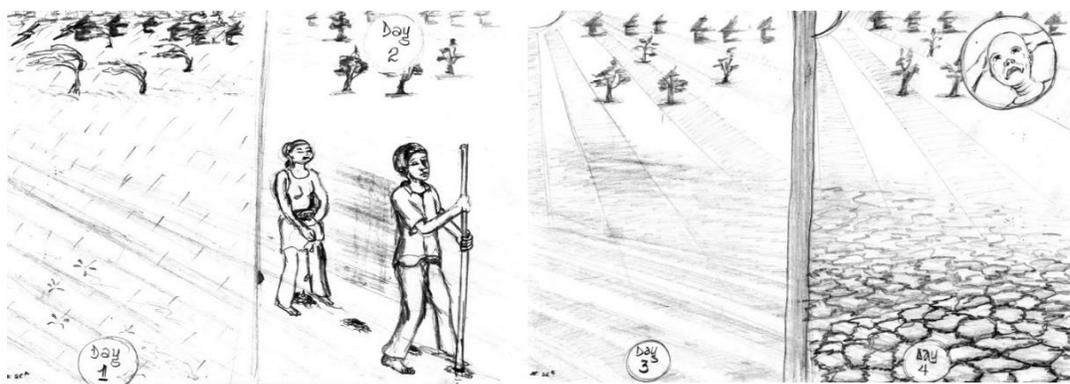
To address this problem, you can attempt to harvest water when rains are more frequent and use it to water your crops after they have ceased. You can do this by joining hands with your neighbours to construct small reservoirs. By building a reservoir, you can collect and store rainwater in the field during the rainy season. You can construct mini-reservoirs on your field by digging and connecting canals or channels around farms that connect to a deep wells built with mud. This will serve as a mini-irrigation scheme that will provide your crops with water after the rains have ceased and your crops are suffering from drought. In-situ water harvesting including tied-ridging and ridging across slopes are also useful ways of water harvesting.

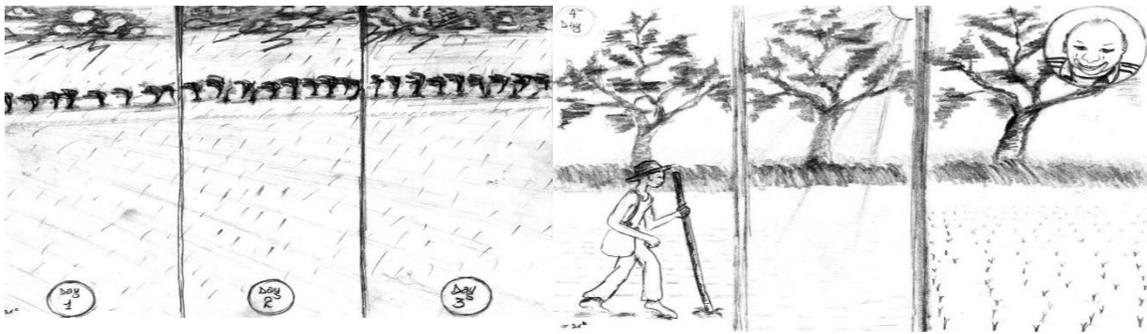
19.1.3 Strategic timing of field activities

One of the earliest activities you will carry out is planting. With regard to water management, the timeliness of your planting is a very critical decision you need to make.

In deciding when to plant, you should consider the rainfall patterns of your community and neighbouring communities as well as the maturity period of your variety. It is important for you to not rush into planting your seeds after the first rain of the season – **you need at least three heavy rains at the onset of the season before you plant.** This is because your seeds will need sufficient water to aid in germination.

If you plant after only one rain, the amount of water in the soil might not be enough to support germination and the early stages of growth of your young plants. Timing your planting date and waiting for three good rains before you plant is one way you can manage the rainfalls you will get in the season to support the growth of your plants.





If you are not sure about what time to plant, consult your AEA. But generally, you should plant between June and July to ensure your plants do not face dry spells that will cause a failure of your crop.

19.2 Water application practices

If your farm is near a river/stream or you have constructed the mini-reservoir discussed above, one thing you can do to better manage water for your crops is to plan your water application schedules. Water is important for your maize plants throughout the season but there are three critical stages/periods during the development of the crops that result in heavy crop losses if water is not made available to the plants.

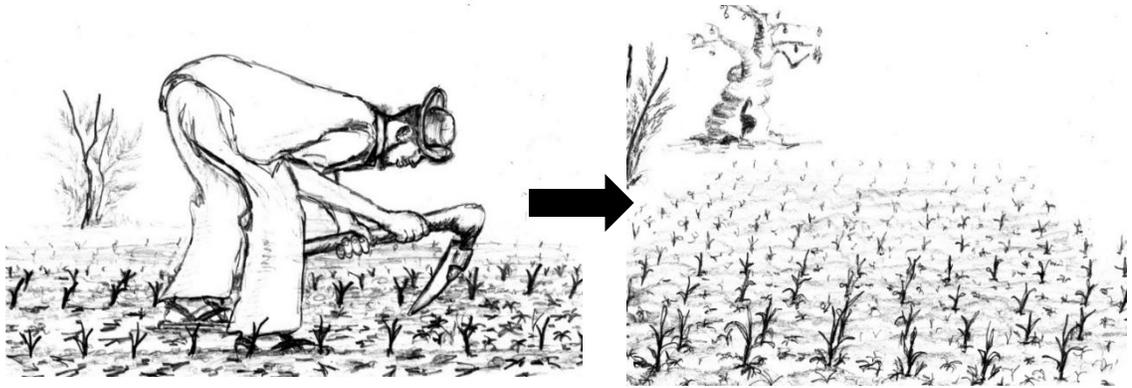


1. **The first stage is during planting and the few days after.** Without sufficient water at this stage, your seeds will either not germinate or face poor growth. It is therefore very important to water them regularly at this stage, at least once every three days.
2. **The second stage is when the crop is about four weeks to six weeks old.** Usually at this stage, you will be preparing to apply the second fertilizers to your crops. To help in the dissolution of the fertilizer and easy uptake of these nutrients by the crop, you need to have sufficient moisture in the soil. If it hasn't rained, this will be a good time to irrigate your field.
3. **The third stage is when the crop is about nine or 10 weeks old.** At this stage, the plants are preparing to flower and produce cobs, and one key ingredient for this

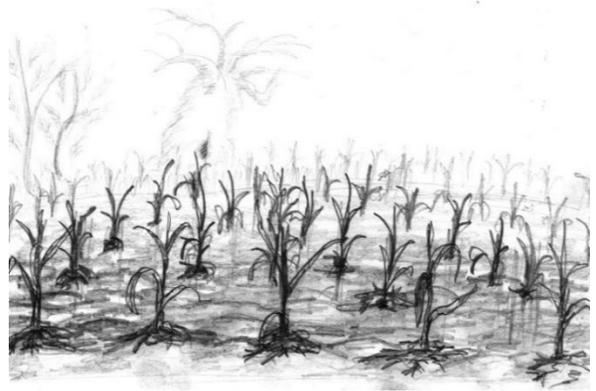
production is water. It is therefore very important to apply water to your crops to help this process. This will help in getting higher yields and good harvest.

Water Retention Practices: After clearing your field, **do not burn the weeds.**

Instead, 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.



Do THIS!



Also, you can intercrop your maize with legumes such as cowpea or soya bean which will maximize the use of soil water

If you have sandy soil, your soil will not be able to keep water for long. Increasing the organic matter content through mulching and composting is very important on sandy soils. If you have a choice, select loamy soils instead of sandy soils.

Why is Water Management Important?

- No water = No life!
- Water is essential for plant growth and good water management increases your yield
- You can manage how much water is available for your crops through:
 - Proper planting,
 - Mulching
 - Harvesting water

CHAPTER TWENTY

INTEGRATED PEST AND DISEASE MANAGEMENT

20.0 Introduction

All farmers have to cope with pests and diseases that attack crops and reduce productivity. A pest is any animal that can cause damage to your crops and harvest either on the field or in storage. This means that even your own farm animals can become pests to your crops if they cause damage to your crops. Diseases are like sicknesses that infect your crop and suppress productivity by making them unhealthy. Quite often, pests and diseases work together. Just like for humans, you need to protect your crops from these pests and diseases.

Environmental concerns such as depletion of natural resources, pollution of soil, air, water and chemical residues in foods have become important topics in agricultural production. Rising concern of public health risk of pesticides use as well as its burden on the environment has added momentum to the need to re-evaluate the current chemical-based pest management practices. The Integrated Pest Management (IPM) programs use the most economical combination of cultural, physical, and least hazardous chemical controls to manage pest infestations and minimize damage.

IPM is a holistic way of thinking that improves the ability to mitigate the negative impacts of pests in agricultural production, horticulture, buildings and other situations, while at the same time reducing costs and improving environmental quality. IPM is a broad concept that is composed of a complete range of control methods including biological, cultural genetic, physical and chemical and the integrated use of these methods.

20.1 Integrated Pest Management practices

The following are a list of IPM practices which farmers are encouraged to employ in controlling pest and diseases on their farms.

- **Cultural control** is a method of crop protection using careful timing and a combination of agronomic practices to make the environment less favourable for the increase of certain pests or diseases. It includes practices such as tillage, planting/ transplanting, irrigation, sanitation, mixed cropping and crop rotation.

- **Sanitation** Use of clean planting material is important in IPM. Any infected plants are to be rogued and destroyed by burning in order to avoid further spread of the diseases.
- **Resistant** varieties are one important part of an IPM program. They do not increase farmers' costs, but rather limit damage at all levels of pest population throughout the season, require less pesticide than susceptible varieties do and can be integrated effectively with other control methods in a pest management program.
- **Biological control** use natural enemies such as predators, parasites, and pathogenic microorganisms or antagonists to control pests or diseases. This can be achieved by conserving indigenous natural enemies or by mass introduction of exotic natural enemies or rearing them. Spiders for example are very active predators that feed on a variety of pests.

Some of the more desirable characteristics of natural enemies are good searching ability; attacking only the target pest; having high rate of increase in reproduction; having shorter life cycle than host; adapting well to host habitats; well adapted to different stages of life cycle of target host; and able to maintain itself after reducing host population. Thus, there are lots of advantages in deploying biological control because it has no side effects, safe to handle, occurs naturally, self-perpetuating and has high degree of host specificity with good searching ability, cost effective, and survive at low host density.

- In IPM, **chemical control** is recommended as the last resort option for combating pest menaces owing to the negative effects on the ecosystem.
- Physical controls are tangible materials and devices used to control pests. They involve routine maintenance, exclusion, and use of mechanical devices such as traps and flyswatters.

20.2 Pests

Let's begin with the pests and how they affect our crops. Below is a table of some common maize pests and how best to control them.

Field Pests	Control Measures
Farm animals (cattle, goats, sheep, etc.)	Boarder Trees & Shrubs, Field monitoring, Smearing their dung on the plant leaves.
Rodents (rats, mice, grass-cutters, etc.)	Seed treatment, Poison traps
Birds	Seed treatment, Scarecrows
Locusts, Moth, Weevils	Spray insecticides, Mulching
Armyworms, Wireworms,	Seed treatment, Spray pesticides (afternoon or evening)

Leafhoppers, Thrips, Mite, Aphids	Hybrid & Resistant Varieties, Spray Insecticides, Mulching
Termites	Spray insecticides, Apply Phostoxin

20.3 Diseases

Now let's move to the diseases. It is important to know that a disease is not a sudden event – it develops in stages. It is therefore very important to closely observe your crops throughout the season for early signs and symptoms of diseases before they develop to a stage where control is impossible.

Below is a table of some common maize diseases and their symptoms.

DISEASE	PATHOGEN/VECTOR	SYMPTOMS	CONTROL
Common Rust	Fungus	Red or golden-brown spots on leaves	Copper-based fungicides
Gray leaf spot	Fungus	Long narrow lesions on leaves	Fungicides
Common smut		Small, hard and dry galls on stalks, ears, tassels or leaves	Copper-based fungicides
Anthracnose	Fungus	Irregular shaped lesions with dark brown centers. Starts with bottom leaves	Fungicides

For effective control of diseases, there are also a few principles you need to follow.

Entry Prevention: These are the measures you put in place to avoid infection of your plants. Prevention includes planting resistant varieties, crop rotation, soil treatment (fumigation), seed treatment, siting your farm at a safe distance away from other fields, and proper farm sanitation practices.

Spread Containment: You should always observe your field for signs of disease or infection. **Spotting signs and symptoms early can save your crop!** Always look out for spores and larvae under leaves, spots or lesions on leaves, abnormal formation on stems, etc. If your field has already been infected, you should



reduce the spread and further development of the disease by applying chemicals to the plants at recommended rates.

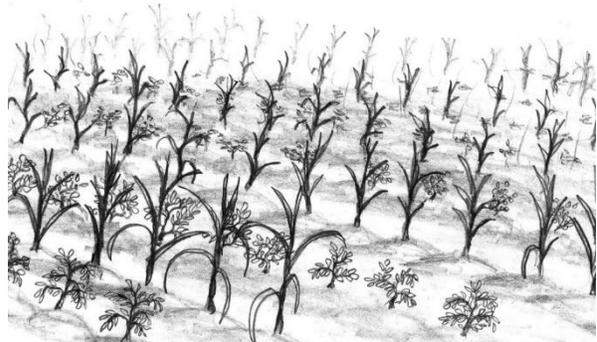
Using a fungicide, bactericide or pesticide will destroy existing inoculum, prevent inoculum formation and kill the insects/pests that carry these diseases. However, if the infections are at an advanced stage, you should remove all infected crops from the field and destroy them by burning them before they spread to all other crops and cause complete crop failure.

Note: You should always get in touch with the AEA to help you in identifying the particular diseases on your farm and the best control measures to apply.

Sometimes what appears to be a disease is actually a lack of nitrogen, phosphorous, potassium or micro-nutrients.

Both pests and diseases have the potential to cause significant losses to crops and most often they come together. For your control measures to be complete they have to cover both pests and diseases – this is called Integrated Control (of pests and diseases).

Practices such as crop rotation, intercropping, timely weeding and farm sanitation also help in controlling pests and diseases on your fields. **Doing these practices is the best farming method to preventing pests and diseases.**



Why Should You Manage Diseases and Pests?

- **These creatures can cause a total crop failure, meaning no harvest.**
- When you look for signs of these creatures, you will avoid total crop failure.
- When you have questions regarding pests and diseases, ask your CEA to contact your AEA.

CHAPTER TWENTY ONE

TIMELY AND PROPER HARVESTING

21.0 Introduction

Farming is a very hard work and like all other difficult activities, we expect to be rewarded at the end of our toils! For you the farmer, your reward is a good harvest at the end of the season which provides you with food to feed your family and money when you sell your maize for a good price.

21.1 Harvesting operations

For your harvest to be successful, it has to be timely and done properly. In Northern Ghana, harvesting usually starts around late October to early November when the rains have ended. If your harvest does not coincide with the end of the rainy season, your maize will not dry properly and might go bad easily. To ensure that this does not happen, talk to your AEA about the maturity period of your maize variety and plan when to plant your crops because different varieties have different maturity periods.

Make sure you don't delay your harvesting too long after maturity... Unless you plan to share your hard-earned harvest with pests, bush fires and thieves!

Maize is mature for harvest when a black layer develops between the kernel and the cob. Maize may be harvested dry or green. If you want to harvest it green/fresh, it should be done as soon as the silk turns brown. To harvest it dry, leave it on the field until the silk, the husk and the leaves are completely dried. At this point, the grains will feel very hard when you press them

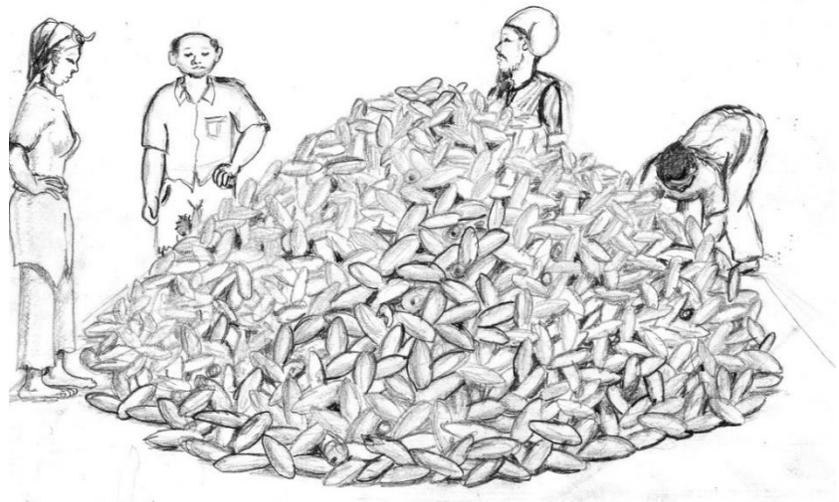


with your fingers and your plant and cobs will all be brown in colour. To harvest properly, start early in the morning when the sun is not very hot. If possible, get some people from your household to help you with the harvesting. Harvesting should be done in an orderly manner from one end of the field to the other. Moving in a random manner might cause you to miss some plants. Know that even one less grain means less money. You should break the cob from the plant at the base and gather them in heaps at several points on the field for easy gathering.

After the whole field has been harvested, you can now proceed to gather all the individual heaps into one big heap for collection.

It is not good to heap the harvest on the bare ground for long. You should use a tarpaulin or a platform to avoid damage to the cobs or grains.

Note that the next stage is de-husking and can be done either on the farm or at home. Whichever location you decide to de-husk at, make sure you protect the harvest from rains, thieves and pests.



Why Should You Harvest Properly?

- Harvesting at the end of the maturity period ensures that your maize is as good as it will ever be
- Harvesting in an organized way ensures you don't miss any maize plants.
- Gathering the maize on a tarpaulin helps keep the maize clean and pest-free
- All of these help the quantity and quality of your maize which will get you a better price.

CHAPTER TWENTY TWO

DEHUSKING AND THRESHING

22.0 Introduction

De-husking is the process of removing the husk from the maize cob. This process takes a lot of time. So after harvesting your produce on your field, move your heaped cobs into the shade (under a tree) to protect you from the sun when you are de-husking your cobs. You do not have to de-husk your maize if you plan to shell it with maize sheller.

22.1 How to de-husk

- With a sharp object like a small knife, split the cob at the top and strip it off from the ear. This needs to be done with care to avoid damaging the grains with the knife.
- Husks need to be gathered at one side whilst the kernels are also gathered separately.
- Usually, the process of de-husking is carried out on the field and it might take some time before all the kernels can be transported to the home for further post-harvest processing. This means that you must provide extra care or protection to the kernels since the grains are now exposed. You can do this by gathering them on a tarpaulin or a platform – avoid keeping them on the bare ground.
 - If it rains, the grains might begin to germinate causing the quality of your produce to decrease.
 - **Also, keeping the cobs on the bare ground makes it easier to be infested or attacked by soil pests.**



22.2 Threshing

Once you have finished de-husking, the next process you need to take care of is threshing. This is the process of separating the grains from the cob. This can be done by hand or by machine. When you plan to shell using machine, then you may not need to de-husk your maize. Make the decision on shelling early so that you will not have to spend time and money on de-husking when it is not necessary. The difficulty of threshing especially by hand depends on the varieties grown, how dry the maize is, and how mature it was before being harvested.

Varieties Grown: The smaller the grains, the harder it is to thresh. Some varieties such as Obatampa and Aburohemaa are much easier to thresh compared to other varieties such as Akposoe because they have relatively bigger grains.

Moisture Content / How Dry the Grains Are: The lower the moisture content of the maize, the easier it is to thresh. If your kernels are fresh, threshing will be very difficult. Therefore if you realize after de-husking that your maize has not dried properly, **dry them for a few days until the grains feel very hard before you try to thresh them.**

Maturity Level at Harvest: If your crops are not fully matured before they are harvested, you will have more trouble threshing. This is because at this stage, the attachment of the grains is not too loose and will require more force to separate them.

22.3 Methods of threshing maize

Now let's talk about the different methods of threshing.

- **Hand Threshing:** for hand threshing, you rub your fingers over the grains on the ear. This causes the grains to fall off onto the bare ground or into a pan. It is advised to do this directly into a pan or on a tarpaulin to avoid introducing dirt or debris into the grains. This process is very difficult and takes a lot of time. If your harvest is a lot, it might take you weeks to complete the threshing.

If you plan to save some maize as seeds, it is okay to leave them on the cob – BUT ALWAYS REMOVE THE GRAINS FROM THE COB IF YOU ARE KEEPING THEM AS A GRAIN.

To make this process easier, you can try beating the ears very gently in a bag to loosen the grains before moving on to use your fingers to separate the grains. After beating, pour the contents of the bag onto a platform to separate the grains from the cobs. Note, however, that if you do it this way, you will spend more time on cleaning and winnowing. Do not use excessive force as this might cause the grains to break. Broken

grains make pest/insect infestation easier and also reduce the market value of your maize.

- **Mechanical Threshing:** Mechanical threshing is done by a machine called the thresher or sheller. In some communities, operators move to farms and homes to thresh the produce for a fee. If this is the case in your community, make arrangements with the operator to come and thresh your produce early.

Because these threshers are used for multiple crops, it is important to ensure the proper machine adjustments for your maize (different crops have different adjustments). With the wrong adjustments, your grains might be broken and lose value.

Below is a table of the different average thresher settings for different crops.

CROP	THESHING SPEED	YIELD
Maize	800	1500 – 2000 kg/hour
Rice	800	450 – 600 kg/hour
Sorghum	1200	450 – 600 kg/hour
Beans	600	450 – 600 kg/hour

With a maize sheller or thresher, you will ensure little damage to your grains if the proper adjustments are used. The threshing speeds above are average estimates for given crops – it is important to begin with these settings and only a small amount of grain. You can then slightly adjust the settings to better fit your particular variety and grain size. Adjustments that are too high will cause your grains to break and adjustments that are too low will leave grains on the ear.

If you plan to keep your seeds for the next season, do not use a mechanical thresher – it will lower the quality of the seeds.

Mechanical threshing saves time because it is faster than hand threshing. After shelling, make sure you collect all loose grains that spilled from the sheller. You might end up with a bowl or two of maize that could help feed your family.

Why Should You De-husk and Thresh Properly?

- This is another stage that is very important to maintain the high quality of your maize.
- Poor threshing can lower the quality of your maize and lower the price you get.
- Make sure to always thresh in a clean environment where you can collect all the grains.

CHAPTER TWENTY THREE

DRYING

23.0 Introduction

Drying is one of the most important post-harvest activities in maize farming and has to be taken very seriously. This is because it affects both the quality and shelf life of your grains. Drying begins on the field when your plants have reached maturity and continues after harvesting when you have de-husked and threshed your maize.

23.1 Sun drying procedure

For drying to be done properly, you should pay close attention to the following:

The Drying Surface: You can use either a tarpaulin or a wooden board for drying your maize on. If you do not have them, you can cut open several sacks and stitch them together to form a large surface on which you can spread and dry your grains. Drying your grains on such materials makes it easier for you to **collect your grains at night (to protect them from dew which will counter drying) or when it threatens to rain.** In the absence of a tarpaulin, a wooden platform or stitched sacks, you can use a cemented floor as a drying surface.

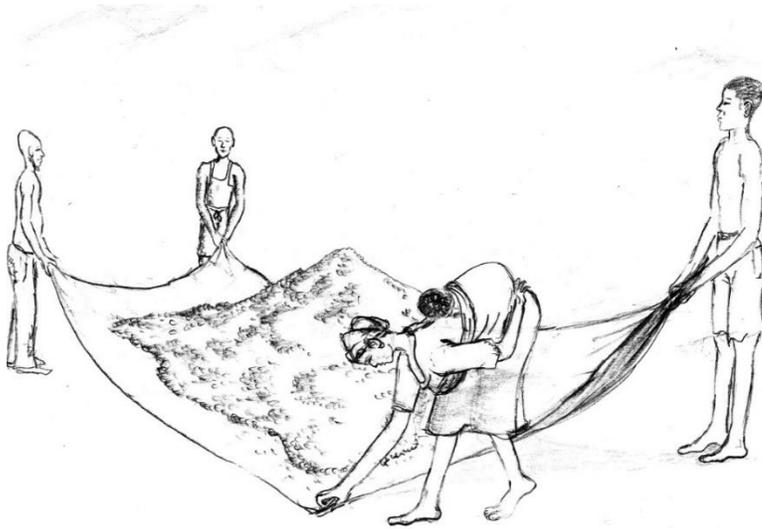
A local mixture of dung and water to create a smooth and uniform surface can also be used to dry the grains. **If you decide to use this, make sure you prepare the surface early in the season so that it is well dried before the time comes for you to dry your maize.**

The Duration of Drying

*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. Also, don't dry them on the roadside as your grains will become very dusty and make them look dirty and less appealing on the*

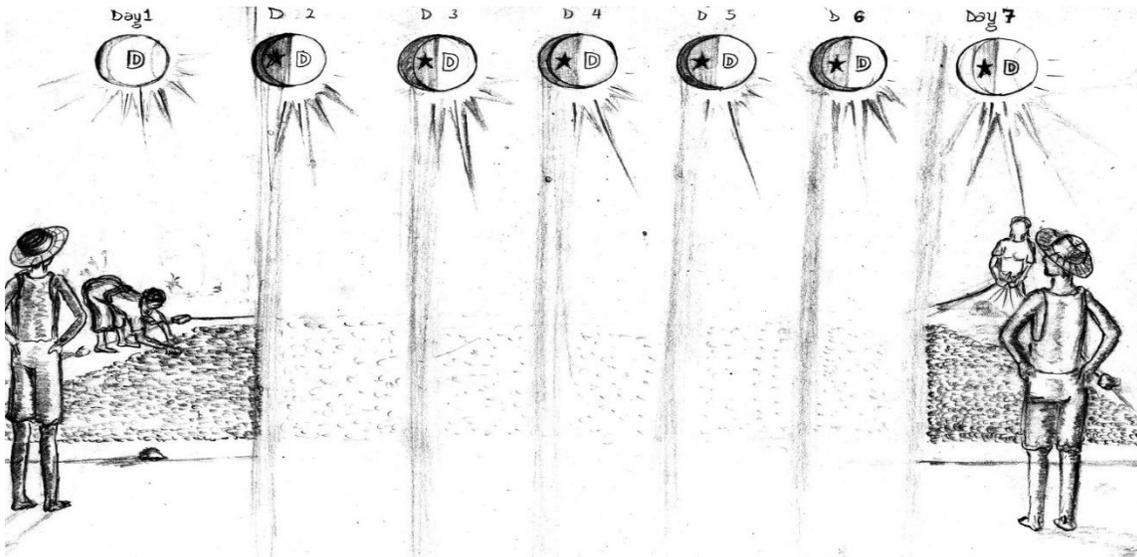
When drying, a minimum of 7 days of consistent sunshine will properly dry your grains. If the days are interrupted by rains or insufficient sunshine, you will have to dry them longer

to ensure that they attain the recommended moisture content of about 13%. This will prevent them from going bad when stored over a period of time.



Insufficient drying periods will make the grains mouldy and loose value giving you less money for your harvest. If you notice your maize becoming mouldy after drying or notice strange smells

from your dried grains, make sure you take them out and re-dry them (even if you dried them for the minimum recommended 7 days or even more).



23.2 Mechanical drying

So far, we have only talked about **sun-drying**. Sun-drying is only possible when there is sufficient sunshine and the rainy season has fully ended. Note, however, that depending on the maturity period of the variety of maize you cultivated, the planting date or the rainfall patterns of a particular year, your harvest might not coincide with the end of the

rains. This might make sun-drying very difficult to carry out. In such cases, you will have to use a different approach.

You can either use a mechanical dryer (which is very rare in northern Ghana) or provide the most protection while attempting to dry your maize. A mechanical dryer creates an environment that causes the grains to quickly lose water as it rests in, or runs through, the machine. This process of drying is very efficient and does not rely on the sun.

Alternatively, if the rains have not ended, you need to clear out a room in your house to be used as a drying room for your produce – this can be your storage hut. First, empty the room of all contents and clean it out thoroughly. Make sure that this room has at least two windows for good ventilation. After this, make about four or five pegs firmly to the wall (vertically) on both sides of the hut about two feet apart.

*If you can make
more windows,
please do!*

Now, rest four or five wooden boards on the pegs – these boards will serve as drying platforms for your maize on days when the weather is not clear. It is important to always remember to move the grains around on the board every day to expose all sides to the air/wind that will help in drying them and avoid mold. With this method, you can move the boards out on clear and dry days and move them back inside on days when it threatens to rain.

This method takes a much longer time for the grains to get dried but without a mechanical dryer and with rains, it is the best you can do to prevent your grains from going bad and maintain good quality.

The following are some signs of well-dried grains:

- They are very hard and give a loud ringing sound when they are poured in bulk
- When you squeeze the grains in your hand and they do not stick together
- When you bite the grain, the inside looks very bright white
- The colour of the derma (skin) reduces in brightness (white). It becomes slightly cream or off-white.

Remember: never bag or store poorly dried grains because they will get moldy or rotten and decrease the market value of your crop.

Why is Drying Important?

- This stage allows you to store your maize for longer periods of time without getting moldy. This is important if you keep your maize to consume or to sell
- Proper drying increases the quality and the value of your grains.

CHAPTER TWENTY FOUR

WINNOWING AND CLEANING

24.0 Introduction

After your maize has gone through de-husking, threshing and drying, you will realize that the grains are mixed with a lot of unwanted materials and chaff. When you go to the market to sell your goods, the buyer would want to check the quality of the produce before paying for them. Usually, a buyer will puncture a small hole in the sack and collect some of the grains in their hand to check – **they look out for stones, twigs, sand, broken grains, parts of the cob or kernel, etc.** The more of these unwanted materials they find, the lower the price they will offer you. They might even decide not to buy from you at all if they find a lot of these unwanted materials in your grains.

To ensure that you get a good price for your produce for high quality, you need to remove all these unwanted materials from your grains. The process of doing this is called winnowing and cleaning.



During threshing and drying, it is advisable to begin the process of removing all unwanted material from your grains. If this is done, you will spend less time dedicated to winnowing and cleaning to have your grains free of contaminants or debris. For big farms, they have all these machines that thresh, dry and clean the maize of all unwanted materials but the smallholder farmer does not have all these machines and therefore has to do this manually.

Although winnowing can either be done before or after drying, it achieves the best result if done after complete drying.

24.1 Steps of winnowing

Follow the following steps for proper winnowing:

- First, you will need a very clear weather and slightly windy conditions.
- Get two big bowls or pans. Gauging the direction of the wind, position yourself with your side to the direction of the wind.
- With one pan filled with the grains, raise it high and pour slowly into the other container on the ground. The wind blows out most of the unwanted materials from the grains as they are being poured. This action has to be repeated several times for each pan of grains.
- After doing this, you can spread out the grains on a clean platform to pick out all other



debris and unwanted materials such as sticks or stones that could not be blown out by the wind. If you do this properly, your harvest will be clean and rid of all foreign materials to enable you get a high price on the market for your maize.

Why is it Important to Winnow and Clean Your Maize?

- You will get better quality maize meaning more money for your maize.
- Even if you eat your own maize, it will ensure that you do not accidentally eat stones and other debris.

CHAPTER TWENTY FIVE

BAGGING AND STORAGE

25.0 Introduction

Farmers toil throughout the season so that they can harvest their produce and sell for a good price on the market. Bagging and storage form a very critical part of this process. Bagging involves measuring the right amount (weight) of grains to put into a single bag and how to properly package your grains for storage or sale.

There are different kinds of sacks and they come in different sizes. Typically in northern Ghana, maize is sold in 100-kg bags and the sacks used for this amount are commonly called

“grade 5”. You can either use the white sacks usually called “fertilizer sacks” or the brown sacks referred to as “cocoa sacks” to bag your maize. Regardless of the type you choose, the most important thing to remember when bagging is to weigh or measure the grains so that you don’t over-stock — otherwise you will be cheated by the buyer and get less money for your produce.

Also, do not add debris (husk, cobs, etc.) to your grains with the intention of cheating the buyer— if you do this, you will lose credibility and have difficulty selling your produce next season. If you decide to sell your produce immediately after bagging, you don’t need to treat grains while bagging. However, if you are planning to store your produce for much longer and treat with chemicals, you need to place your tablets in the sack before you stitch the sack tightly. Turn to the next chapter for more information on treating your grains.

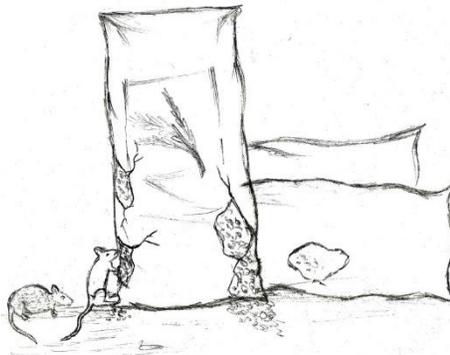
If you plan to store your maize for a while before selling, you should have a storage facility even before the beginning of the season.



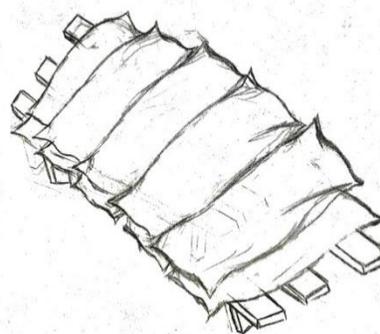
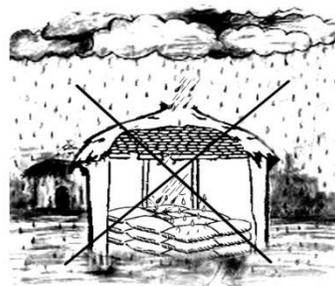
25.1 What to consider before storing maize

Consider the following when storing your produce:

- Grains should always be stored in a clean environment. Make sure to sweep the storage rooms very well before you take in the maize.
- All holes in the storage facility should be properly sealed. It could be a passage channel for pests and rodents. Clear the environment of all weeds in order not to attract pests or insects. Torn bags should not be used for storage. There should be no grain spills in the storage facility. This can attract storage pests.



- There should be no leakage in the roof. This can make the grains go mouldy. Use many layers of thatched roofs.
- Bags should always be placed on platforms (pallets) and not be dumped anyhow in the storage room.
- In the storage room, leave space in-between bags and the wall and bags and the ceiling to ensure proper air circulation to protect grains from mould.
- Try to avoid storage rooms that are completely aluminium sheet as this will not be good for the grain.



Why Store Your Maize Properly?

- You have spent all the farming season working hard. If you don't pay attention to storage, all your hard work won't matter.
- Good storage ensures that your maize will stay safe for a long time.

Storage Structures – From the MoFA Agricultural Extension Handbook 2006, page 293

It is estimated that in the tropics each year between 25 and 40% of stored agricultural products is lost because of inadequate farm and village level storage. In the field and during storage, food crops are threatened by insects, rodents, birds, and other pests. Farmers' traditional methods protect the product reasonably well.

Storage Losses

- Losses in weight due to insects, rodents or birds eating the grain.
- Deterioration through fungus growth and rotting.
- Loss in quality through biting damage, insect and rodent excrement and fungus growth.
- Loss of motivation in the farmer to grow more, because he is not able to store his harvest or part thereof in a safe way for any long period of time.
- Damage to sacks, which causes waste during transportation
- Decline in germination capacity of stored seeds.

Storage Structures and Methods

The following two factors determine the choice of the best storage structure:

1. The moisture content of the product when it comes from the field.
2. The relative humidity of the outside air during the storage period.

Depending on the weather during the harvesting period and the duration of the storage, there are four possible combinations.

1. *Dry harvesting period and dry storage period.* There are no problems with storage, provided the general conditions are fulfilled.
2. *Dry harvesting and wet storage period.* The dried product will take up moisture from the more humid air during storage unless it is stored in an airtight and waterproof condition. This makes storage more expensive. The threshed product can be stored in the following ways:
 - a. *In Small Quantities:* In airtight gourds, in plastic bags, in well-closed metal drums,
 - b. *For daily use:* In improved mud-block silo made air and water-tight, in silo made of clay, plastic foil and metal strips with an outflow opening.
 - c. *For occasional use:* In airtight and waterproof silos
 - d. *For a very long storage:* In an underground pit made air-tight and water-tight.
3. *Wet harvesting and dry storage period.* During storage the moist product has to dry and therefore it should be ventilated as much as possible and thus loosely packed: in a thin layer, un-threshed in a well-ventilated structure (basket), in a maize crib, in jute sacks.

Storing Seeds for Sowing – From the MoFA Agricultural Extension Handbook 2006, page 298

The main aim when storing seed reserved for sowing is the preservation of the seed viability. For that purpose the seed has to be stored within certain limits of temperature and humidity. In general the following can be stated:

- For seed with moisture content between 5 and 14% every 1% increase in moisture content doubles the possible storage time.
- Every 5°C decrease of the storage temperature doubles the possible storage time.
-

Airtight Storage

The seeds have to be dried very well and if possible mixed with a moisture-absorbing material and/or appropriate seed-protecting chemicals. The seed is then stored in one of the following containers:

- Polythene bags thicker than 0.25 mm that are sealed
- Earthenware pots or gourds that are made airtight with paint, varnish, or linseed oil, then waxed
- Tins that are closed airtight or can be made airtight with candle wax
- Paper bags with an intermediate layer of aluminium foil.
- Oil drums with screw-tops

Storing Root Crops – From the MoFA Agricultural Extension Handbook 2006, page 299

Root Crops, crops producing root or stem tubers, have special requirements with respect to storage because of the high moisture content of the tubers (60-80% when fresh.) On one hand, desiccation should be avoided and on the other hand one has to guard against too much humidity around the tubers, which may cause rotting.

Curing

In order to make tubers more suitable for storage they can undergo a special treatment called “curing.” The tubers are stored under very warm (25-35°C) and very humid (90-95% relative humidity) conditions for several days. During this period a layer of cork cells, a few layers thick, forms around the tubers. This layer greatly reduces the desiccation process and largely prevents infection by bacteria and fungi.

Cassava Storage Method

- Curing: A temperature of 30-35°C and a relative humidity of 80-95%, 4-7 days; wounds should be treated and left to dry
- Freshly harvested tuber deterioration starts 1-7 days after harvesting
- To preserve tubers for a few days, use the following techniques: Reburial, Keeping under water, Smearing with mud, Stacking and daily watering.

Yam Storage Method

- Curing: A temperature of 29-32°C and a relative humidity of 90-95% for 4 days
- During the dry season, yams can be left un-harvested in the ground. You can also use a Yam Barn which provides adequate ventilation and protection from termites but not against theft.
- You can also store in huts after curing. The tubers are stored in heaps on the floor in boxes or on shelves or racks in such a way that air can pass everywhere. Also, a maize crib can be used for storage provided the roof is large enough to prevent irradiation by the sun. For small amounts of well-dried tubers you can use earthen silos

Sweet Potato Storage Method

- Curing: A temperature of about 30°C and a relative humidity of 85-90%, for 5-7 days
- Sweet potatoes have low storage potential in the tropics. Temperatures of 13-16°C and a relative humidity of 85-90% are the optimum conditions for storage. Higher temperatures promote sprouting and increase respiration, leading to heat production and dry matter loss. To store sweet potatoes use a clamp storage, pit storage, or hut storage.

CHAPTER TWENTY SIX

GRAIN TREATMENT WITH CHEMICALS

26.0 Introduction

When we farm, we produce grains and other products that will be consumed by humans or used as feed for animals. Because of this, it is not advisable that we use toxic chemicals for grain treatment because they might be harmful to us and our animals. However, it might be necessary to chemically treat your grains if you plan to store your produce for a long time and prevent insects (for example weevil) infestation).

NEVER use field pesticides for grain treatment – they are not the same!

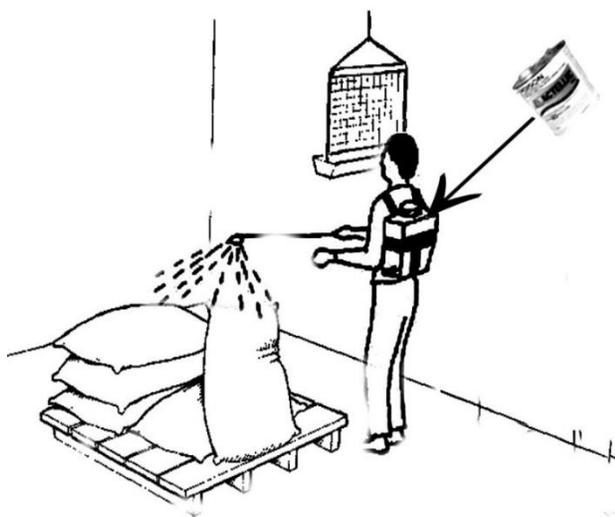
26.1 Guidelines for treating maize grains

If you decide to treat your maize with chemicals, there are guidelines you have to follow.

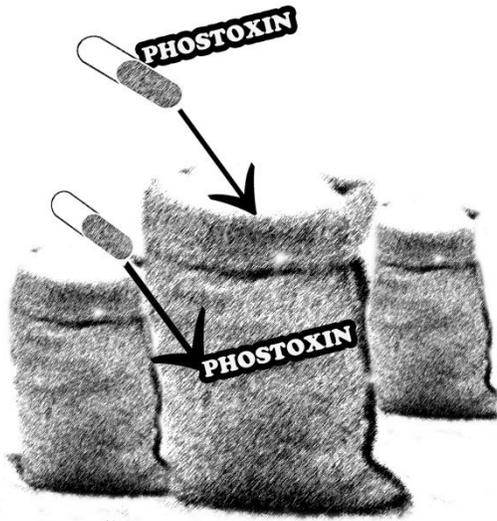
1. First, you have to **seek guidance from your input dealer or AEA**. Do not treat grains by yourself—make sure you talk to a professional for assistance.
2. To protect your grains in storage, apply ACTELLIC 2% dust or Actellic 25 EC.

First, spread one bag of maize on a tarpaulin on the ground. Mix 10 ml of Actellic 25 EC with 175 ml of water (i.e. 1 empty milk tin).

3. Next sprinkle the mixture evenly on the maize. Use a spade or shovel to turn the grains to ensure even mixing of the grains with the chemical. (Do not use your hands). Leave some of the chemical in the container so that you can rub in the inside of the bag with the rest of the mixture.

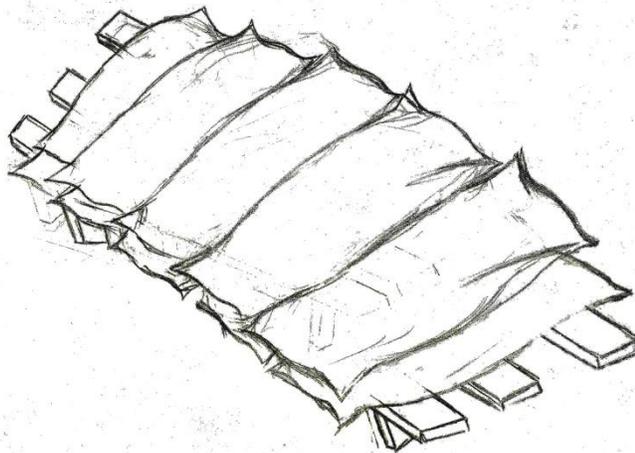


4. Now your maize is ready for bagging.



When storing the grains in 100-kg sacks, fumigate with PHOSTOXIN (3 MONTHS). Place one tablet in a piece of cloth in the middle and another in a piece of cloth at the top of the bag which is lined with a polythene bag and sew the bag tight. The piece of cloth will ensure that your maize is not damaged.

Place wooden pallets on a clean floor and stack the maize bags on them. Spray the bags with ACTELLIC at regular intervals.



If you do not protect your stored grains from insects, you can lose more than half of your grain by the next year.

Remember that all chemicals are poisonous.

- Do not sleep in same room in which you store your treated maize.
- Wear protective clothing when using chemicals.
- Always seek guidance from your input dealer or AEA before you treat your grains with chemicals.

IMPORTANT

*Wait at least 4 weeks
before eating maize
stored with
chemicals!*

Why Should You Treat Your Grain with Chemicals?

- When done correctly, from the advice of an AEA, it will ensure your maize is protected from pests.
- This will help you keep your maize for a long period of time.

CHAPTER TWENTY SEVEN

SELLING YOUR PRODUCE AND FINDING BUYERS

27.0 Introduction

The principal challenge confronting governments and international development organizations is how to ensure that smallholder farmers benefit from the commercialization of agriculture by participating in the market. It is anticipated that commercialization would shift the goals of farm households from self-sufficiency to profit and income oriented decision making.

Access to markets has been one of the key obstacles that have influenced smallholder agriculture in developing countries. Accessing markets allows smallholder farmers buy inputs and sell surplus of their subsistence and semi subsistence agriculture to improve household incomes. These markets can be between communities, villages, sub countries or countries. Markets that are often accessed by smallholder farmers who form majority of the poor in developing countries are characterised by poor infrastructure and limited investment capital. Market access helps alleviate poverty through commercialising agriculture and results in an even distribution of incomes in developing economies. Restriction of smallholders from market access locks them into long term poverty for generations.

27.1 Accessing the market

In Northern Ghana and Ghana as a whole, farming is 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 place the measures and structures that will boost their operations and increase the profitability of their farms. 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 maize at the end of the season, you should begin looking for buyers at the beginning of the season.** The most reliable buyers are poultry farms, aggregators and companies who are interested in purchasing the maize in bulk. However, because your farms are small and individual farmers cannot produce the quantities demanded by these companies, first you

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 centers in bulk which will save you some money on transportation costs.

will need to meet with your fellow farmers and agree to combine the bags harvested from your separate fields. This way, you will be able to raise the quantities of maize 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 maize.

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 interested in certain varieties as this will inform your decision on which maize 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 maize and compare to the agreed prices. If there has been a significant change in the prices, you can try re-negotiating with the buyers and make arrangements for them to come for the maize.

It is important to ensure that every farmer in the group who has agreed to combine their harvest has high quality grains and that everyone's maize is properly weighed and bagged to ensure that there is no cheating and no poor quality maize in the group. This way, all your harvest is bought at once and this saves you time and money transporting your maize to the market and the difficulty in finding buyers.

Always make sure to find out before the beginning of the season which varieties of maize are in demand the most and cultivate them. This will enable you to have a ready market for your harvest at the end of the season.

Secondly, always try to do things in partnership with your fellow farmers. This reduces the overall cost of purchasing inputs, transporting your produce and also increases your negotiating power.

Why is it Important to Partner with other Farmers?

- When buying inputs you can buy in bulk which will save you money.
- When selling your maize you can arrange to sell to a bigger organization which will offer you a better price than the market making you more money.

CHAPTER TWENTY EIGHT

SAVING TOWARDS NEXT SEASON AND PURCHASING INPUTS IN ADVANCE

28.0 Introduction

Because most farmers in Northern Ghana are engaged in subsistence farming, they do not realize that farming is a business and needs adequate planning and management. Remember that most farming costs are incurred at the beginning of the season. It is therefore important that you save enough money from proceeds of the previous harvest to be used in the next farming season.

Buying your inputs for the following season immediately after you sell your produce will ensure you don't spend your money on other activities.

At the beginning of the season, **you will need to purchase several inputs such as seeds, fertilizers and weedicides** and also pay for services such as weeding/land clearing and tractor services (ploughing and harrowing). It is necessary that you have enough money to pay for these activities and therefore safer to purchase all the inputs you will need immediately after selling your farm produce from last season. If you decide to wait until the next season begins to purchase them, you might have spent all your money.

Also, sometimes some inputs such as certified seeds and subsidized fertilizers are sold out in the middle of the season, so it is important that you try and purchase them ahead of time to ensure that you do not face a shortage even though you might have the money to buy them.

Because 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 them. 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 planting delays

To ensure good profit from your farm, you need to start treating it as a business.

You can use a rural bank or cooperative to save your money. This is safer than keeping it in your house where it can be stolen or you could be tempted to spend it. With a bank you know that your money will be kept until you need it.

One of the most important aspects of business is planning. Saving towards next season means that you are planning well and this will help you avoid lot of problems such as shortage of inputs and unavailability of tractor services when you need them.

Why Should You Plan and Save For Next Season?

- Planning and saving for next season will make the start of next season less stressful.
- You will already have the inputs themselves OR you will have saved the money needed for the inputs (which still is risky if the stores run out of stock of what you want)
- By using a bank, you ensure that the money is safe from thieves, family members, and even yourself for non-necessary purchases

APPENDIXES

Appendix A: Fact Sheet on General Vegetable Cultivation

– From the MoFA Agricultural Extension Handbook 2006, page 379

Vegetable	Method to Propagation	Time of Planting	Spacing (in cm)	Seed Rate	Time to reach Maturity (weeks)
African Spinach	Sow at stake or raise seedlings	At any time	40 x 25	2 kg/ha	3-6 from sowing
Bean, French	Sow directly 2-3 cm deep	At any time	60 x 70	60 kg/ha	10-12 from sowing
Bean, Lima	Sow directly 2-3 cm	At any time	Climbing varieties 60 x 40	60 kg/ha	2-14 from sowing
Bean, Broad	Sow directly 2-3 cm deep	At any time	60 x 20	35 kg/ha	16 from sowing
Brussels Sprouts	Sow in boxes or seed bed 1 cm deep. Transplant when seedlings are 5-8 weeks old	Preferably during the harmatan season	70 x 40	0.8 kg/ha	14-16 from transplanting
Cabbage	Sow in boxes or seed beds and transplant when seedlings are about 10 cm high	Preferably during the harmatan season	60 x 50 or 30 x 80	1 kg/ha	12-16 from transplanting
Cauliflower	(seed cabbage)	-	60 x 40 or 40 x 80	0.8/ha	8-14 from transplanting
Beetroot	Sow directly in drills 2 cm deep. Later thin to 5-8 cm in rows		30 x 5-8	20 kg/ha or 20 dkg/are	10-12 from sowing
Carrot	Sow directly in drills 1 cm deep and 30 cm apart. Later thin to 4-6 cm in rows	At any time	Rows 30 cm apart	4-10 kg/ha	10-12 from sowing
Cocoyam	By mature corm. Large corm can be split for planting	At any time if water is available	60 x 40 to 90 x 90	2-4 tons of corm/ha	24-32 from planting
Cucumber	Sow directly 3-4 seeds per hole about 1-2 cm deep later thin to 1-2 plants per stand	At any time	9-120 x 90	2 kg/ha	6-8 from sowing
Garden eggs	Sow in boxes or seedbeds. Transplant when seedlings are 8-10 cm high or 6 weeks old	At any time if water is available	70 x 50 to 75 x 90	1 kg/ha	10-16 from transplanting

Garlic	By cloves in drills with the tip of the clove just showing above the ground	Preferably at the beginning of the dry season	25-30 x 8-15	600 kg of bulbs/ha	10-16 from planting
Green gram	Sow directly	At any time	60 x 15		8 -12 from sowing
Indian Spinach	By seeds and cuttings		60 x 60		6
Leeks	Sow in boxes or seedbeds transplant when seedlings are 15-18 cm high	Preferably during the harmatan season	30 x 10	3 kg/ha	16-20 from transplanting
Lettuce	Sow in boxes or seedbeds. Transplant when seedlings are 5-6 cm high	At any time	30 x 20	0.5 - 0.8kg/ha	6-8 from transplanting
Water Melon	Sow directly 2-3 cm deep	Preferably during the dry season	1.2 x 2.5 – 4 m or 4.5 x 3 m	3 kg/ha	10-14 from sowing
Okro	Sow directly 2-3 seeds per hole 1-2 cm deep	At beginning of rains	30 – 60 x 60-90	7 kg/ha	8-14 from sowing
Onion	By seeds or small bulbs. Sow in boxes or in seedbeds. Transplant when seedlings are 10-15 cm high	Preferably during the dry season	30 x 8	4 kg/ha	12-15 from sowing
Pumpkin, Fluted	By seeds or yams	At the beginning of the rainy season	75-90		16-20 from sowing
Squash, Marrow, Pumpkin	Sow directly 2-3 seeds per hole and later leave only the best plant per stand	At the beginning of the rainy season	80 x 80 to 150 x 150	450 kg/ha	10-16 from sowing
Potato, sweet	By softwood cutting 25-30 cm long	At the beginning of rainy season	70-80 x 30-40	25,000-125,000 cuttings/ha	12-24 from planting
Potato, Irish	By tuber 8-10 cm deep	October November December	60 x 30	1.8 kg/ha	12-16 from planting
Pepper, Hot	Sow in boxes or seedbeds. Transplant	Preferably at the beginning of the rains	60-80 x 60-90	1 kg/ha	8-10 from transplanting

	when seedlings are 8-10 cm high.				
Pepper, sweet	(see hot pepper)	At any time	60 x 40	1 kg/ha	8-12 from transplanting
Pigeon pea	Sow directly 3-4 seeds per hole, 2 cm deep	At the beginning of the rains	90-120 x 30-75	8 – 20 kg/ha	24-36 from sowing
Radish	Sow directly in drills 1-2 cm deep	At any time except February – April	12 kg/ha	25 x5	4-8 from sowing
Sorrel or Rosselle	Sow directly 1 cm deep	At the beginning of the rains or anytime under irrigation	15-30 x 30-45		8-16 from sowing
Tomato	Sow in boxes or seedbeds. Transplant some 4-5 weeks later	At any time except from January to March		0.3 kg/ha	10-14 from transplanting
Turnip	Sow in drills 2 cm deep	At any time except from February to April	30 x 6	6 kg/ha	8-12 from sowing
Sesame	Direct sow	At start of rainy season	30-45 x 60-90		12 -16 from planting
Sweet Corn	Sow in drills 3 cm deep	Preferably at the beginning of the rains	60 x 30	25-35 kg/ha	12-16 from sowing.

Appendix B: List of Input Dealers

-From the Agro-Dealer Directory for the Northern Region, Ghana (Compiled by AGRA, DANIDA, and GAABIC, 2013

Business Name	Telephone Number	Products
Central Gonja District		
Mahamud Ent Yapei	0240437155	Fertilizers/ Chemicals
Ewuta Ent Yapei	0243984322	Fertilizers/ Chemicals
Yadanaaya Ent Yapei	0540475112	Fertilizer/ Chemical/ Seeds
Kegbeni Meto Ent Yapei	0245533577	Chemicals only
Sky Agro-Chem. Ffulso	0241086788	Fertilizers/ Seeds/ Chemicals
Gbepo Ent. Jatamoape	0243571044	Fertilizers/ Chemicals
Midway Store Yapei	0245953788	Chemicals only
Gumaya Ent. Sankpagla	0244978988 / 0267034878	Fertilizers/Chemicals/ Seeds/Tools
Kashi Agro-Chem Kusawgu	0271456218 / 0262865147	Chemicals only
Kanyitiwale Ent Kusawgu	0245485286 / 0261852846	Chemicals only
A. Seidu Agro-Chem Ffulso	0241086788	Fertilizers/ Seeds/ Tools
Abukari Toahidu Buipe	0248548292	Chemicals only
Home Is Home Buipe	0246916744 / 0261934323	Fertilizers/ Seeds/ Chemicals/ Tools
Abudu Gado	0263244519	Chemicals Only
Insha Allah Ent. Buipe	0206347419 / 0269474477	Fertilizers/ Chemicals/ Seeds/ Tools
Karaga District		
Alhassan Ziblim Ent	0208564560	Chemicals Only
Bombehigu Ent.	0246791572	Chemicals Only
Yakubu Alhassan Mbanaa	0245124008	Fertilizers Only
Musah Ent.	0240465041	Fertilizers Only
Fuseini Ziblim	0203845208	Fertilizers/ Chemicals
Zaks Ent. Nyong-Nayili	0208936721	Fertilizers/ Seeds/ Tools/ Chemicals
Suglo Agro-Chemicals Pishigu	0207582019	Chemicals/ Seeds/ Tools
Ziblim Bomsimli Ent. Pishigu	0200565181	Fertilizers/ Chemicals/ Tools

Bella Nnabra Ent. Nyong-Gumma	0204037218	Fertilizers/ Chemicals/ Tools
Ndinyori Ent.	0203031906	Fertilizers/ Chemicals/ Seeds/ Tools
Mba Gonda Ent.	0203845209	Fertilizers/ Chemicals/ Seeds
Saboba District		
Abutaraye Agro Chemical Limited	0249582587	Chemicals Only
Solomon Banabi	0243717675	Chemicals
Muku	0546903712	Chemicals
Sayibu Bisang	0249578553	Chemicals
Taadam Yacham	0208572616	Chemicals
Abdallah	0245722738	Chemicals
Janliyamni Agro-Chemicals Limited.	026169320	Fertilizers/ Chemicals
Daliri Agro-Chemical Ltd.	0201741777	Fertilizers/ Chemicals
Alidu Agro-Chemical .	0541168894	Fertilizers/ Chemicals
Ayidachaw Agro-Chemicals	0209941688	Chemicals
Alhassan Mohammed Agro-Chem.	0201126157	Chemicals
Adom Ent., Saboba	0246534161	Chemicals/ Tools
Savelugu/Nanton District		
Issah Mohammed Amin	0543840052	Chemicals
Bello Ent.	0246561400	Fertilizers/ Chemicals
Zakaria Yahaya Ent.	0243703256	Fertilizers/ Chemicals
Adam Stores	0246602800	Fertilizers/ Chemicals
Abdul-Somed Saibu Agro-Chem.	0243089755	Chemicals Only
Bahigu Ent.	0243948006	Chemicals Only
Musah Ibrahim Agro-Chem.	0548181342	Chemicals Only
Gubkatimali Agro-Chemicals	0242387397	Chemicals
Suhuyini Agro-Chemicals	0246593042	Fertilizers/ Chemicals
Fuseini I Nankana Ent.	0243618812	Fertilizers
Faddrison Ent.	0242567941	Fertilizers
Kukpi Ent.	0266530599	Fertilizers/ Chemicals
Jarazamah Royal Ent.	0246990977	Fertilizers/ Chemicals
Ganye Agro-Chemicals	0243701917	Fertilizers/ Chemicals/ Tools/ Seeds
Gbunjara Agro-Chemicals	0242812529	Fertilizers/ Chemicals
Toteeya Ent.	0246346453	Fertilizers/ Chemicals
Dagbandoo Agro-Chemicals	0243740932	Fertilizers/ Chemicals/ Seeds/ Tools
Guy Patience Ent., Savelugu Mkt.	0243068705	Fertilizers/ Chemicals
Moggle Ent. Savelugu Mkt.	0205506800	Fertilizers/ Chemicals/ Seeds
Tamale Metro District		
Chekosi Ent.2008	0268329444	Fertilizers/ Chemicals/ Seeds
Dobila Enterprise	0248970734	Fertilizers/ Chemicals/ Seeds

Garnoma Agro Chemicals	0208773451	Fertilizers/ Chemicals/ Seeds
Omed Enterprise	0208199794	Fertilizers
Papa Atifa Enterprise	0240991237	Fertilizers
Vansaddo Enterprise	0244780151	Chemicals/ Seeds
Abdul Karim Enterprise	0548182311	Fertilizers/ Chemicals
M Yabdoos Enterprise	0245820613	Fertilizers/ Chemicals
Z.L. Tampuli Enterprise	0249394500	Fertilizers/ Chemicals
Ayi Agro Chemicals	0240509475	Fertilizers/ Chemicals
Zet Agro Chemicals	0208079627	Fertilizers/ Chemicals/ Seeds
Yardanaaya Agro Chem.	0246829600	Fertilizers/ Chemicals
Nashiru Chemicals	0548130843	Chemicals
A A Sugri Agro Chemicals	0247073936	Fertilizers/ Chemicals/ Seeds/ Tools
A Zabs Ltd	0244778370	Fertilizers/ Chemicals
A Alhassan Enterprise	0547076012	Fertilizers/ Chemicals
Nbuzaid Enterprise	0208254547	Fertilizers/
Wumpini Agro Chemicals	0202164798	Fertilizers/ Chemicals/ Tools/ Seeds
Fertile Agro Care	0246642366	Fertilizers/ Chemicals
Labandoo Royal Ent.Vittin	0546367549	Fertilizers/ Chemicals/ Tools/ Seeds
Amaraba Agro Chemicals Kukuo	0548742254	Fertilizers/ Chemicals/ Seeds/ Tools
Bella N'nabra Ent, Vittin	0201906322	Fertilizers/ Chemicals/ Tools
Makhteshim Agan W. Africa,Choggu Yapalsi	0505441043	Chemicals
Damore Agro-Chemicals Choggu Yapalsi	0246307437	Fertilizers/ Tools
Zomfabihi Ent.,Choggu:-Hill-Top	0209740572	Fertilizers/ Chemicals
Roman Store, Gurugu	0240756647	Fertilizers/ Tools
Napodow Ent.,Malshegu	0246665212	Chemicals/ Tools
Bobila Ent.,Kanvilli	0248970734 / 0261772048	Fertilizers/ Chemicals/ Seeds/ Tools
Rakadiri Ghana Ltd,Kakpagyili	0243646155	Fertilizers/ Chemicals/ Seeds/ Tools
Tahidu Ent.,Malshegu	0547623823	Fertilizers
Salmasaa Ent.,Damankungyili	0240507013	Chemicals
Tamalia Ent.,Sanarigu-Dungu	0207246039 / 0266629363	Fertilizers/ Chemicals/ Seeds/ Tools
Moses A. Agro-Chemicals, Aboabo Mkt.	0209968169	Chemicals

A.A Alhassan Agro-Chemicals,Aboabo Mkt.	0201435927 / 0244893925	Fertilizers/ Chemicals/ Seeds/ Tools
A.A Piegu Ent.,Wamale	0240474533	Fertilizers/ Chemicals/ Seeds
Kayoma Agro-Chemicals,Aboabo Mkt	0203841176 / 0277196208	Fertilizers/ Chemicals/ Seeds/ Tools
Zesung Agro-Chemicals,Aboabo Mkt	0275758847	Fertilizers/ Chemicals/ Seeds/ Tools
Namdo Ent.,Aboabo Mkt	0246292678	Fertilizers/ Chemicals/ Seeds/ Tools
Tehisuma Ent.,Aboabo Mkt	0244794711	Fertilizers/ Chemicals/ Seeds/ Tools
Chekosi Ent,Aboabo Mkt	0546295374 / 0268329444	Fertilizers/ Chemicals/ Seeds/ Tools
A.A Sugri Agro-Chemicals, Datooyili	0247073936	Fertilizers/ Chemicals/ Seeds
Rukaya Royal Ent.,Opposite Mida Office,Tuunayili	0246621508	Fertilizers/ Chemicals/ Seeds
Hadiola Agro-Chemicals, Yapalsi, Kumbungu Road	0208419483	Fertilizers/ Chemicals
Tolon/Kumbungu District		
I Believe(Imani),Ent.	0549287672	Fertilizer/ Chemicals
Bedam Ent.	0260586140	Fertilizers/ Chemicals
Nassara(Good Mother) Agro-Chemicals	0206744777	Fertilizers/ Chemicals
Gbanyali Ent.	0242674624	Fertilizers/ Chemicals
Abedi Agro-Chemicals	0243031534	Fertilizers/ Chemicals
Naapuu Ent.	0243779678	Fertilizers/ Chemicals
Kpringa Agro-Chemicals	0246834893	Fertilizers/ Chemicals
Ganorma Agro-Chemicals Nyankpala	0243384101	Fertilizers/ Chemicals/ Tools
Nbigang Ent.,Waribogu	0246732936	Fertilizers/ Chemicals
Iddrisu Sani, Tale	0243031534	Fertilizers/ Chemicals/ Tools
Wunzoya Agro-Chemicals Kumbungu	0242967375	Fertilizers/ Chemicals/ Tools
A Salam Ent.Kumbungu	0204113651	Fertilizers/ Chemicals
Di Boriyom Agro Chemicals Kumbungu	0243579535	Fertilizers/ Chemicals/ Tools
F A Sugri Ent.Nyankpala	0248452236	Fertilizers/ Chemicals/ Tools
Ngangwuni Ent.Nyankpala	0246403438	Fertilizers/ Chemicals/ Tools
Iddi Ent.Tolon	0249958284	Chemicals
Yendi District		

Dagara Ent.	0240560746	Fertilizers/ Chemicals
Yelimali Ent.	0201099923	Fertilizers/ Chemicals
Nduu Agro Chemicals	0240953313	Chemicals
Farah Ent.	0267550381	Chemicals
Rashid Ent.	0249943878	Chemicals
Dokpam Ent.	0207178119	Fertilizers
Amdawe Ent.	0244407872	Fertilizers
Amos Agro Ent.	0245294153	Chemicals
Dj Enterprise	0542174798	Fertilizers/ Chemicals
Ling Ent. Yendi	0269407207	Fertilizers/ Seeds/ Tools
Begnidaa Ent. Yendi	0200571803	Fertilizers
Alhaji Mash Ent.Yendi	0247881056	Fertilizers/ Tools/ Seeds
Abdulai Musah Ent.Yendi	0207230760	Fertilizers/ Chemicals/ Seeds/ Tools
Mansuru Ent.Yendi	0249697594	Fertilizers/ Chemicals/ Seeds/ Tools
Kwaku Ent. Yendi	0243654563	Chemicals/ Seeds/ Tools
Nawuni Zomti Nambogu Ent Yendi	0245711149	Fertilizers/ Chemicals/ Seeds/ Tools
Binveila Ent.Yendi	0248127872	Fertilizers/ Chemicals
Naazo Ent.Yendi Market	0205355766	Fertilizers/ Chemicals/ Seeds/ Tools
Zabzugu/ Tatale District		
Man No Be God	0245235458	Fertilizers/ Chemicals
Benlynda Ventures	0245957864	Chemicals
Wumgeme Ent.	0245294582	Fertilizers/ Chemicals
Mohammed Ent.	0545050133	Chemicals/ Tools
Wumbei Ent.	0248563437	Chemicals
Abukari Nabia	0243386217	Fertilizers/ Chemicals/ Tools
Tabiba Ent.	0245161842	Fertilizers/ Chemicals/ Tools
Issah Ent.	0547422378	Fertilizers/ Chemicals
Sommed Ent.	0244875798	Chemicals/ Tools
Sheihu Ent.	0243857546	Chemicals/ Tools
Baajike Ent.	0242802883	Fertilizers/ Chemicals/ Tools
Nyengnan	0209689745	Fertilizers/ Chemicals/ Tools
Alhaji Issah Ent.	0246250360	Chemicals/ Tools
Tijani Brothers	0246513134	Chemicals/ Seeds
A.A Ent.	0246164881	Chemicals/ Seeds/ Tools
Sule Chemicals	0246838481	Fertilizers/ Chemicals
Suale Agro-Chemicals	0242817752	Fertilizers/ Chemicals
Mohammed Gbarigbari Ent.	0242817755	Fertilizers/ Chemicals
Seidu Ent.	0542168360	Fertilizers/ Chemicals

Baba Ent.	0246341632	Fertilizers/ Chemicals
Inusah Ent.	0543114547	Fertilizers/ Chemicals
Sonaa Ent, Lanjeti, Zabzugu	0205415039 / 0242270172	Fertilizers/ Chemicals/ Tools
Nbitebe, Kukpaligu	0261831213	Chemicals/ Tools
Fatawa Mamea, Ent.,Kukpaligu	0260714702	Chemicals/ Tools