Ethiopian ATI
Agricultural Transformation Institute
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GREEN MAIZE COB PRODUCTION AND PROCESSING BUSINESS

TRAINING COURSE FOR YOUTH AGRI-ENTREPRENEURS

Ethiopian Agricultural Transformation Institute

ADDIS ABABA, ETHIOPIA
2025

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OVERVIEW OF THE MODULE

This Technical Training Module on green cob Production and supplies aims to equip youth agri-entrepreneurs who are organized in maize value chain agribusiness with the necessary technical skills. In addition, It will support training facilitators mainly focusing on production, processing, and marketing business processes. The module serves as a guide for creating a power point presentation, digital/online and off-line training materials, or handouts for trainees. The primary objective is to enhance the technical skills of the agri-entrepreneurs, including youth groups who are interested in market driven green cob production and processing business. The module has been prepared through the involvement of multi-disciplinary professionals, such as breeders, agronomists, pathologists, entomologists and irrigation experts.

The module has six main sections, such as

1. input requirements,
2. production practices including agro-ecological requirements,
3. irrigation and pest management,
4. harvesting and post-harvest management,
5. marketing,
6. principles of understanding financial feasibility of the business. Each section has its own learning objectives, and pre and post assessment questions.

The Agriculture-focused Dignified Employment for Youth (ADEY) program is implemented by the Ethiopian Agricultural Transformation Institute in partnership with the Mastercard Foundation to enable 611,343 inclusive and dignified work opportunities for young women and men and support youth entrepreneurship, employability, and sustainable livelihoods in the agribusiness sector.

INTRODUCTION

As the unemployment rate in Ethiopia has increased from 4% in 2005 to 8% in 2021—and projections indicate a continued rise—creating job opportunities in the agricultural sector has become increasingly critical. The sector holds vast, yet underutilized, potential for employment across diverse commodity value chains. Among these, maize stands out as one of the top five cereal crops, widely cultivated by a significant portion of the Ethiopian population. With strong potential under both rain-fed and irrigated conditions, maize can contribute to surplus production of both grain and green cobs when productivity is enhanced.

One particularly promising area within the maize value chain is green cob production. This segment holds significant appeal for youth groups, especially as demand for green maize cobs remains high in urban and peri-urban areas—particularly during the off-season. Compared to grain production, green cob production offers several advantages, including lower production costs and higher returns. These benefits stem from the shorter growing period, and the fact that costs related to threshing, primary value addition, and storage management are largely avoided.

When practiced under irrigation, green cob production enables continuous market supply through adjusted planting schedules. It also offers income diversification opportunities by allowing intercropping with other crops such as cabbage and climbing beans (for green pod harvest).
This module is therefore designed to technically equip agri-entrepreneurs—including unemployed and underemployed youth groups, with a particular focus on young women and youth with disabilities—for both rain-fed and irrigated green cob maize production. It aims to support youth already engaged in the business as well as those in newly established groups.

Target audience and Expected Outcomes

The primary target audience for this module includes unemployed youth groups, with a special focus on female and disabled youth. It also supports youth already involved in green cob production who seek to strengthen their business operations.

By the end of the training, participants are expected to be well-equipped with the knowledge and practical skills necessary for successful maize green cob production and processing. In addition, this module will serve as a reference for trainers and facilitators conducting related training programs.

Target groups: The primary targets of this module are youth agri-entrepreneurs—including organized youth groups and small to medium enterprises (SMEs)—who are interested in establishing or expanding businesses in green cob maize production and supply.
The complete training module is designed to be delivered over approximately 15 effective hours, utilizing the proposed training methodologies outlined below.

Training methods: learning questions, group discussion, presentation, sharing success stories, self-learning rules, key messages and post assessment questions.

Total materials needed: flip chart, LCD, marker, pen, notebook, sticky notes, materials (e.g. seeds, sample pesticides, sprayer, etc.) required for practical demonstrations, etc.

SECTION 1: MAIZE PRODUCTION

Section Overview

This section specifically covers the economic importance of maize, current production and productivity.

Learning Outcomes

At the end of this section, participants will be able to:

- Understand the economic importance of maize production
- Reason for choosing green cob production as potential business opportunity

Duration: 1hr

Learning question

- Would you explain the economic importance of maize in Ethiopia?

1.1 OVERVIEW OF MAIZE PRODUCTION

Maize is one of the most important cereal crops in Ethiopia, both in terms of production volume and contribution to caloric intake. It accounts for approximately 37% of the country's total cereal grain production and 20% of its overall caloric consumption. Maize also has high productivity potential—reaching up to 100 quintals per hectare—which makes it more profitable than many other cereals by reducing the cost of production per unit.

Its productivity has been doubled over the past decades in Ethiopia, which surpass yields of other major regional maize producers, such as Kenya, Tanzania, and Uganda. This has been led by an increased use of improved varieties, adoption of inputs and expanded access to extension services as well as post management options. Therefore, it is possible to enhance the return per unit area by enhancing productivity through the adoption of improved agronomic practices.

In general, major production of maize is targeted for grain production whereas green cobs, mainly under irrigation conditions, are relatively produced in some areas. Green cob production is one of the potential businesses, which could potentially attract youth groups due to its low cost of production and high return per unit area. In addition to planting secondary crops as intercropping, such as cabbage, pumpkin, both bush and climbing types of common bean green pods and grain, its green leaves at the time of green cob stage could also be another income generation since it is used for animal feeds, mainly for dairy farming.

1.2 ECONOMIC IMPORTANCE OF MAIZE

Green cob maize is a healthy and popular snack in Africa including Ethiopia. It is mainly demanded in urban and pre-urban areas, particularly during the off-season. Maize could be utilized for different purposes, which are indicated below.

A. Food: It is mainly consumed as 'injera or kita', porridge, chapatti, bread, homemade alcohol, maize-soybean blending.


Roasted maize


Boiled maize


Injera


Maize-soy blends

Figure 1 Different forms of maize product as food utilization

B. Green cob: it is mainly used in home and for sale as roasted and boiled green cob. The so called 'Maro or Kijo', which is a type of bread is prepared from green maize grain after grinding and baking. It is very tasty and costly, which is mainly sold along the roadside. The grain of green cob could also be used as one ingredient for soup preparation.

C. Forage and Feed: maize is also used for livestock feeding viz, cattle, poultry and piggery both in the form of grain and fodder. Green fodder in the form of silage can be used for dairy farming to enhance milk productivity. It is also possible to harvest green leaves and other maize parts for animal feeds after green cob harvesting, which could be an additional income generation for the green cob producers. In general, easy availability and affordable price of maize is an important implication for the profitability and growth potential of feed in livestock production.

Maize grain for poultry

green maize for forage

Figure 2: Animal feeds from maize sources

D. Others economic importance of maize: some maize biproducts such as stalks of maize can be used or sold as firewood and biochar, which could also be one of the opportunities for income generation.

Figure 3 Biochar preparation from maize cobs for soil acidity amendments

Post assessment questions

1. Please list the economic importance of maize in general and green cob maize in particular
2. Is grain production or green cob production of maize having lower production cost? Why?

SECTION 2: AGRO-ECOLOGICAL AND INPUT REQUIREMENTS FOR MAIZE GREEN COB PRODUCTION

Overview of the section

Understanding the agro-ecological requirement such as temperature, rainfall distribution, soil etc. is also important parameters to be understandable by the youth groups.

Uses of different inputs in terms of types, application methods and rates are the basic requirements for enhancing productivity of maize crop in general and green cob production in particular. The timely availability of the inputs for both off-season and rainy season production is very critical to enter the business. Therefore, the youths and other producers should know very well about the types of input required for production of the green cob.

Learning outcome

At the end of this section:

- Youth/participants are expected to understand the agro-ecological requirement and basic inputs required for production of green cobs both under rain-fed and irrigated condition

Duration:1 hour

Learning question

Please tell us types of basic inputs required for production of green cobs in your local area.

2.1 AGRO-ECOLOGICAL REQUIREMENT

In general, currently 75% of maize area of the country is located in mid and high land agro-ecologies, characterized by moist and semi-moist, whereas the remaining 25% is located in low moisture stress areas. Some of the key potential production zones of the country are East and West Gojjams, Jimma, East and West Wollega, Horro Guduru Wollega, Buno Bedele, and the altitudes of the zones is ranged from 1500-2000 m.a.s.l. Suitable temperature, and annual rainfall range is 10-35oC and 500-1500mm for production of the crop.

2.1.1 SOIL AND CLIMATE REQUIREMENT

Ideal soil suitable for maize production:

- The soil should be silty loam with 5.5-7.0 pH, fertile and well-drained soil types.
- It is a crop that is widely grown in the lowland, mid-altitude and transition highland areas, which are also potential areas for production of the crop.

2.2 TYPES OF INPUT REQUIRED TO ENHANCE PRODUCTIVITY

2.2.1 VARIETY SELECTION

There are different varieties suitable for different agro-ecologies and for different purposes. There are also varieties specifically adaptable to lowland, midland and highland areas. Early to medium varieties are preferable for green cob production to reduce the cost of production while increasing returns per unit area per year. Varieties having 90-110 days to maturity are categorized as early maturity, which are suitable in low moisture stress areas, such as in rift valley areas. Some of the early maturing varieties which are currently under production are Melkasa-1,2,3,4,5&6, MH-130 and MH-140. On the other hand, varieties having 130/140-150 days to maturity are medium types which are suitable in mid-land areas with enough moisture availability.

Some of the medium maturity types, such, BH546, BH547, are very suitable in lowland mainly under irrigation and midland areas and preferable for green cob production. Some Pioner varieties are also preferable in the green cob market segment. Sweet corn maize varieties are also available from Bako National Maize Research Center. They can be produced and availed the big hotels based on contractual agreement.

Parameters that should be considered to select appropriate varieties for green cob production are:

- Early and medium variety are the most preferable
- Both open and hybrid varieties, but hybrid ones are preferable
- Variety having long cob, it's roasted and boiled cob is tasty
- The variety should be vigor, tasty, fitness (fat cob)
- Resistant/tolerant to pest, such as major maize disease
- Adaptability and yield potential
- Varieties tolerant to high population density

Note that any maize producer may contact Melkasa (for varieties adaptable to lowland and low moisture stress areas), Bako (for varieties adaptable to mid-altitude areas) and Ambo (for varieties adaptable to highland areas) to access the seeds or get information.

2.2.2 SEED SELECTION

In general, seeds of improved varieties should be certified, particularly for hybrid varieties. High maize yield begins with the use of good quality seed. Quality seed selection is an important criterion in green maize production. Seed selection:

- Buy from known seed source having certified tags on the bag
- Treated seed
- Certified seed
- Free from seed born diseases
- Free from any admixture (off types, other variety, broken seed, weeds, undersized)

Figure 4 Identification of quality seed source

Benefits of using good quality seeds are:

- Ensure traceability and guarantee
- Ensure efficient input utilization
- Reduce the cost of green maize production (labor, pesticide cost etc)
- Increased productivity (long cob size and attractive with high kernel rows)
- Increased income for the farmers (good market price)
- Farmers' satisfaction and preference for variety

2.2.3 FERTILIZERS SOURCES

Different fertilizer sources that are locally available could be used for production of grain crops, and both inorganic and organic fertilizer sources can enhance the productivity.

- **Inorganic fertilizer:** Urea and NPS fertilizers are the two major fertilizer types mainly applied in Ethiopia. Maize green cob producers should know the location-specific nutrient requirements of the maize crop and ensure proper application of the nutrients at the recommended stages of growth. Rate of inorganic fertilizer depends on soil types and fertility status, types of variety used.

Figure 5 Sample of inorganic fertilizer sources in Ethiopia

- **Organic fertilizer:** compost, vermicompost, and farmyard manure fertilizers are the main organic fertilizer sources that are mainly used by smallholder farmers around homesteads for maize production. The rate of organic fertilizer sources may vary according to the soil fertility status, its nutrient content, and sole use or combined uses with inorganic fertilizer sources.

Figure 6: List of major organic sources in Ethiopia

2.2.4 PESTICIDES USED IN GREEN MAIZE PRODUCTION

Insecticide is the major input for management of inspect to reduce losses of the production in maize grain production in general and green cob production in particular.

Some of the major insecticides that are locally registered are indicated below.

INSECTICIDES FOR THE CONTROL OF ARMY WARM, STALK BORER AND TERMITE

CONTROL OF ARMYWARM	CONTROL OF STALK BORER	CONTROL TERMITE
• BELT 480 SC • Coragen 200 SC • UPHOLD 360 SC • MAX 247 SC • Methozide 240 SC • Highpyro 220 EW • Karate 5EC • Diazinon 60% EC • Diazinon 10% GR, Chlorpyrifos 48% EC Malathion 50% EC • Lume 500 (Lufenuron + Emamectin benzoate)	• Diazinon 60% EC • Malathion 50 % EC • Carbaryl 85%WP • Diazinon 10% GR • Chlorpyrifos 48% • Karate 5EC • Cypermethrin • Deltamethrin • Indoxacarb	• Chlorpyrifos 48% EC • Diazinon 60% EC

Figure 7 Lists of agro-chemicals registered for the control of maize foliar army warm, stalk borer and termite

Weed and disease management are also the key management practices to enhance the productivity of the crop. Some registered agro-chemicals for the control of weeds and major diseases are listed out as follows.

LISTS OF MAJOR AGRO-CHEMICAL REGISTERED FOR THE CONTROL OF WEED AND MAJOR DISEASE

HERBICIDE	MAJOR FOLIAR DISEASE CONTROL
For pre-emergence • Primagram Gold 660 SC • Surestart TMSE • IntegrityTM For Post emergence • 2,4-D 720 g/l A.E (broad leaf herbicide) • Auxo EC 337 • Mescha 300 OD	• Mancozeb • Propiconazole (tilt250EC) • Acanto Plus 280 SC

Figure 8 Lists of agro-chemical for the control of weeds and major foliar disease

Post assessment questions

1. Please tell us the major potential maize producer zones of Ethiopia in general and your nearby area in particular
2. What are the key parameters you should know to choose appropriate variety for green cob production?

Key message

- Please first decide to choose appropriate variety and certified seeds to secure high return
- Knowing types of the locally registered agro-chemicals is also critical

SECTION 3: GREEN COB MAIZE PRODUCTION PRACTICES

Overview of the section

Under this section, the basic principles and practices of green cob maize production systems are addressed. Site selection, land preparation, seeding rate and methods, cropping practices, fertilizer uses are some of the key sub-topics to be covered under this section. Understanding the key inspect, weeds and foliar disease with their economic importance as well as with their control options are also the areas that must be covered to be clearly understandable by the green cob producers.

Learning outcomes

At the end of this section the trainees equip on:

- Clearly understand the basic agronomic management practices in green cob maize production
- Understand options of pest management practices

Duration: 8 hours

Learning question

Do you know any agronomic practices implemented in your area for maize production?

3.1 SITE SELECTION

In Ethiopia green maize is produced during main season (rainy season) and off season (irrigation). For producers, growing maize for marketing as green cob maize is attractive, because the value of green maize is higher than that of maize grain during offseason.

- Green cob maize is mainly advised to be produced during off-season, which employed using irrigation system, is a significant benefit for the producers since the supply to the market is relatively lower than during the rainy season. This could create high return per unit area and ensure continuous supply to the local market by adjusting cropping calendar.
- The ideal locations for off-season green cob maize production are in lowland to midland areas where water irrigations, and potential local market outlets for the product are available, and where the growing period is relatively shorter.
- During the rainy season, many people in maize growing areas grow maize in home gardens, fields and even on open spaces along the road. In order get higher price for higher return, the producers should plant as early as possible, which may be in month of May if the on-set of rainfall is started early.

For maize production, it is important to consider the following aspects for site selection in both rainy and off-season

- The sites should be fertile, well-drained, deep and soil with good water holding capacity
- Free from excessive water
- Have appropriate climatic features (rainfall, temperature and soil nutrient status) for the growth of the maize.

3.2 LAND PREPARATION

- Since the growth of maize roots will go to 30-40 cm and beyond, the land should be prepared very well through plowing using different ploughs and should be free from clod and levelled very well before planting.
- Depending on soil type and plot situation it can be ploughed 3-4 times.
- **Land preparation with tractors:** first plowing, harrowing, smoothening, leveling and finally row making can be done using different tractor mounted farm implements depending on soil and weather conditions of maize growing areas.


First plowing


Harrowing


Ridging by oxen


Ridging by tractor

Figure 9 land preparation and levelling of field for maize plating

3.3 PLANTING TIME

Maize planting time may vary from place to place depending on the on-set of rain, types of varieties, and the purpose of the production.

Under rain-fed production systems

- Planting of maize should be done at the onset of rainfall when the soil moisture is good enough to support uniform maize seed germination and seedling growth.
- However, planting early on set and then every two weeks within the recommended planting time is recommended for green cob maize producers to supply the market at different times.
- In general, the planting time may be started at the end of April to mid-June depending on the on-set of rainfall, maturity period of varieties to plant, agro-ecology, and purpose of production.

Under irrigation production system

- The plating time under irrigated conditions could mainly be driven by market outlet at which the shortage of green cob is common to enhance the return per unit cost.
- Planting the crop every 2-3 weeks after the first time of planting could help to continuously supply for the local market.

3.4 SEED RATE, PLANT SPACING AND PLANTING METHODS

Row planting with appropriate seed rate is the best agronomic practice to enhance the productivity of the commodity as it helps for resource utilization efficiency and easy for weed control. Depending on the type of variety, seed size and quality of seeds (e.g germination capacity), the amount of seed required per hectare is 25-30 kg.

Planting methods

- Row planting method is the most appropriate method for grain and green cob maize production.
- Variety specific recommended spacing between rows and within rows should be followed correctly to get the recommended population density per hectare.
- For green cob maize production
    - The spacing between rows is 80cm and between plants is 50cm for late maturity (e.g BH661), which gives 50,000 plants/ha planting two seeds/hill.
    - The spacing between rows is 80cm and between plants is 40cm for medium maturity (e.g BH546, BH547, BH549), which gives 62,500 plants/ha planting two seeds/hill.
    - For the two seeds to be planted in one place, it is necessary to first put NPS with a measuring stick or similar measure and place the seeds 5cm away from the fertilizer on the right and left sides.
- If planting machines are to be used, experienced technicians should properly calibrate according to a variety specific recommended plant spacing.

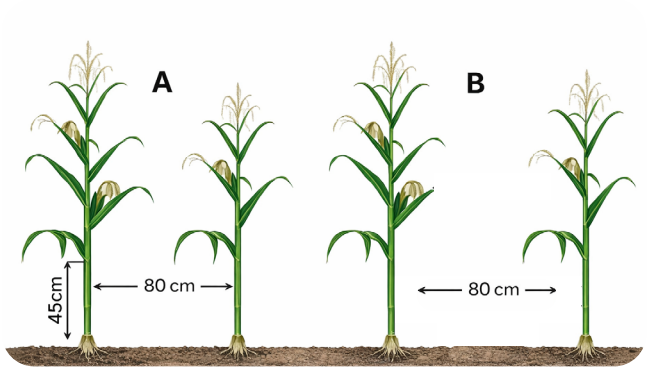


Figure 10 Different recommended planting space of maize, 80cmx45cm (A) for late maturing l and80cmx40cm (B) for medium maturing double plating per hill

- The depth at which maize is sown can vary from 5cm-10cm depending on the type of soil.
    - On light clay soil (40% clay > 20% sand) 5-8cm depth
    - On Luvisols/alluvial soil, 6-7cm depth.
    - On Sandy soil, 7-10cm depth is recommended.
- Note that the seed rate, plant spacing, and depth recommended for early and medium types for production of grain maize is applied for green maize production based on maturity group, variety types and soil type.

Figure 11: Maize variety (BH-549) recommended for green cob production in mid-land areas

3.5 IRRIGATED MAIZE PRODUCTION PRACTICES

Irrigation based green cob maize production is mainly practiced through furrow methods since it is relatively simple to practice and affordable price, although loss of water and soil salinity development may be the main constraints of this practice.

Furrow Length: it depends on soil types and slope of the land.

- On smallholder farmer land, furrow length can be ranged from 5m to 20m.
- On largescale farms, its length can be 30-50m.

Furrow Spacing: is mainly determined by recommended planting row spacing.

- In general, irrigated maize can be planted by making rows 75cm- 80cm wide ridges that can be made even by oxen driven local maresha.

Furrow slope:

- Furrow slope on average ranges from 0.05 to 0.5% which is suitable for furrow irrigation.
- If the slope of the land, however, is above 0.5% and up to 3%, the furrow preparation must be against the slope.
- If the slope of the farm is above 3%, it is critically advisable to build contours or check dam.
- At the end of the irrigation furrows, there must be another furrow that removes excess water from the farm.

Figure 12 Example showing furrow preparation using local and modern plowing machine

3.5.1 IRRIGATION WATER QUALITY, AMOUNT, FREQUENCY, AND TIME OF IRRIGATION

Knowing quality of irrigation water, which should be salt free, is very important for production of maize by irrigation. Utilization of salty water for irrigation apart from yield reduction causes the land to be out of crop production. Hence, it needs attention to efficiently utilize irrigation water with improved irrigation technologies to reduce the development of salt in the soil.

- To avoid the expansion of salt affected soils, careful irrigation and water utilization is very important.
- Avoid flooding of farmland and remove excess water from the field.

watering by furrow irrigation

Appropriately irrigated maize field

Figure 13 Example showing furrow irrigation methods of maze production

Maize Irrigation water requirements: it varies according to environmental weather conditions, types of soil and maize varieties or growing periods of the crop varieties.

- Maize production using irrigation in mid-altitude areas requires 610-755 mm of water, but relatively less amount is required for green cob production.
- Lowland areas, 910-1120 mm net irrigation water is required for production of the maize.

Irrigation frequency: understanding irrigation frequency during the growing period of the crop is very important to use the water efficiently and avoid extra cost. Therefore, the amount of water required at a time and the required frequency is considerably important to be known by the producers. In general, maize water requirements and irrigation frequency are calculated based on soil type and altitude differences as indicated in the table below.

ALTITUDE	MATURITY (DAYS)	MAIZE GROWTH STAGE	NET IRRIGATION WATER (MM)	IRRIGATION FREQUENCY INTERVAL IN DAYS		
				LOAMY SAND SOIL	LOAM SOIL	CLAY SOIL
Lowland areas < 1000m above sea level	100-130	Seedling stage	40-65	6-7	7-9	8-10
		Growth stage	90-95	8-10	9-11	9-12
		Flowering & grain filling time	200-215	10-12	11-14	11-16
		Maturity Time	110-125	11-15	13-16	16-18
Midaltitude Areas 1000-1700M Above Sea Level	130-160	Seedling stage	90-120	8-9	9-11	9-11
		Growth stage	50-70	9-11	11-13	12-15
		Flowering & grain filling time	130-150	9-12	12-14	13-15
		Maturity Time	70-100	10-13	13-15	14-17

Table 1: Green cob production areas, amount and frequency of irrigation interval in days
Source: Maize production manual 2024

3.6 FERTILIZER APPLICATION: TYPE, RATE, TIME AND FREQUENCY

Fertilizer is one of the key inputs for enhancing the productivity of the crop. Either inorganic or organic fertilizer can be used, but combined application is the best practice for enhancing productivity while maintaining soil fertility and health.

Inorganic fertilizers: The amount of inorganic fertilizers required per hectare is based on the soil fertility status of the production area, types of varieties used, production for different purposes. This could help to achieve maximum green cob production while considering economic and environmental factors. Although locally recommended rates are primarily advised to apply, which is still possible to get locally recommended practices from nearly agricultural research centers, the general recommended rate of inorganic fertilizers for maize production are summarized below.

AGRO-ECOLOGY/ REGION	TYPES OF FERTILIZER	RECOMMENDED AMOUNT KG/HA
For areas in Oromia and Southern National Regions which has medium altitude and receive sufficient rainfall (Wet mid altitude and lowland)	NPS	150
	UREA	250
For areas in the Amhara National Region that get medium altitude and enough rain fall (Wet mid altitude and lowland)	NPS	200
	UREA	300
Low moisture stress areas	NPS	100
	UREA	150

Table 2: Areas with NPS and Urea fertilizer recommendations
Source: Maize production manual 2024

Time and methods of application of inorganic fertilizers

NPS fertilizer sources

- NPS should be applied at the time of planting by placing along the seed rows, but away 2-3 cm from the seeds.
- Direct contact of seeds with NPS fertilizer should be avoided.

Nitrogen fertilizer sources

- Split application practices of UREA should be in place to ensure efficient utilization of the fertilizer and reduce losses of the fertilizer.
- In general, two split applications of UREA are recommended: half (1/2) of the recommended UREA should be applied at planting time, whereas the remaining one (1/2) at knee height.

- However, to enhance the utilization efficiency of the crop, particularly for green cob maize production, three applications is recommended: one-third (1/3) of the total recommended UREA is at planting time, (1/3) at knee height and (1/3) is at flowering time.
- The average amount of NPS and UREA to be applied for one maize plant is 4.8-8-gram plant-1- and 8-9.8-gram plant-1, respectively.
- In all cases, band application and side dressing are the best methods for efficient use of the fertilizers.
- Fertilizer should be incorporated into the soil to avoid any wastage such as through volatilization and erosion.

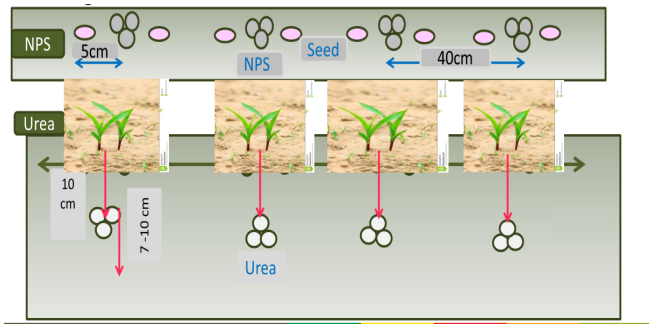


Figure 14: Band and side dressing methods of fertilizer application for green maize cob production

Organic fertilizer: application of organic fertilizers such as compost, vermicompost, farmyard manure can also be used for production of maize. Since these organic fertilizers, however, are often too high quantity to be used alone, combined application of organic and inorganic fertilizer sources is primarily advised to enhance productivity.

- In general, in maize production area where soil is black soil, combined application of 55 qt ha-1 compost, 87.5 kgha-1 of UREA and 75 kgha-1of NPS should be used. However, UREA should be applied two times: half at time of planting and the remaining half at knee stage.
- Combined use of 45 qt ha-1 of compost, 87.5 kgha-1 of UREA and 60 kgha-1of NPS is also recommended in maize production areas where the soil is red.

3.7 CROPPING SYSTEMS FOR INCOME DIVERSIFICATION AND SOIL FERTILITY IMPROVEMENT

3.7.1 RELAY CROPPING

It is one of a sustainable cropping system that optimize systems productivity and diversified income generation. It possesses the capacity to improve soil fertility and increase return per unit cost and area. Secondary crops, mainly common beans, are planted when the maize is near to maturity stage or at the green cob stage, which is ready to harvest as green maize cob.

Some of the key practices to plant common bean in maize as relay cropping are:

- The common bean should be inter-sown at the maize physiological maturity stage or before green cob maize is harvested.
- This is mainly practiced under rain-fed on light verti-soil to use the residual soil nutrient and moisture.
- The seed rate of common bean for relay cropping in maize is 120-200 kg ha-1 depending on the size of the seeds and residual moisture of the soil.
- The common bean crop is planted by broadcasting methods.
- The maize should carefully be harvested after its harvest maturity or at a time of green cob harvesting stage.
- The common bean could be matured within 80-100 days depending on varieties.
- In general, relay cropping ensures different products per unit area per year

Figure 15 Common bean(left) and soybean (right) crops relayed in maize main crops in Sidama area, Ethiopia

3.7.2 INTERCROPPING

- Although green cob maize production is the primary commodity, it is also possible to intercrop suitable crops to harvest additional income during the same growing period.
- Example, common bean (either bush or climbing types) can be planted at the center of maize rows (under rain-fed), or between plant spacing (under irrigation). The common bean can be planted simultaneously with maize or 7-10 days after maize is planted.
- In addition, some vegetable crops, such as cabbage, pumpkin, etc., can also sparsely be planted in green cob maize production field.

Figure 16: Common bean intercropped between rows of maize

3.7.3 DOUBLE CROPPING PRACTICES

Double cropping is the practice of growing more than one crop on the same land within a single crop year, using consecutive planting cycles. This system allows farmers to maximize land use and increase overall productivity. In Ethiopia's highland areas, where the rainy season is extended, maize producers can adopt this approach by selecting maize varieties suited to the local agro ecology.

After harvesting green cob maize, farmers can plant leguminous crops such as common beans, grass peas, chickpeas, and other pulses. These crops not only improve soil fertility through nitrogen fixation but also enhance farm productivity and profitability.

3.8 MAIZE PEST MANAGEMENT OPTIONS

Maize is highly attacked by numerous pests and diseases if it is not properly managed. The level of pests and disease incidence depends on the presence of organisms, weather, soil conditions, and the relative resistance or susceptibility of the variety. Management techniques to minimize losses due to pests and disease attack include habitat manipulation, modification of cultural practices, chemical control, and integrated pest management.

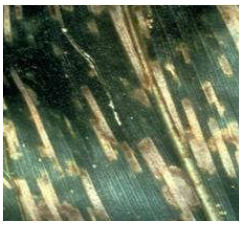
Insect pest: the most common inspect pests that attack maize production are fall armyworm, stalk borer, cut-worm, termite. The symptoms and control options are summarized below.

INSECT PESTS	SYMPTOMS	MANAGEMENT METHODS
Fall armyworm 	A migratory pest causing heavy damage, and they feed heavily on shoot and sometimes stalk and mid-rib of leaves	• Deep plowing, timely planting, chemical control. • The rate of chemicals should be applied as per indicated in leaflet or label of the recommended chemical

Stalk borers 	Bores into leaves, stalk and cobs causing damage, retarded growth	Plant early, uproot infected plants, practice crop rotation, use recommended insecticides as its recommended rate.
Cutworms 	Cutworms emerge at night and cut the seedling off at soil level.	Use treated seed
Termites 	Attack all parts of the maize plant	Destroy all termite anti-hills in the field; use recommended insecticide

Table 3: Summary of major insect pest of maize

Disease Pest: the most common diseases that attack maize production are Tursicum leaf blight (TLB), Gray leaf spot (GLS), Maize Lethal Necrosis, smut, leaf rust, ear rot and maize streak virus. The main symptoms and control measure options are summarized as follows.

DISEASE	SYMPTOMS/SIGNS	CONTROL MEASURES
Turcicum leaf blight (TLB) 	• It is a residue born disease. • It causes premature withering and leaf shedding	• Crop rotation • use resistant varieties • bury infected residues • spray recommended fungicides as soon as lesions are noticed
Gray leaf spot (GLS) 	• It is transmitted through residue born and rain splash. • Small leaf spot which later develop into brown, gray long and narrow spots • It appears on lower leaves	• Crop rotation • use resistant varieties • deep plough and • use recommended fungicides
Maize smut 	• It is transmitted through seed. • Tassels become malformed and overgrown. • Gradually, black masses develop in place of the ears and male florets	• Rogue out & burn infected crops • Use resistant varieties and disease-free seeds • Practice crop rotation • Spray with copper-based fungicides.

Maize smut 	• It is transmitted through seed. • Tassels become malformed and overgrown. • Gradually, black masses develop in place of the ears and male florets	• Rogue out & burn infected crops • Use resistant varieties and disease-free seeds • Practice crop rotation • Spray with copper-based fungicides.
Common leaf rust(CLR) 	• Its main symptom is small elongated powdery dark brown spots on both surfaces of the leaves. • It is most common when plants are approaching to tasseling	Practice crop rotation; spray with copper-based fungicides
Ear rot (Fusarium ear rot) 	• Irregularly bleached areas on husks and gradually enlarged. • Ears appear chaffy, with a white, cottony growth between the kernels. • Insects and birds create a route for ear rot.	Uses good husk cover and resistant varieties. Avoid insect and bird damage
Maize streak virus (MSV) 	• It is transmitted through leaf hoppers. • Small round scattered yellow spots on the leaves that later join into the typical leaf streaks. • Severe infection leads to stunting growth and plants die prematurely	Uproot and destroy infected plants; use resistant varieties and recommended insecticides to control leaf hoppers

In general, use of seeds free from seed-borne diseases, and resistant variety are the main control measures of maize foliar diseases. Some disease resistant improved hybrid maize varieties are BH546, BH547, BH549, BH520 whereas open pollinated maize varieties, such as Gibe3 and others are resistant to Grey Leaf Spot (GLS), Turcicum Leaf Blight and Common Leaf Rust. Indeed, producers should be advised to use integrated Pest Management (IPM). IPM is a pest management system that utilizes a combination of all suitable techniques. IPM includes planting resistant maize varieties, cultural practices, biological control, and chemical applications as per recommendation.

- It should always be noted that the producers should read the label for recommended dilution rate, time and frequency of application of chemicals.
- The producers should also get more advice from his/her nearby development agents and/or agricultural one stop services on how to calibrate the knapsacks sprayers, methods of spraying and any precaution.

3.9 WEED MANAGEMENT PRACTICES

- Weeds are plants that grow in locations where they are not intended.
- Weeds reduce the quality and productivity of crops by competing for water, minerals, sunlight, spaces, which are required for basic growth and development of the crop.
- Maize is very sensitive to weed competition at seedling stage.
- Weeding by hand is one of the options and the first weeding and cultivation should be done 18 – 25 days after planting or when the plant reached 3 leaf stage.
- Cultivation should be done when there enough moisture is available in the soil.
- Second weeding should be done before applying the second split of fertilizer application, 35 – 40 days after planting.
- The third weeding can be done 50- 55 days after planting as required.
- There are two main strategies for weed control methods
  - Protection based weed control
  - Before and After crop planting weed control method
  - Early control of weeds recommended at 2-3 weeks after planting is extremely important.
  - It is also recommended weed 5-6 weeks after planting.
- Control of weeds can be manually done using hand hoes, hand pulling, mechanical weeders or by chemical means.

Advantages of chemical weed control

- Herbicides are very effective and take a short time to control weeds.
- Reduces the frequency of tillage and hence it is labour saving.
- There is no root damage and soil disturbance to bring more weed seeds to the surface for germination.
- Herbicides are important for zero or minimum tillage practices.

Maize field affected by weed

Maize well weeded

Figure 17: Maize field affected by weed and weed free

DO	DON'T DO	POINTS TO BE CONSIDERED FOR CLEANING
Carefully wear the protective material put warning sign in field during spraying spray in the direction of wind walk withihn the rows and direct the nozzles to the target pest preferably spray in the morning or late near to sun set apply pesticides evenly and the right amount trun of the knapsprayer when ever you pause	spray near other people or water sources when it is about to rain eat, drink, smoke while spraying chemical touch your face or any otehr of your bare skin	While still dressed in protective gear, wash the knapsack and rinse it well to ensure that no residues remain Pour all the washing on bare ground Do not wash spray pumps near water sources like rivers, lakes or swamps Remove the protective gear ending with gloves. Wash the protective gear. Wash your body thoroughly well with clean water after spraying. Put on clean clothing Store the clean spray pump properly. Keep records of spray application

Table 16. Some precaution points to be considered during and after chemical spraying

Knapsack sprayer | Washing of spray pump | Bathing after spray

Figure 18: Cleaning spray equipment after spraying

Post assessment questions

1. Please list out at least three best recommended maize varieties preferable for green cob maize production
2. Which production season is more attractive and profitable for green cob maize production? Why?
3. List at least three of insect and disease pest that economically reduce the productivity of green cob maize production

Key message

- Assess market for adjusting time of planting
- Please keep recommended plant density
- Apply recommended inputs to get high return
- Monitor your field and take control measure as required

SECTION 4: HARVEST AND POST-HARVEST HANDLING

Overview of the section

Under this section, the trainee will understand appropriate time of harvesting, harvesting methods, primary value addition such as sorting and grading as well as post-harvest handling methods.

Learning Outcomes

At the end of this section, participants will be able to:

- clearly understand the basic steps to follow for harvesting, grading and packing of green cob maize production

Duration: 3hrs

Learning question

1. Do you know any agronomic practices implemented in your area for green maize production?
2. What are the basic practices you follow during harvesting and post-harvest?

4.1 GREEN COB MAIZE HARVESTING

- Green cob maize has no strict maturity indices for harvest unlike grain maize, which is harvested at harvest physiological maturity (kernel develop a black layer at physiological maturity, 30-35% moisture content).
- Green maize is harvested at least one month before the grain reaches physiological maturity. This gives the opportunity to free up land for the next crop sooner than when the crop is grown for grain.
- At about 24-30 days after the time of silking stage, the green cob can be harvested.

- The cob appears white when kernels are removed, and kernels are about 70%–80% moisture content. This is the best stage for using green maize for sale or consumption.
- Harvest large size cobs that attract consumers to buy as green cobs.
- Don't remove the ear shank and the husk not to lose moisture and keep the cob green.

4.1.1 GREEN MAIZE HARVESTING METHOD

- Manual or hand picking is an appropriate and best method for harvesting green maize.
- Green cob early reached for market is harvested before the lately planted reach cob stage. This is done through selecting by hand picking.
- After 3-5 days a second ear will be ready and harvested manually.
- Harvesting in the morning is better to minimize moisture loss and wilting of ear.


Figure 19: Green cob indicating ready for harvesting

4.1.2 GREEN MAIZE SORTING

- Sorting of green cob mainly based on the size is an important to sale for good market price.
- Don't' mix cobs that are harvested at different date.
- It should be free of damage from insects or birds and disease.
- Sorting of cob based on uniformity of cob (large, filled with kernels and good husk cover).


Good cob size


Good cob size


Undesirable cob


Insect infected cob

Post assessment questions

- How do you determine to know the appropriate time of green cob maize harvesting?
- What are some basic criteria for green cob sorting and grading?

SECTION 5: FINANCIAL FEASIBILITY

Overview of the section

Financial feasibility describes whether agri-business is financially viable. It involves determining initial investment (resource) requirement to start the business, estimating production cost, operation expenses, and sales revenue. These are used to determine the initial investment requirement, profitability of the business, break-even point (minimum level of production) to attain the profit zone, and pay-back period (number of years required to recover initial investment). These series procedures are used to make wise decisions to accept or reject the agribusiness investment alternative.

Learning outcome

To equip trainees on Key procedure to follow for effective marketing in agri-business.

Duration: 4hrs

Learning question

- Do you know how to determine financial feasibility of the given specific agri-business to make wise investment decision?

5.1 INITIAL INVESTMENT

- Initial investment is the minimum capital requirement to start the business.
- Example of initial investment requirement to start seed production business includes tools and equipment, seed storage, land, tractor, working capital, etc.

DESCRIPTION	TOTAL COST	REMARK
Total		

Table 4: Template to estimate initial investment requirement for agri-business.

5.1.1 LONG-TERM INVESTMENT

- Long-term investment in agri-business involves all asset requirements for the business which can serve for more than one year.
    - Example tools and equipment, tractor, storage, land, etc.

TYPES OF INVESTMENT	UNIT OF MEASUREMENT	QUANTITY	UNIT COST	TOTAL COST
Total				

Table 5: Template to calculate total cost for acquisition of long-term investment

5.1.2 WORKING CAPITAL

Working capital for the planned agri-business includes all payments requirement for day-to-day operating activities such as production costs and operating expenses.

Example

- Production costs include cost of seed, fertilizer, chemical, labor cost etc
- Operating expenses includes administrative salary, sales commission, promotion, etc
- Working capital excludes long term investments such as warehouse, tools and equipment, land, tractor, and etc

A. Production cost

- Production costs are a key component in agri-business.
- It includes all costs associated with production including value addition to make the product ready for sale.

TYPES OF INVESTMENT	UNIT OF MEASUREMENT	QUANTITY	UNIT COST	TOTAL COST
Total				

Table 6: Template for estimating production cost per hectare for green cob production

B. Operating expenses

- Operating expenses are all costs not directly associated with production.
    - They are common costs incurred for administrative and selling activities. Example administrative salary, promotion cost, sales commission, transport cost to sale,

TYPES OF COSTS	TOTAL COST

Table 7: Template to estimate operating expenses for agri-business

5.2 ESTIMATED PRODUCTION AND SALE REVENUE

- Production volume is the main source of revenue for the agri-business to generate profit.
- Producers should determine the estimated average production volume from the planned production season.

Formula -1
Total production volume = Average Production per hectare X Land size (ha)

- After determining the estimated volume of production, it is possible to determine the expected sales revenue for the planned production.

Formula -2
Total sales revenue = Total production Volume X unit selling price

A TYPES OF PRODUCT	B LAND SIZE (HA)	C ESTIMATED PRODUCTION/ HA	D TOTAL PRODUCTION B X C	E ESTIMATED SELLING PRICE/UNIT	F TOTAL SALES REVENUE (F X G)				

Table 8: Template for estimating volume of production and sale revenue

5.3 PROFIT AND LOSS STATEMENT

- The primary objective of any business is to generate profit.
- Profit and loss statement is the main tool to calculate profitability of the business.
- It is used to accept or reject the investment based on estimated profit.

Formula -3

a. Gross profit = Total sales revenue – Cost of goods sold
b. Net profit = Gross profit – Total operating expenses

DESCRIPTION		
Sales Revenue		
• Cost of production (-)		
Gross profit		
Operating Expenses (-)		
Net profit		

Table 9: Template for profit and loss statement preparation

5.4 BALANCE SHEET

Balance sheet used to know the total resource owned, amount of claim by creditors and amount of owners' equity

- Balance sheet contains assets, liability, and own capital
- Assets are all resources available for use or for sale
    - Example cash, inventory, warehouse, land, equipment etc
- Liabilities are all debts obtained from banks, microfinances, individuals or others
- Own equity/capital involves own/member contribution, grant/donation, etc.

Formula -4
Total Asset = Total liability + Total own capital

DESCRIPTION		
Asset		
Current asset		
Cash		
Inventory		
Total current asset		
Fixed asset		
Tools and equipment		
Warehouse		
etc		
Total fixed asset		
Total asset		
Liability and Capital		
Liability		
Loan		
Total liability		
Owners capital		
Own capital contribution		
Grant/donation		
Total owners' capital		
Total liability and capital		

Table 15: Template for balance sheet preparation

5.5 CASH FLOW STATEMENT

Cash flow is all cash inflow and outflow for any purpose in the business operation

Example:

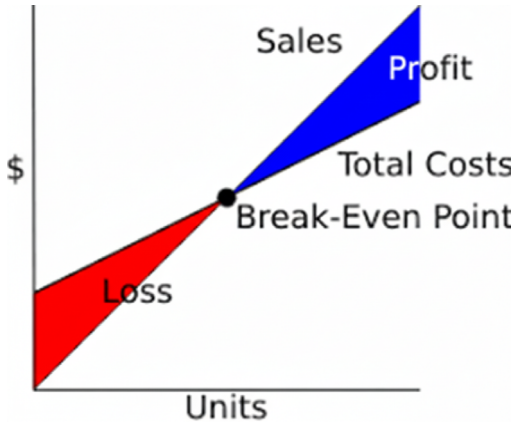
- Cash inflows include sale of seed/seedling, debt obtained from banks, members capital contribution, etc.
- Cash out flow includes purchase of input, payment for construction, repayment of debt, payment for salary, etc.

Formula -5
Beginning cash balance + total cash inflow = ending cash balance + total cash out flow

DESCRIPTION	AMOUNT OF OUTFLOW	AMOUNT OF INFLOW
Owners' investment		
Debt		
Grant		
Sales revenue		
Warehouse construction cost		
Purchase of equipment		
Purchase of input		
Land rent		
Irrigation cost		
Labor cost		
Cash Operating costs		
Ending cash balance		
Total		

Table 16: Template for cash flow statement preparation

5.6 BREAK EVEN ANALYSIS



- Break even analysis is used to determine the minimum level of production to cover total cost
- At break-even point no profit no loss
- To make profit, the level of production and sale should exceed/greater than breakeven point.
- Fixed costs are fixed in total amount regardless of increase/decrease in volume of production.
    - Example depreciation, warehouse rent, administrative salary, promotion cost, etc
- Variable costs varied in total in response to increase/decrease in level of production
    - Example production costs, packaging cost, loading and unloading, etc

Formula -6
Break-even point = Fixed cost/(Unit selling price – unit Variable cost)

5.7 PAYBACK PERIOD

Payback period is used to determine the number of years/periods it takes to recover initial investment.

Formula -6

a. When the annual profit of the business is uniform/equal
   Payback period = Initial investment/annual profit
b. When the annual profit fluctuate/vary from year to year
   Payback period = # of year before coverage + uncovered amount/profit of the next year

Post assessment questions

1. Which of the following is part of working capital
   a. Purchase of fertilizer
   b. Purchase of tractor
   c. Transportation cost
   d. purchase of chemical
2. Which of the following should include in profit/loss statement
   a. Purchase of tools and equipment
   b. Sales revenue
   c. Debt
   d. Owner investment
2. Which of the following is variable cost
   a. Purchase of seed
   b. Administrative salary
   c. Depreciation
   d. Rent of storage

Key message

- Analyzing financial feasibility of agribusiness enables to pre-determine the applicability of the business in terms of initial investment requirement, profitability, and sustainability.

Possible risks	Risk response
Limited demand driven input/ seed supply	Create strong, sustainable, and diversified linkage with input suppliers through contractual based seed production, and last mile input delivery systems
Climate change	Use climate adoptive crop varieties, use irrigation scheme, use climate prediction information and tends of climate change, use diversification, understand effective crop Calendar
Inflation/market fluctuation	Conduct effective demand assessment, understand competition in the business, apply cost-based pricing strategy, understand the market trend, use diversified market outlets
Limited access to finance	Create strong linkage with diversified sources of finance such as banks, microfinance, use family/ friends/partner, develop saving,
Insects and disease	Use quality and certified seed, apply crop rotation, understand the type of the insects/disease and use chemicals/manual mitigation method
Security	

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