

TOMATO PRODUCTION AND PROCESSING BUSINESS

TRAINING MODULE FOR YOUTH AGRI- ENTREPRENEURS

Ethiopian Agricultural Transformation Institute



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OVERVIEW OF THE MODULE

This training module is designed to equip youths and women groups, tomato growers and any group interested to acquire knowledge and skill on both open field and protected tomato production and management practices. These skills and knowledge enable the youth groups, tomato growers and others involved in tomato production to apply the technologies so as to increase the production of tomato fruits thereby improving their income. The module consists of eight sections: Agroecological requirement of tomato production, selection of appropriate tomato types and varieties, crop management practices, pests of tomato and its management, harvesting and postharvest handling, crop calendar, marketing and distribution, and financial feasibility and risk management of tomato production as business. The module also contains pre and post assessment questions at the end of each section to enable the trainee to evaluate their understanding about each topic.

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

Tomato is the most vital vegetable in Ethiopia and is important source of a healthy diet and home to micro-nutrients. Tomatoes play an important role in Ethiopia's poverty and food security programs because they have a short harvesting season, relatively high production per hectare and one of the strategic commodities prioritized by the Ethiopian government for agro-industry development. Tomato production can be produced both under field and greenhouse/polyhouse condition. Tomato production under open field is affected by climate change-related factors such as high temperatures, drought and high incidence of pests and diseases infestation pressure. Protected tomato farming has proven to be the most efficient method of producing high-quality fresh tomatoes for both domestic and international markets.

In Ethiopia, under both production system, tomato is being produced as cash crop and source of income for small scale farmers and provides employment opportunities along the tomato value chain: production, marketing and processing. Hence, tomato fruit production is one of the business areas among the value chain where youth and women groups can be organized to produce the fruits.

Training Group: Target group of this module are youth and women groups, tomato growers and other groups who have an interest on tomato production.

Training Methods: Group discussion, brainstorming, lectures, presentation, assignment, visit

Target Materials: Flip chart, LCD, markers, white board

Total time required: 18 hours

SESSION 1. AGRO-ECOLOGICAL REQUIREMENTS

Overview of the section

One of yield determining factors of tomato production is environmental suitability regarding altitude, temperature, soil type, moisture regime (rain fall amount), and soil pH. Hence, this section intended to deal with the appropriate/suitable agro-ecologies for the best tomato production.



Learning objectives

After this training session youth and women groups will be able to identify appropriate agroclimatic conditions for tomato production

Time required: 30min



Learning question

1. What is your expectations after this training?
2. List tomato producing districts/Kebeles in your areas.

AGROECOLOGICAL SUITABILITY/OPTIMUM	OPTIMUM CONDITIONS
	700 to 2400 , but >2400 stunted growth, frost damage & long growth period & <700 stigma dryness, anther tip burning, poor pollen & flowers abortion
	21 to 27 day & 10 to 20 night, but >30 above stigma dryness, anther tip burning, poor pollen & <10 stunted growth & flowers abortion
	600 to 1400but, >1400 high pressure of diseases & < 600 aggressive insect infestation



- deep, well drained, and sandy loam soils



- 5.5 to 7.5, but <5.5 magnesium, molybdenum & phosphorus availability drop & > 7.5 zinc, manganese and iron become deficient

Table 1. Agro-ecological requirements of tomato productions



Key message

Selection of appropriate agroecology maximize tomato fruit yield and quality.



Learning question

1. What are the best climate conditions to produce tomatoes (more than one possible answer)?
 - A. Temperature: 21 to 27 day & 10 to 20 nights
 - B. Altitude: 700 to 2400
 - C. Rainfall: 600 to 1400
2. Which type of soil is the best for tomato cultivation?
 - A. Sandy loam with 5.5-7.5 pH
 - B. Less than 5.5
 - C. More than 7.5

SESSION 2. TOMATO TYPES AND VARIETIES

Overview of the section

Tomato varieties is one of the decisive considerations for optimum production of tomato. There are different types of tomato varieties based on their growth habit and usage which are commonly produced in Ethiopia. Open pollinated and hybrid varieties are differentiated based on their pollination nature and productivity. Hence, this section describes the properties of the commonly used tomato varieties in Ethiopia.



Learning objectives

At the end of this training section the trainees are expected:

- able to identify the three tomato types
- able to identify, use and recommend improved tomato varieties with higher productivity and accessibility
- differentiate open pollinated and hybrid tomato varieties
- able to transfer acquired knowledge for other youth groups.

Time required: 30min



Learning question

1. What is your expectations after this training?
2. What are common types of tomato produced in your location?

2.1 TOMATO TYPES.

- Tomatoes can be classified into different types based on growth habits or usage/fruit types.

2.1.1 CLASSIFICATION BASED ON GROWTH HABIT

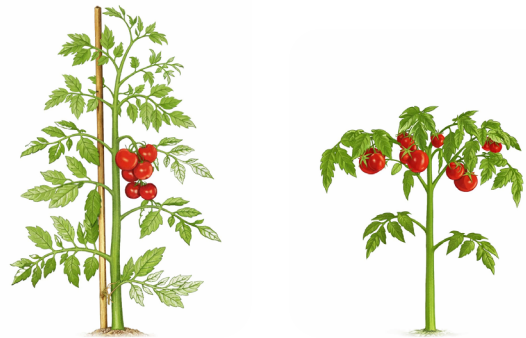
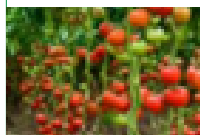


Figure 1. Tomato growth habit indeterminate (left), determinate(right)

INDETERMINATE	DETERMINATE	SEMI DETERMINATE
 - Grow much longer than determinate varieties (up to 4 m). - They are usually grown under greenhouse and requires staked	 - Grow much shorter than indeterminate varieties (0.9-1.2m). - The main and side stems stop growth after a specific number of inflorescences that varies with the specific variety. - Are often referred to as "bush" tomatoes	 - somewhere between determinate and indeterminate tomato varieties. - show branches that stop growth with an inflorescence. - plants are taller than determinate and yet not as sprawling as indeterminate.
 - need stakes, cages, and trellises	- Most sauce tomato varieties are determinate. - fruits have fewer seeds and more flesh.	- but this usually occurs at an advanced growth stage.

	- mature faster than intermediate .	- are usually grown under outdoor and non-staked tomatoes.
- give a slow and steady supply.		
- Continue to grow after flowering	- are great to grow in a short growing season and on limited space.	
- pruning is required.	- usually do not need to be pruned.	

Table 2. Types of tomato classified based on growth habit

2.1.2 CLASSIFICATION BASED ON USE

TOMATO TYPE	FEATURE
Fresh market types	are picked green, so they can cope with the transport shock
Processing type	fruit with high total soluble solids content (TSS), deep red color, determinate plant habit, compact vine, uniform ripening and joint-less pedicel for mechanical harvest or faster harvest.
Cherry types	- are small in size (30g by weight) - are perfectly round and come in a variety of colors - are used for fresh consumption.

Table 3. Types of tomato based on their usage or fruit type

2.2 VARIETY SELECTION

There are two types of tomato varieties based on pollination habit. These are:

Hybrid tomato varieties

- hybrid tomato varieties are a cross between different parents
- bred for traits such as high yield, disease-resistance and cold hardiness.
- known for higher yield per unit / produce more yield compared to open pollinated varieties
- There are many registered hybrid varieties by different private companies

Open pollinated varieties (OPVs)

- tend to have the best flavour and come true to type from seed
- produce less yield compared to hybrid varieties
- many varieties have been released in Ethiopia by research centers

OPC	YIELD (T/HA)	HYBRID	YIELD (T/HA)
Melkashola 	45	Gelilea 	66.6
Gelilema 	50	Gelilea 39 	74.8
Cochoro 	46	Venise 	75

Table 4. Yield of open pollinated (OPV) and hybrid tomato varieties (some example)



Key message

The type of tomato varieties planted governs the production and productivity of tomato fruit and seed yield



Post assessment questions

1. What are the importances of producing different tomato types?
 - a. Get varieties for different purposes
 - b. Get resistant varieties
 - c. Avoid risk due to unexpected calamities
2. How much tomato seed is required to cover a hectare of land?
 - a. 250-300 gm
 - b. 1-2 kg
 - c. 300-400 kg

tomato production.

- able to identify appropriate sources of tomato seeds and/or seedlings.
- able to understand the amount/number of seeds/seedlings to cover a given area of land.
- Structural components of greenhouse and greenhouse orientation,
- greenhouse types, soil/Media/Bed Preparation

Time required: 3Hrs

SESSION 3. CROP MANAGEMENT

Overview of the section

This section deals with the overall crop management of tomato from input preparation to field management such as tools preparation, site selection and land preparation, seed preparation, transplanting, fertilizer application, trellising/staking and field inspection.



Learning outcomes

At the end of this training section the trainees are expected:

- identify tools and equipment that are required for tomato production
- acquire knowledge on the field preparation and crop management practices
- learn / or practice different methods of irrigation management
- able to identify appropriate cropping calendar for tomato production
- able to identify appropriate site for tomato production.
- able to understand how to prepare land for



Learning question

1. What are your expectations after this training?
2. What are common tools and equipment used for tomato production in your location?
3. How many rounds of tillage are needed for optimum tomato production in your area and why?

3.1 FARM TOOLS AND EQUIPMENT REQUIRED



Digging hoe



Watering can



Rope



Spade



Staking pole



Wheelbarrow



Rake



Trowel



Sprayer



Rake



Grass straw
for mulching



Water pump



Hose



Plastic crate



Spade



Greenhouse



Tractor with its accessories



manage and train the plants vertically.

- There are different types of greenhouses that can be used for tomato production
- Glass Greenhouse: glass as covering material has the advantage interior light intensity and expensive to purchased.
- Plastic Film Greenhouses: flexible plastic films including polyethylene, polyester and polyvinyl chloride are used as covering materials.
- Galvanized metals including steel are the preferred construction material as they are durable and require less amount of material for construction
- Wood such as bamboo is an alternative material



3.2 SITE SELECTION AND LAND PREPARATION

3.2.1 PRODUCTION SITE SELECTION

The site should fulfil the following points

- Have slight to moderate slope which promote drainage and necessary to avoid poorly drain fields.
- Previously not be planted with the same crop or plants of the same family such as pepper, potato, tobacco, eggplant or other Solanaceous crop in the last 2- 3 seasons.
- Rotated with non-solanaceous crops like pulses/legumes to avoid pests and diseases affecting tomato and to enrich the fertility status of the soil.
- Crop rotations following those mentioned crops should also be avoided as they are susceptible to many of the same diseases.

3.2.2 GREENHOUSE STRUCTURE AND ORIENTATION FOR TOMATO PRODUCTION

- Tomatoes can be grown in every type of greenhouse, provided it is sufficiently high to



Greenhouse constructed by steel (left); constructed by wood (right)

Ploughing

Plough the land thoroughly for a minimum of three rounds to a depth of 25-30 cm

- 1st plough immediately after harvesting of the previous crop.
- 2nd plough is done after a month following the first plough to break clods and level the field.
- 3rd plough to ensure a smooth levelling of the field for transplanting.
- Manure and fertilizers are applied before

the last ploughing and covered by the fourth ploughing.

- Well decomposed farmyard manure (FYM) of 20-25 Kg/ha is incorporated into the soil at the time of final ploughing.
- Raised bed is preferred for growing tomatoes in greenhouse
- Growing beds are disinfected with Formaldehyde 4% and closed with polythene sheet and ventilators are closed under the greenhouse.



- Primary tillage with disc plow



- Secondary tillage (pulverization) with disc harrow



- Land consolidation or leveling by power harrow



- Row making

Figure 8. Step by step land preparation for tomato transplanting

3.3 SEED PREPARATION (SOURCES OF SEEDLING)

- Seed/seedlings must be obtained from known and certified sources such as research centres, accredited public and private suppliers.
- A total of 250-300 gm of tomato seed is sufficient to prepare seedlings that intended to cover one ha of land.
- Number of seedlings to cover a hectare of land depends on the type of varieties and spacing
 1. Open Pollinated: 33,334 plants per hectare
 2. Hybrid varieties: 20,000 plants per hectare
- Plant population can be varied with the fertility of the soil where plantation is intended to be carried out.
- The higher the fertility the higher the population density; the lower the fertility the lower the population density.

3.4 PLANTING

- Raw planting of seedlings is the common method of production in tomato.
- If the seedlings were maintained by the farmers, great care should be taken to minimize seedlings damage.

Attention during transplanting seedling

- Seven to eight days before transplanting seedlings are hardened
- Thoroughly watered 12-14 hours before uprooting
- Healthy, vigorous and uniform size seedlings are selected
- Seedlings are ready for transplanting when it has 4-6 true leaves / 25-30 days after sowing.

- The seedlings must be strong and erect.
- Seedling are uprooted from the seedbed with a ball of soil around the roots
- Once removed from nursery, seedlings should be transplanted immediately
- he seedlings can be planted in rows made by ploughing or in holes made using dibble, trowel, shovel or spade
- Spacing between seedlings and rows depends on different factors
- In Ethiopia spacing between plant is 30cm and 70 cm between rows. If tomatoes are staked the disease between rows can be decreased to 20-40cm
- Great care to position the roots properly when the seedlings are placed in the hole.
- Keep the seedling under shade until transplanting
- Cover the seedling with wet cloth/ jute sack while transplanting



Figure 9. Step by step of uprooting and handling tomato seedling

Transplanting time

- Transplanting late afternoon or late in the evening or cloudy days gives best results
- Planting holes are prepared in rows using pegs or any materials.
- Place seedlings properly into the hole to the level of the cotyledons or first true leaves without damaging or bending the main root.
- The soil should be well pressed after transplanting and irrigate immediately to establish good root to soil contact.

Spacing

VARIETIES	SPACING BETWEEN PLANTS (CM)	SPACING BETWEEN ROWS (CM)	POPULATION DENSITY (REQUIRED NUMBER OF SEEDLINGS/ HA)
Open pollinated variety	30	100	33,334
Hybrid	50	100	20,000

Table 7. Recommended spacing of tomatoes varieties

3.5 FERTILIZER APPLICATION METHOD, TIME AND RATE

- Tomato requires both organic (compost, vermicompost, farmyard manure) and inorganic fertilizers (urea, DAP, NPS) to optimize the productivity under field condition (Table 7)
- Time of application varies with the type of fertilizer applied
- Appropriate application method should be used to maximize their utilization by the plant both under field and greenhouse
- Appropriate rate of fertilizer should be applied based on research recommendation for both production systems (Table 7 and Table 8)
- Fertilizers used for fertigation applied one week after transplanting and twice a week under the greenhouse
- Fertilizers are put into a container and thoroughly dissolved with water for greenhouse fertigation.
- Before the fertilizer solution was injected into the drip laterals, water was given for five minutes to fill up the system (first flushing) under the greenhouse. This was done to enable a uniform fertilizer distribution and to avoid fertilizer burning of young roots under the greenhouse

TYPE OF FERTILIZERS		RATE/ HA FOR LAND	TIME OF APPLICATION	APPLICATION METHOD
Organic	Compost	10 ton	Before transplanting	Broadcasting and incorporate with soil before row making
	Vermicompost	8 ton	Before transplanting	Broadcasting and incorporate with soil before row making
	Farmyard manure	10-12 ton	Before transplanting	Broadcasting and incorporate with soil before row making
Inorganic	NPS	242 kg	At transplanting	Drilling along the row and incorporate with soil before transplanting
	Urea	100 kg	50 kg applied 15-20 days after transplanting & remaining at early flowering	Side dressing

Table 7. Type of fertilizer and blanket recommended rate

TYPES FERTILIZERS	RATE (KG/HA)
NPS	242
Urea	250
KNO3	150
MAP	100
CANO3	250
MgSO4	50

Table 8. Fertilizers used for fertigation in protected tomato production

3.6 IRRIGATION WATER REQUIREMENT AND APPLICATION

- There are different methods of water application and each of them has their own advantage and disadvantages
- Appropriate method of water application should be used based on environmental conditions that maximize water utilization

A. Furrow Irrigation

- Furrow irrigation is the most widely used method in tomato production in Ethiopia
- Furrow is done at end of all land preparation operations
- Furrow irrigation requires lower capital investment, less technical knowledge, and greater labor than most other irrigation systems.

- It is suitable for slope of 1-3 % for straight furrow but not for steeper contour.
- Furrow length can be 5-20 m length whereas under commercial farms it can be from 30-50 m length.
- Furrow width depend on water movement and tomato agronomic requirements.



Figure 10. Furrow irrigation method for tomato production

B. Drip Irrigation

- It is the recommended methods for tomato production with 90% or higher water efficiency.
- Irrigation water used for greenhouse production can be obtained from rivers, ponds or reservoirs, rain, groundwater (boreholes), and tap water

- It is easy to install, easy to design, and can reduce disease and weed problems associated with high levels of moisture on some plants.
- It is more expensive compared to furrow irrigation
- Commonly used where there is shortage of water for irrigation



Tomato drip irrigation both under field and greenhouse

3.7 MULCHING

- Mulching practices have pronounced effects on water use efficiency (WUE).
- Mulch is a protective layer of either organic or inorganic material that is spread on topsoil to
 1. Reduce the moisture loss
 2. Suppress weed emergence
 3. Improve soil condition
 4. Provide home for earthworms and natural enemies



Mulching by grasses (top) and plastic mulching (bottom right side)

3.8 CULTIVATION

- Cultivation between rows of young plants is done to keep the soil loose and to control weeds.
- Shallow hoeing is recommended to control weeds.
- Earthing-up of the soil promote the development of additional roots which reduces lodging due to strong wind.
- Done 2-3 time throughout the growing period depending on soil type (1st 15-20 days after transplanting, 2nd 15 days after the 1st cultivation, 3rd at early flowering stage).



Cultivation of tomato main field

3.9 TRELLISING/STAKING

- Staking is an important operation in tomato production system
- The plants should be loosely tied on vertical stakes and the timely staked plants produce better fruits, qualitatively and quantitatively.
- The plants are supported by wood, plastic wires or blinder twine
- Staking has several importance

STAKING

Lowers incidence of disease, insect pests and Sunburn

Improves quality, and yield Of tomato fruits

Improves quality, and yield of tomato fruits

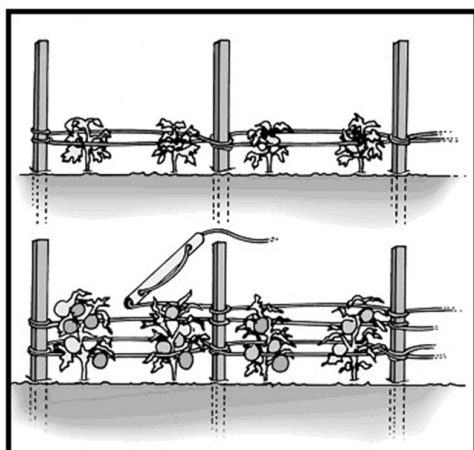
Facilitate easily management of disease and insect pests (easy chemical spray)



Tomato staked under the field



Wire caging



Staking

Staking and wire caging of tomato in the field

3.10 TRAINING/PRUNING

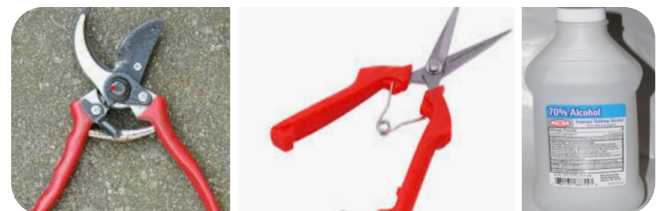
- The suckers can be pinched or cut using pruners such as knives, scissors and secateurs and using an alcohol-based sanitizer or washing with soap to prevent the spread of

pathogens. This practice is commonly used under a protected production system.

- Pruning can be done on weekly basis to improve or ensure efficient air circulation/aeration



Tomato branches pruning



Materials required for pruning/training of tomato production

3.11 FIELD INSPECTION

- Regular field inspection is crucial to minimize/take possible correction measures against pests on time.
- The field should be inspected on daily basis or on the other days.



Post assessment question

1. Discuss on the most important parameters while selecting sites for production of tomato. The site should

- A. have slight to moderate slope which promote drainage and necessary to avoid poorly drain fields.
- B. not be planted with tomatoes in a field previously or plants of the same family as pepper, potato, tobacco eggplant or other Solanaceous crop in the last 2 - 3 seasons.
- C. not be rotated planted with other solanaceous crops during last season
- D. not be rotated with Solanaceae families

2. Why is land ploughed at least three times before planting?

- A. To turn over weeds & previous crop remenets.
- B. To break clods and level the field.
- C. To ensure smooth level field for transplanting.
- D. To incorporate manure fertilizers into the soil
- E. To row making for transplanting.

3. What are the benefits of producing tomato under protected cultivation ?

- A. Easy to irrigate and control pests
- B. Protect the crop from direct sunlight
- C. Maintain the temperature to optimum range
- D. Increase production and productivity
- E. Able to produce out of tomato niche areas



Key message

Selection of appropriate site, seamless preparation and subsequent filed management is very critical to optimize tomato fruit production

SECTION 4. PESTS OF TOMATO AND THEIR MANagements

Overview of the section:

Tomato production is highly affected by the infestation level of the crop particularly by disease, insect pests and weeds. Hence, this section addresses the major tomato diseases, insect pests, and weed species, their symptoms as well as possible management options.



Learning outcome

At the end of this training section the trainees are expected:

- Know the common diseases, insect pests and weed species affecting tomatoes.
- Recognize the signs and symptoms of different diseases and insect pests that attack tomatoes.
- Understand the critical stages of growth of different diseases insect pests and weed species to target control in tomatoes production.
- Understand different disease, insect pests and weed species management approaches

Time required: 4 hours

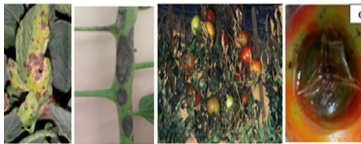


Learning Question

1. What are your expectations after this training?
2. What are common diseases, insect pests and weed species that affect the production of tomato in your location?
3. What are major management practices of tomato diseases, insect pests and weeds in your localities?

4.1 TOMATO DISEASES AND THEIR MANagements

- Tomatoes are affected by various diseases during their growth stages under the production fields. If they are not checked timely, they will cause to yield reduction or even crop failure.
- Controlling diseases effectively helps the tomato growers/farmers to improve the yield of tomatoes. It is recommended that control starts even before the disease symptoms are seen.

DISEASE	SYMPTOMS	MANAGEMENT PRACTICES
Damping off • Considered as a nursery disease • Caused by a complex of soil dwelling fungal species including pythium, Phytophthora, Rhizoctonia, and Fusarium and bacteria • Has wide host range including pepper, onion etc.	• Pre-emergence seed discolorations (decays) • Water soaked and discoloured hypocotyl of the seedling at the surface of the soil • Patchy seedling appearance at seedbed or try on the nursery • Stunting growth and wilting • Poor stand, wilting and stunting of the plants 	• Choosing well drained nursery location • Use of raised seedbed • Soil solarization • Use of certified (disease free) seeds • Seed treatment with Thiram 80% WP, Proseed plus 63 WS (Carboxin + Thiram + Imidaclopride), Imdalm T 450 WS (Imidaclopride + Thiram) and Carbendazim prior to sowing. • Avoid overcrowding of plants and infested soil or contaminated plant materials • Water plants only when the soil is dry. • If possible, use plug transplants and a soilless pathogen-free growth medium.
Early Blight • caused by Alternaria tomatophila or Alternaria solani • favoured by warm temperatures and extended periods of leaf wetness • Stressed Plants are more susceptible • The pathogen over winters primarily on an infected crop debris and survive in the soil	• develops on leaves, stems and fruit usually on older leaves as irregular, dark-brown, necrotic lesions. • The lesions expand as disease progresses and they eventually develop concentric, black rings. • If there are numerous lesions on a leaf, then the entire leaf will turn yellow and senesce. • Complete defoliation of plants can occur 	• Use health seedlings of tolerant varieties • Field sanitation • Rotate with cereals or legumes • Maintaining adequate nutrition • Implement proper spacing and staking • Use plastic mulch. • Orient rows in the direction of prevailing winds, • Avoid shaded areas and wind barriers. • Use recommended fungicides
Damping off • Caused by Phytophthora infestans • Low temperature with continues rainfall aggravates the disease • The entire field may collapse (100% loss) within five days	• Round, dark brown watery soaking blotches/ lesions, usually on leaf tips/petioles and tender plant stems • White-colored fuzz (fluff) that appears surrounding the blotches • Dry, dark brown, brittle blotches/lesions, usually, of the tender portion. • Brown patches grow to cover entire leaves. • On the underside of the lesions, there is white fluffy growth.	• Field Sanitation • Crop rotation • Use healthy tomato seedlings of tolerant varieties • Reduce moisture in the leaves by spacing plants or watering them from the base of the plant. • Increase aeration through staking and pruning indeterminate varieties. • Avoid overhead irrigation or, if it is used, water early in the morning.
	• Irregular brown patches, usually, around the stem-end, or where two fruits come in contact. • Dark, brown or coppery glossy patches grow to cover the entire fruit. • Infected tissues are firm at first, but they soon become soft	• Avoid planting tomatoes near to potato crops • Use relatively resistant tomato varieties. • Recommended fungicides Use of Fungicides

Late blight - Caused by <i>Phytophthora infestans</i> - Low temperature with continuous rainfall aggravates the disease - The entire field may collapse (100% loss) within five days	- Round, dark brown watery soaking blotches/lesions, usually on leaf tips/petioles and tender plant stems - White-colored fuzz (fluff) that appears surrounding the blotches - Dry, dark brown, brittle blotches/lesions, usually, of the tender portion. - Brown patches grow to cover entire leaves. - On the underside of the lesions, there is white fluffy growth.	- Field Sanitation - Crop rotation - Use healthy tomato seedlings of tolerant varieties - Reduce moisture in the leaves by spacing plants or watering them from the base of the plant. - Increase aeration through staking and pruning indeterminate varieties. - Avoid overhead irrigation or, if it is used, water early in the morning.
Septoria Leaf Spot - Septoria leaf spot is one of the most destructive of tomato foliage. - It is caused by <i>Septoria Lycopersicon</i>, fungus 	- Symptoms usually appear on the lower leaves after the first fruit sets. - Lesions may appear on stems, petioles and calyx. - The disease spreads from upward from oldest to youngest growth. - If lesions are numerous, some infected leaves turn yellow and then brown, and they weather. - Fruit infection is rare. - The fungus can be spread by wind, rain, and irrigation- water and by cultivation	- Crop rotation using non solanaceous crop species - Use of tolerant/resistant varieties - Use of pathogen free seed - Seed treatment using seed dressing fungicides (Apron star) - Application of registered fungicides (such as Ridomil Gold, Agrolaxyl)
Powdery mildew - The disease is caused by <i>Leveillula taurica</i> and <i>Oidium neolyopersici</i>. - It is a polycyclic disease that can impair photosynthesis, stunted growth, and increase the rate of senescence of host tissue. 	- Yellow blotches or spots on the upper leaf surface. - A white powdery growth occurs on the underside of the leaves. - symptoms first appear as small, powdery white colonies on the upper surface of the leaves. - With both pathogens, the older colonies of the fungus may turn a dirty white color with age. - Severely affected leaves turn yellow, then brown, and later become shrivelled. - Generally, the lower leaves are affected first, and the disease gradually moves up the plant. - Entire leaves can wither and die but remain attached to the stem. - With extensive loss of foliage, fruits can be exposed to sunburn.	- Avoid high rates of nitrogen, which make plants more susceptible to infection - Avoid crowding and shading, which leads to the development of leaf wetness and conditions that promote infection. - Avoid overhead irrigation for the same reason. - Avoid planting young tomato plants while diseased plants remain nearby. - Control weeds around the planting site since both fungi have a wide host range - Proper cultural practices (watering, cultivation, fertilization). - Application of fungicides
Viral diseases - Tomato mosaic virus (ToMV), tobacco mosaic virus (TMV), tomato yellow leaf curl virus (TYLCV) are the most important ones. - Depending on the kind of virus and severity of infection, viruses can cause complete crop failure on tomato	- Stunting or dwarfing of plants - Yellowing of leaves - Curling or rolling of leaves - Malformed/deformed leaves 	- Use of healthy seedlings - Discourage tobacco smokers during seedling raising and cultivation - Rouging of virus infected plants - Crop rotation - Avoidance of volunteer solanaceous crops and weeds - Application of insecticide against insect vectors (virus transmitters)

Tomato nematode - caused by species of meloidogyne, - are obligate sedentary parasites of vascular plants. - The disease is widely distributed in tomato growing areas - can survive on many weeds particularly broadleaf species.	- Roots will display characteristic galls or swellings - Severe infestation results in stunted plant growth and induces high root-shoot ratio. - wilting and nutrient deficiency symptoms. 	- Use resistant varieties. - Rotate the tomato crop with other crops such as grasses or brassicas (tolerant), followed by onion (resistant) and then dry fallow during hot, dry weather if possible. - Repeated ploughing of the soil - Adding organic matter at 4–10 t/ha to be effective. - Solarization for 4 to 8 weeks in small gardens is also possible. - Use healthy planting material. - Chemical control
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4.2 MAJOR ARTHROPOD PESTS OF TOMATO AND THEIR MANAGEMENT

4.2.1 TOMATO LEAF MINER AND FRUIT BORER (TUTA ABSOLUTA)

- It is a serious pest of both outdoor and greenhouse tomatoes.
- The larval stage is economically important stage of the insect that causes damage on tomato

Damage symptoms:



- On leaves, young larvae feed only on mesophyll tissues, leaving the epidermis intact.
- Leaf mines are irregular and may later become necrotic.



- On stem: Galleries in stems alter the general development of the plants.



- On fruits: small pin holes with irregular appearance on fruit surface.
- Feeding on fruits can lead to invasion by secondary pathogens resulting in fruit rot.

Management practices

- Crop rotation
- Remove crop residue (after harvest)
- Sanitation – removal of weeds and/or alternate hosts
- The selective removal and destruction of infested plant parts
- Land preparation – repeated and deep tillage
- Physical control method – hand picking
- Using pheromone based or light traps (sticky or pan traps) to catch adults of T. absoluta.
- Application of insecticides containing active ingredients such as, Chlorantraniliprole, Chlorfenapyr, Emamectine benzoate, Indoxcarb, Spinosad, spinetoram



4.2.2 AFRICAN BOLLWORM (HELICOVERPA ARMIGERA)

- African bollworm is a polyphagous insect pest that attacks a number of economically important crops. Infestation begins during early flowering and reaches pick at fruit development.
- **Damage symptoms:** The larvae feed externally and internally on all above-ground parts but prefer flowers, buds, seeds and fruit
- Internal feeding is revealed by boreholes or cutting open fruit and buds. Rotting of damaged fruits due to secondary infection by fungal pathogens results in total loss of fruits



Management practices

- Field scouting for early detection
- Field sanitation – avoid alternate hosts/weeds
- Plough soil after harvesting to expose pupae to sunlight and natural enemies
- Use trap crops such as maize and other forage crops as intercrop to reduce infestation and also promote biological control
- Use recommended and registered insecticides in rotation (Chlorfenapyr, Chlorantraniliprole, Emamectine benzoate, Indoxcarb, Spinosad, Spinetoram)

4.2.3 LEAF MINER (LIRIOMYZA SPP.)

- Leaf miners are insects that develop inside the leaves of their host plants. There are several groups of leaf miner species, but Liriomyza leaf-miner flies are the most important
- **Damage symptoms:** cause mine blotches on leaves
- Foliage punctures caused by females during the acts of oviposition or feeding may cause a stippled appearance on foliage. Remove the mesophyll between the surfaces of the leaf.



Management practices

- **Cultural control method**
- Sanitation – removal of alternate hosts and/or weeds and crop residue
- **Chemical control methods:**
- Use of insecticides with active ingredients Cyromazine, Thiamethoxam, Lambda-cyhalothrin

4.2.4 SPIDER MITES (TETRANYCHUS SPP)

- Mites are very small arthropods that are more closely related to ticks than insects.
- Become a problem during hot and dry seasons.
- There are two commonly known species affecting tomato; two spotted spider mite (*Tetranychus urticae*) and red spider mite (*Tetranychus evansi*)
- **Damage symptom:** mostly damage leaves but can also feed on fruits
- Stippling on leaves (leaves appear bronzed) due to removal of chlorophyll and sap. Severe feeding causes “mite burn”.
- Spider mites produce fine silk webbing that becomes apparent when populations are high



Management practices

- **Cultural control methods:**
- Grow healthy crop- avoid water and nutrient stress
- Field sanitation- Remove alternate hosts from the field and remove and burn infested crop residue
- **Chemical control methods**
- Use recommended and registered miticides and insecticides: Some of the recommended

insecticide/ miticide active ingredients includes, Chlorfenapyr, Abamectine, Amitraz and Dicofol

4.2.5 WHITEFLY (BEMISIA TABACI)

- It is a typical phloem sap-feeding insect and is regarded as one of the most devastating pests of agricultural crops and ornamentals worldwide.
- It is known for transmitting viral diseases on plants (vector)
- **Damage symptom:** Whiteflies feed on plant phloem by injecting enzymes and removing the sap, reducing the vigor of the plant
- The most obvious whitefly feeding damage symptoms are stem blanching, chlorotic spots, leaf yellowing and shedding, and at high population levels plant death



Management practices

- **Cultural control methods:**
- Field sanitation – remove weeds and/or alternate hosts
- Remove and destroy crop residue after harvest
- Crop rotation
- **Chemical control methods**
- Use recommended and registered insecticides with active ingredients such as, Thiamethoxam, Imidacloprid and Sulfoxaflor

4.3 MAJOR WEED FLORA OF TOMATO AND THEIR MANAGEMENT

There are different weed species that affect tomato production by

- Reducing yield and quality,
- Increasing cost of cultivation,
- Impairing input use efficiency and agricultural operations

- Serving as alternate hosts of insect pests and diseases
- Common parasitic weeds of tomato are Orobanche ramosa, Orobanche cernua and Orobanche minor



Orobanche ramosa



Orobanche cernua



Orobanche minor

Management practices of Orobache spp:

- Use of clean seed
- Avoid source irrigation water from orobache infested field
- Clean farm tools and equipment
- Use botanical plants (leaf powder of Xanthium abyssinicum)
- Soil fertility management
- Soil Solarization- cover the soil with black polyethylene sheets reduces Orobanche seeds upto 89%
- Use of trap crops
- Hand pooling and hoeing infested field before it bears flower and seed.
- Use of resistant varieties: Tomato varieties, LE 244, CLN 2123 A, Melkashola, Riogrande, Seedathip, LE 180 A, and Cherry were found tolerant to O. ramosa.



Key message

Tomatoes are prone to different diseases, insect pests and weed species resulting in “economic” yield loss



Post assessment question

1. What are major diseases management practices
 - Produce disease resistant varieties.
 - Field and equipment sanitation
 - Use disease free seedlings
 - Application of appropriate nutrition and spacing
 - Intercropping, crop rotation and fallowing
 - Spray chemicals
2. What are the major tomato pests?
 - Leaf minor
 - African ball worm
 - White fly
 - Spider mites
3. What are common weed species that affect tomato production in your locality?



Learning Questions

1. What are your expectations after this training?
2. How is tomato seeds processed in your locality?

5.1 HARVESTING OF TOMATOES

- Harvesting of tomato fruits depends on physiological maturity
- Don't harvest at premature stages as it is susceptible to easy deterioration and difficult to develop pleasant flavor and color.
- Tomatoes have six maturity stages (green, breaking turning, pink, light red)

SESSION 5. HARVESTING AND POST HARVEST HANDLING OF TOMATOES

Overview of the section

Improper harvesting and post-harvest handling of tomato resulted in 45 % yield loss in Ethiopia. The purpose of this section is to train youth and women small scale business groups on proper harvesting and post-harvest handling as well as processing practices of tomato. Hence, this section addresses harvesting, postharvest handling, storage, processing and value addition of the crop.



Learning outcomes

- Identify when and how to harvest tomatoes
- Understand appropriate tomato handling practices
- Understand how to reduce post-harvest losses and preserve tomatoes

Time required: 2Hrs

NO.	RIPENESS STAGE	FRUIT SURFACE DESCRIPTION
1	Green	Surface is completely green
2	Breaking	Pink or red upto 10%
3	Turning	10-30% pink or red
4	Pink	30-60 pink or red
5	Light red	60-90 pink or red
6	Red	> 90% red

Table 10. The commercial industry and growers recognize the following change as an indicator of maturity required for specific purpose

- Harvest carefully at each maturity stage based on the purpose it desired for
- Harvest at green stage for distant market purpose as it has storage advantage
- Harvest red ripe tomatoes for processing purpose



1. Green mature



2. Breaking



3. Turning



4. Pink



5. Light red



6. Red

Tomatoes stage of maturity

Harvesting practices of tomatoes

- Carefully pick during the coolest part of the day, early morning or late afternoon.
- Use glove during picking of tomatoes and never pick it during rain time
- Personnel hygiene and materials should be well maintained
- Sort according to size, color/ maturity stage and collect in either plastic or wood-based containers



Harvesting practice of tomatoes



Postharvest Handling (PHH) is the stage of crop production immediately following harvest, including cooling, cleaning, sorting and packing.

The goals of PHH are:

- To keep the product cool,
- To avoid moisture loss and slow down undesirable chemical changes, and
- To avoid physical damage for e.g. bruising to delay spoilage

5.2 PRE COOLING

- Remove field heat from harvested tomatoes as it preserves quality and extend the post-harvest life of tomatoes because it reduces the microbial activity, respiration rate, ripening and post-harvest decay
- Field heat should be quickly removed before it subjected to various post-harvest handling.
- Performed when harvesting tomatoes outside of the recommended harvesting periods
- Can be done by submerging tomatoes into cold water (hydro cooling) that has been combined with disinfectants such as sodium hypochlorite and thiabendazole or under tree shade, and on farm in small hut made of grass or straw
- Evaporative cooling system are applicable for tomato preservation in some tropical countries.



Precooling of tomatoes using cold water

5.3 STORAGE

Definition: It is holding fresh fruits under conditions that will prolong their post-harvest life.

It is keeping produce under controlled conditions such as temperature, relative humidity and gas composition.

The basic principles of vegetables storage are to reduce storage temperature, increase RH and CO₂ concentration and hence reduce respiration rate which leads to shelf life improvement. E.g., ripe-red tomato fruits at temperature of 8-10 oC at and 90-95% RH could be stored from 8-10 days.

- It is difficult to preserve tomatoes for an extended period at room temperature due to

its high moisture content.

- Physiological stages such as maturity, ripening and senescence are influenced storage life of tomatoes

To ensure long term storage of tomatoes

- Harvest at proper maturity stage
- Wash under running water to remove soil and soil borne decay-causing oorganisms
- Use disinfectant like sodium hypochlorite (mix 4 tablespoon of sodium hypochlorite to one gallon of water)
- Wash in 2% sodium bicarbonate (20 grams baking soda per liter of water) to reduce storage rot
- Use aclean clothes to dry the tomatoes before storage
- Keep the sanitation/hygiene of the storage environment
- Green mature tomatoes can be kept up to two weeks at 18-20oC and 90-95% relative humidity (RH).
- Fully ripe tomatoes have only 4 to 7 days' storage life, at 13-15oC and 90-95% RH.

5.4 PACKAGING (SORTING AND GRADING)

- **Sorting:** A preliminary sorting of produce should remove unmarketable pieces and foreign matter (plant debris, soil or stones) before the fruits passes on to further operations.
- Convenient packaging is essential to maintain the freshness and reduces the losses of tomatoes.
- All discarded material should be quickly hauled away from the packing house or placed in closeable bins for later removal.
- Poor packaging resulted 20 to 50% postharvest losses of tomatoes.
- Packaging materials that can be used to package tomatoes such as paper wrap, sacks, plastic packaging materials, polyethylene bags, wooden boxes, and fiber board cartons.
- To keep the quality of packed products before packaging:
 1. Clean the raw materials
 2. Select the right packaging materials
 3. Carefully check the hygiene of packaging materials

4. Use ventilated containers

- Producer and distributor could use packaging materials that have the following properties
 1. Readily available
 2. Easy to handle
 3. Protect fruits from physical damage and deterioration
 4. Cost effective
 5. Environmentally friend



Good packaging practice

Bad packaging practice

Tomato packaging practices

5.5 TRANSPORTATION

- Temperature management is critical during distant transport, so loads must be stacked to enable proper air circulation to carry away heat from the fruits itself as well as incoming heat from the atmosphere and of the road.
- Transport vehicles should be well insulated to maintain cool environments for pre-cooled commodities and well ventilated to allow air movement through the fruits.
- Traveling during the night and early morning can reduce the heat load on a vehicle that is transporting fruits.
- Avoid mixed loads during transportation.
- Do not mix high ethylene producer and less ethylene producer.
- Whatever the means of transportation, tomato fruits should be transported using plastic crates or wooden boxes.

Great problems during transportation:

- Inadequacy of infrastructure roads, bridges, means of transportation,
- lack of cold storage
- distance from market.
- lack of proper transportation facilities
- Means of transportation

- Humans labour, donkeys, cart, public transports (i.e. bus, minibus), truck, etc.



Good transportation practice



Bad transportation practice

Transportation practices

5.6 TOMATO PROCESSING

Primary processing

- washing, sorting, and grading

Secondary processing

- Peeling, cutting, grinding, extraction, boiling to convert tomatoes to the products which have textural, sensory and nutritional properties.
- Value added products made from tomatoes are juice, ketchup, puree, chutney, sauce, powder, paste and tomato soup.
- Processed products have a potential role to prolong shelf life, improves sensorial, functional properties, safety and nutritional values

Tomato sauce

- **Ingredients**
- 1000 g tomato pulp , 100 mL Oil, 10 g Chopped rosemary , 60 g Sugar, 10 g salt, 20g garlic, 10 g ginger, 5g of thyme leaves
- **Procedure**
- Sort the ripe tomatoes and wash using tap water
- Blanch it at 80°C for 15 to 20 min
- Take out it to bowl containing cold water and remove the skin /peel off tomatoes
- Crush it using a juicer or knife and remove seeds using sieve/muslin cloth
- Add each of oil, ginger, garlic, thyme leaves and mix well by using blender.
- Cook the mixture at 100°C for 4 to 5 min,

then add sugar and salt.

- Cook it 100°C for further 25 to 30 min with continuous stirring
- Cook the sauce further at a lower temperature to desirable thickness
- Fill tomato sauce into the bottles pasteurized at 100°C for 15 min and add Sodium benzoate (0.01%) as preservatives to the sauce
- Store in clean, cool, dry place until 1 month



Tomato sauce

Dehydrated Tomato slices

- **Ingredient**
- Red Tomatoes
- **Procedure**
- Sort tomatoes according to size, select firm tomatoes and wash under running water.
- Slice the tomatoes in halves and then cut into slices of similar thickness and remove the seeds.
- Dry in a dehydrator at 60 °C for 20 hours
- Pack the slices after size reduction to pieces
- Keep in clean, cool, dry place until 3 months
- Rehydrate in warm water (45 °C) for 30 minutes for cooking purposes
- **Tomato powder**
- Dry dehydrated tomato slices further to easy crack
- Ground into powder using grinder machine
- Keep in glass packaging materials barrier to moisture
- Used during food preparation



Tomato powder

ACTIVITIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Site selection		X						X				
Land preparation		X	X					X	X			
Seedling preparation			X						X			
Transplanting			X	X					X	X		
Irrigation		X	X	X	X			X	X	X	X	
Cultivation				X	X					X	X	
Fertilization			X	X	X				X	X	X	
Spray/disease and insect pest management			X	X	X				X	X	X	
Harvesting					X	X					X	X
Cooling					X	X					X	X
Cleaning, Sorting and grading					X	X					X	X
Packing					X	X					X	X
Transporting					X	X					X	X
Marketing					X	X					X	X

Table 11. Cropping calendar for areas with suitable agro-ecology for tomato production (East Shewa)



Key Message

Improper harvesting and post-harvest handling contributed to more than 45% of tomato postharvest loss



Post Assessment Questions

1. What are harvesting indices of tomatoes?
2. When and how to harvest tomatoes in your local area?
3. What is the best transporting instrument of tomato and why?

SECTION 6. 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 outcomes

At the end of this training section the trainees are expected:

- How to determine initial investment requirement to start the business
- How to estimate periodical production costs, operating expenses, and sales revenue of the business
- How to determine profitability and cash flow of the business
- How to calculate break-even point (minimum level of production) to recover total cost and generate profit.
- To calculate payback period (time requirement to recover initial investment and
- How to make decision to accept or reject the investment alternative

Time required: 4Hrs



Learning Questions

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

6.1 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

Template to estimate initial investment requirement for agri-business

6.1.1 LONG-TERM INVESTMENT

- Long-term investment in agri-business involves all asset requirement 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

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

6.1.2 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				

Template for estimating production cost per hectare for onion seed 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 COSTS



6.2 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

- 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	B	C	D	E	F
Types of product	Land size (ha)	Estimated production/ha	Total production (b X c)	Estimated selling price/unit	Total sales revenue (f X g)

Template for estimating volume of production and sale revenue

6.3 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 -1

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 16: Template for profit and loss statement preparation



6.4 BALANCE SHEET

- Balance sheet used to know the total resource owned, amount of claim by creditors and amount of owners' equity
- Balance sheet contains asset, 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 bank, microfinances, individuals or others
- Own equity/capital involves own/member contribution, grant/donation, etc

Formula - 4

Total Asset = Total liability + Total own

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		

Template for balance sheet preparation

6.5 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

DESCRIPTION	AMOUNT OF OUTFLOW	AMOUNT OF INFLOW
Owners' investment		
Debt		
Grant		
Sales revenue		
Wate house construction cost		

Purchase of equipment		
Purchase of input		
Land rent		
Irrigation cost		
Labor cost		
Cash Operating costs		
Ending cash balance		
TOTAL		

6.6 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, level of production and sale should exceed/greater than breakeven point.
- Fixed cost 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

6.7 PAYBACK PERIOD

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

Formula - 7

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

Pay back period = # of year before coverage + uncovered amount/profit of the next year



Payback Period

The amount of time it takes to recover the cost of an investment.



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.



Post Assessment Questions

- Which of the following is part of working capital
 - Purchase of fertilizer,
 - Purchase of tractor,
 - Transportation cost,
 - Purchase of chemical
- Which of the following should include in profit/loss statement
 - Purchase of tools and equipment
 - Sales revenue
 - Debt
 - Owner investment
- Which of the following is variable cost
 - Purchase of seed
 - administrative salary
 - Depreciation
 - Rent of storage

SECTION 7. POTENTIAL RISKS AND MITIGATION MEASURES

POTENTIAL RISKS	MITIGATION MEASURES
Limited demand driven input/early generation seed supply	Create strong, sustainable, and diversified linkage with suppliers through contractual based early generation seed production
Climate change	Use climate adoptive crop varieties, use irrigation scheme, use climate prediction information and trends 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 source of finances 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	

