Ethiopian ATI
Agricultural Transformation Institute
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POTATO SEED TUBER PRODUCTION BUSINESS

TRAINING COURSE FOR YOUTH AGRI-ENTREPRENEURS

Ethiopian Agricultural Transformation Institute

ADDIS ABABA, ETHIOPIA
2025

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OVERVIEW OF THE MODULE

Training is a learning process that involves imparting knowledge, sharpening of skills, concepts, change in attitude, behavior and functional capacity of an individual and institution towards the achievement of a predetermined goal. This training module is designed to equip youth and women groups, farmers and any groups interested to acquire knowledge and skill on potato seed tuber production. There are huge employment and business opportunities in investing and engaging individuals in potato seed tuber production. This skill and knowledge enable the youth groups, farmers and others involved in potato seed tuber production to apply the techniques and technologies that can help them produce quality seed tubers of desired variety and increase tuber yield and incomes by planting quality seed tubers of improved potato varieties.

The module consists of eight sections: ecological requirement of potato seed tuber production, variety selection, appropriate site and land selection, agronomic practices for potato seed tuber production, potato crop protection, harvesting and post-harvest handling of potato seed tuber, quality assurance, marketing and distribution and financial feasibility and risk management of seed tuber 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

Potato (Solanum tuberosum L.) is the 4th and 3rd in terms of production and consumption, respectively. It is one of the most important food crops that is highly resource efficient and productive crop per unit area and time, and with versatile utility. More than 20 million hectares of land is put under potatoes production worldwide. Total production exceeds 350 million metric tons in 2020 (FAO, 2021).

In Ethiopia it is the first among root and tuber crops in area coverage and production (CSA, 2021). Around 5 million HHs grow potatoes on about 0.3 million ha and harvest more than 4 million tons (CSA, 2020/21). Almost it is grown year-round (Meher, Belg, Irrigation and Residual moisture) with remarkable . Potato could make a significant contribution to poverty reduction and food and nutritional security for the highland farming communities of Ethiopia. However, its estimated average yield is very low (14.48 t/ha) compared to its potential (25- 40 t/ha) under recommended agronomic practices.

Among several factors that contributed to low yield indicated, limited access to quality seed tubers of high yielding improved varieties worth mention. This limited access to quality seed of improved varieties is due to limited number of seed multiplying and disseminating institutions or business enterprises. Even under such conditions, many farmers still prefer to grow potatoes because of its profitability compared to other crops grown in the same area. This shows the existing clear gap in one hand and potential huge employment and business opportunities for youth and women groups, farmers and any groups interested to engage in potato seed tuber production as business.

Target groups: Target group of this module is youth and women groups, farmers and other groups who have an interest in potato tuber production.

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

Training materials: Flip chart, LCD, markers, white board

Training duration: 20 hours

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SECTION 1. APPROPRIATE VARIETY & SITE SELECTION FOR SEED POTATO PRODUCTION

Overview of the section

Variety is one of the factors that determine the productivity and production of potatoes. So far more than 45 potato varieties have been registered for production in Ethiopia. Seed producers who want to be profitable should choose potato varieties that meet market preferences as varieties that are not demanded by the market will lead them to bankruptcy or failure of the business.

Use of registered and certified varieties has more advantages to boost the productivity of the crop. The quality and productivity of potato seed tuber production depends on the ecological suitability of the production areas. Quality seed potato tuber production is a function of the health status of the initial or starting planting material and the appropriateness of production site such as its altitude, temperature, rainfall, and soil condition. Moreover, access ability to infrastructures and market matters most as potato is bulky, perishable, and costly to transport long distance. Therefore, this section of the module describes the variety and appropriate site selection from ecological and other requirement of potato seed tuber production to maximize the productivity and quality of the produce.

Learning outcome

At the end of this section participants of this training should know:-

1. Understand the type of variety to select for their seed tuber production business.
2. Understand about appropriate site of potato seed tuber production and agro ecological requirements

Duration: 2 hours

Learning question

1. Which types of potato varieties are commonly grown and demanded in your areas?
2. Do you think potato seed tuber production is profitable as business for youth groups?
3. Which ecological requirement is very determinant for seed potato tuber production in Ethiopia?

1.1 VARIETY SELECTION

- Select the variety based on their recommendation area, market demand and accessibility.
- The quality of potato seed tuber is determined by the source of its initial supplier. The initial planting material should be free from the allowable level of mixture of other varieties and true to type to the variety we want to grow.
- Hence, seed potato must originate from healthy parent stock and be free from disease, particularly bacterial wilt and viruses.
- Initial seed should be purchased from known/ reliable certified seed tuber producers since they are disease-free and give the best yields
- Its foundation seeds should be from confirmed institutions/sources
- Seed purchased should be checked for availability of an authentic certificate of authenticity and ensure it contain the information given on the label, such as:
    - Crop species
    - Variety name
    - Seed class
    - Seed size grade in mm
    - Grower number
    - Lot number
    - Year of production
    - Date of certification
    - Country of production
    - Packaging unit

- Use of quality seed tubers of improved variety is a critical production input to increase productivity and production to meet growing demand if complemented with other inputs.
- Description of some of varieties which are commonly produced in Ethiopia

Belete"

- Has the white flower
- Optimal production altitude : 1600-2800 masl
- Maturity period 3-4 months
- Yield: 47 t/ha
- Tolerant to Late Blight of Potato
- Released in 2009

"Gudane"

- White flower
- Optimal production altitude: 1600-2800 masl
- Maturity period: 3-4 months
- Yield: 25-30 t/ha
- Tolerant to Late Blight
- Released in 2006

NO	VARIETY	YEAR OF RELEASE	SUITABLE ALTITUDE	YIELD (T/HA)		RECOMMENDATION AREA
				Research	On-farm	
1	Birhan(CIP-312921.576)	2023	2700-3200	55.00		D.Berhan
2	Dagnawu(CIP-352929.532)	2023	2700-3200	50.00		D.Berhan
3	Worku (AD501645.9)	2022	1800-3000	42.50		Mid to central highland
4	Burka (CIP-391058.175)	2020	1800-3000	30.7		Central highlands
5	Horro (CIP-384321.30)	2015	2000-2800	35-40	27-30	Western Ethiopia
6	Dagim (CIP-396004.337)	2013	1600-2800	33.8- 47.2	24.4- 46	Wide adaptable
7	Bubu (CIP-384321.30)	2011	1650-2330	19.5		East & West Harergie
8	Belete (CIP-393371.58)	2009	1600-2800	47.2	28-33.8	Wide adaptable
9	Hundee (CIP-90147.8)	2006	2400-3350	21-51	28-54	South East Ethiopia
10	Ararssa (CIP-90138.12)	2006	2400-3350	20-42	37-50	South East Ethiopia
11	Gudanie (CIP-386423.13)	2006	1600-2800	29.2	21.0	Wide adaptable
12	Gabbisa (CIP-387096.11)	2005	1700-2000	40.0	31.0	East & West Harergie
13	Shonkolla (KP-90134.5)	2005	1700-2700	31.5	29.1	South Ethiopia
14	Bulle (CIP-387224.25)	2005	1700-2700	39.3	38.3	South Ethiopia
15	Chala (CIP-387412.2)	2005	1700-2000	42.0	35	East & West Harergie
16	Gera (KP-90134.2)	2003	2200-3200	25.9	20.6	North Ethiopia

Table 1. Major released potato varieties and their suitable agro-ecologies in Ethiopia

1.2 APPROPRIATE SITE SELECTION

- Ethiopia has possibly the highest potential for potato production of any country in Africa.
- It has suitable climatic and edaphic conditions to produce high-yield and quality potatoes seed tubers
- The highland area of the country is blessed with cool temperatures and high rainfall, which creates fertile ground to produce disease-free seed potatoes.
- About 70% of the arable land is reported to be suitable for potato production, which is about 3 million hectares of land. However, it only used 0.3 million of it currently.
- However, all the potato growing areas are not suitable for potato seed tuber production.
- **Altitude:** Potatoes are cultivated between 1,800 – 3000 m.a.s.l.
- However, elevations >2500 m.a.s.l that are cool and windy areas away from ware potato are ideal for seed potato production
- **Rainfall:** Well distributed rainfall of between 500 – 850 mm is required during the growing period

Temperature

- Potatoes perform well in cool climatic conditions and the optimum temperature range is 15 – 20oC.
- Temperatures higher than 29, at time of new tubers formation, prevent tubers formation resulting in poor yields.
- The temperature for tuberization is 15oC.

Soil

- Friable, loose and freely draining loams soil containing organic matter are preferred since heavy clays restrict tuber growth.
- The selected site soil should be free from bacterial wilt and not planted by potato families for >4 yeras

Heavy soil can prevent

- Shoots emerging,
- Roots and tubers are growing,
- Cause tubers to be small and deformed.
- The optimal soil pH range is 6.0 – 7.5.

Site Selection

- Potatoes do better on neutral to slightly acidic soils
- Potato crops should be cultivated in open fields, not under the shade.
- The soil should be free from bacterial wilt and nematodes.
- High soil pH causes common scabs.
- The surface topography should be gently sloping to allow proper drainage
- Excessive use of pesticides and fungicides is harmful.

Criteria for Site Selection:

- The site should be in a sunny area with fertile soil as potato requires at least 6-8 hours of direct sunlight for optimal growth,
- The selected plot should be free from aphids and other insect or preferred if windy areas
- The distance between the plots of potato seed tuber farming and other solanum crop farming should be at least 50 meters
- Seed production site should also be distant from table/ware potato fields as well their placement should also be always at the upper position to protect from disease transmission through run-off during the rainy season
- Identification of sites up in the higher elevation, away from ware potato production and free from any sunlight shades
- The site should be free from any Solanaveous families for at least the previous four years to guarantee the seed produced from soil borne diseases like bacterial wilt

Key message

Appropriate variety and site with suitable elevation, temperature, edaphic and moisture condition determine the quality of potato seed tuber production

Post assessment question

- Which potato variety is more popular in your area for production
- What are the best sites for potato seed tuber production?
- Describe nutrient requirement for potato seed tuber production

SECTION 2. TOOLS & CROP MANAGEMENT PRACTICES FOR SEED POTATO PRODUCTION

Overview of the section

Crop management is one of the factors that affect potato seed tuber production and productivity. Application of proper agronomic practices result in higher seed tuber yield of potato crop as potato is sensitive to slight change in growing conditions and managements. This section deals with the overall crop management practices of potato from input preparation to field management such as tools & equipment, site selection and land preparation,planting, fertilizer application, irrigation, and earthing up.

Learning outcome

At the end of this section participants of this training should know:-

1. Understand potato seed production methods
2. Identify and know seed renewal time & why?
3. Observe and understand criteria for site selection for potato seed tuber production
4. Describe how land preparation affects potato seed tuber production
5. Observes and describe the best practices for potato seed tuber production

Duration: 4 hours

Learning question

1. What is the best potato seed tuber production method in your area?
2. Which agricultural tools are commonly used in potato seed tuber production in your area?

2.1 TOOLS REQUIRED FOR SEED POTATO PRODUCTION

- Different farm tools are required for potato seed tuber production in the country
- They are different in kind and some of them are summarized as follows

Digging hoe

Watering can

Rope

Spade

Spade

Wheelbarrow

Rake

Trowel

Sprayer

Rake

Plastic crate

Water pump

2.2 EFFECTS OF RECYCLED SEED AND SEED CLASSES AND METHOD OF POTATO SEED TUBER PRODUCTION

The major constraints and bottlenecks hampering the production and productivity of potato seed tuber are:

- Use of low-quality seed, recycled over many generations
- Limited quality tuber supply and high cost

The use of potatoes from the previous harvest as seed potatoes

- Incurs in an accumulation of seed borne diseases
- Degeneration of the seed potatoes
- Resulting in lower yields and quality

The methods seed tuber production in Ethiopia basically are two:

- Conventional vegetative methods
- The uncommon but recently advocated true potato see method

So, conventional seed tuber production under field conditions is preferable.

2.3 PREPARATION OF SEED TUBER FOR PLANTING

2.3.1 DORMANCY PERIOD

- There is a dormancy period in potato tuber. The newly harvested seed tuber will not sprout immediately after harvest
- The dormancy period of the potato varieties varies between 60 and 90 days.
- We must keep a newly harvested potato seed tuber until it breaks its dormancy before planting

2.3.2 SEED TUBER SELECTION

Features of Quality Seed Tuber

- Free from seed born disease and pests
- Seed tuber must not be mixed with other varieties
- High sprouting vigor
- A seed tuber weight should be 40-60 gm.
- Visually the seed tuber should be healthy.

Uniform quality potato seed tuber of different varieties

- The use of good quality seed increased yield on average from 15 to 25 percent.
- Potato seed have two quality indicators
- Biological attributes ; very crucial for productivity
- Appearance attributes/commercial quality; it affects seed price

Disease infected tuber

Physiologically aged tuber

Therefore, quality of potato seed tuber is defined by uniformity and size of tubers as well as external appearance

Tuber size (weight)

- Select medium sized single potatoes for seeds (40 to 60 g)
- To avoid spread of disease, use single potato tuber as seed
- Non-uniform and big size seed will increase cost, and too small seed can rot before emergence

Uniform seed tuber

non-uniform sized seed tuber

Number of sprouts

- To harvest more select medium sized tuber having more than 3 sprouts.
- Short and strong multiple sprouts are important for a high yield .Seed tubers with short, firm sprouts can be also transported to the field with a low sprout injury
- Long sprouts will deplete the seed tuber, which would also shrivel
- Development of the sprouts is primarily affected by the light intensity.
- If the tubers are well exposed to diffuse light, the sprouts will be slow in growth, colored and sturdy.
- If the seed tubers held in the dark the sprouts will develop pale and long sprouts, and are easily broken off

Firm multiple sprouted seed

Potato seed with single long and weak sprout

- Treatment of seed tuber before planting
- Dipped in solution of 2-3 gm fungicides in one liter of water before sun-light treatment
- Sun- light treatment for potato seed tuber

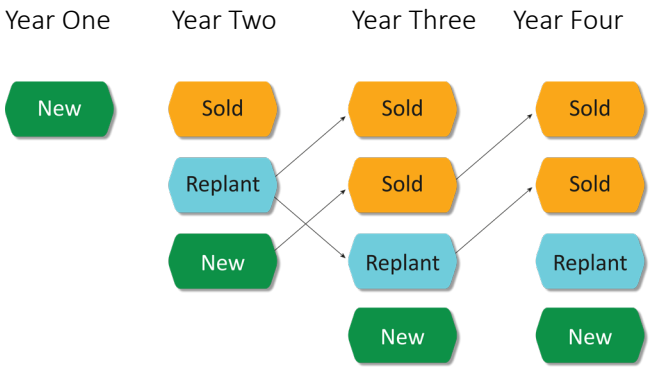
1. It is the process of exposing the seed tubers to sunlight for 20-30 days under temperature 10- 20ºC before planting.
2. It is important for getting healthy, strong and uniform 3-6 sprouts per potato
3. Grow fast, strong and easily which is good for seed production

- The seed tuber with young/strong sprouts, healthy and green emerged from every eye is better for plantation.

Well, sprouted & uniform tuber ready for planting

2.3.3 RENEWAL OF SEED STOCK

- Continuous use of the same seed stocks year after year without periodic renewal facilitates the build-up infestation seed-borne diseases, particularly viruses.
- Virus infestation considerably reduces the yield potential due to degeneration of tuber
- Renewal of the seed potatoes after every two years is vital to sustain the productivity of the selected variety
- Do not recycle seeds beyond the recommended number of times
- The healthier the seed the longer the interval for seed renewal.



Seed replacement through partial renewal of seed stock every season

2.4 LAND PREPARATION

- To ensure uniform emergence, maturity and produce quality potato seed tuber deep and loose seedbed with minimum of clods should be prepared
- Improving soil conditions reduce weed, pest and disease problems
- Prevent soil erosion
- Increase aeration and free drainage
- To loosen and reduce the soil resistance to root penetration and tuber development land should be prepared well

Well prepared land

Poorly prepared land

Ploughing

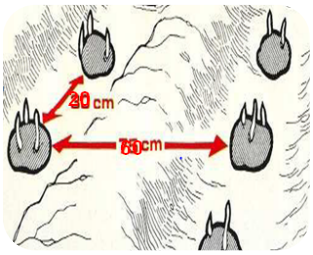
- Plough the land at 25cm depth at least 4 weeks before planting
- If the land is virgin, plough 3-4 time at a week interval
- If the land is cultivated, ploughing 2-3 time is sufficient
- Harrowing is done just before preparing of furrows or ridges
- Levelling is required to allow equal surface water distribution to achieve flat site

Land levelling

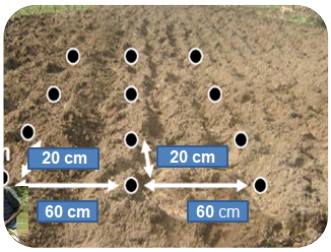
Land ridging for potato planting

2.5 PLANTING

- Potato tuber should be planted at spacing of 60-70 cm between rows and 20-30 cm between tubers within the row depending on seed tuber size
- Seed tubers should be planted 10 to 15 cm deep
- Planting time should coincide with the start of the rainy season (potato tuber should be planted at the onset of rainfall or 2-3 days after irrigation)
- Potato seed tuber commonly planted from late May to third week of June
- Use 2 t/ha of medium sized and well sprouted seed tubers
- Use healthy disease free and true to type seed sourced from certified seed producer.



Spacing of Seed potato



Spacing of seed potato tubers

- Sprouted tuber should be placed in the furrows or in ridges or on flat beds facing upward

Planting potato using oxen ploughing

Planting potato using planter

2.6 FERTILIZER APPLICATION AND RATE

- The amount and type of fertilizer applied should be based on soil tests and site specific. However, generally the following fertilizer is used for potato seed tuber production
- Use 236 kg ha-1 NPS
- Use 140 kg ha-1 Urea
- Mix it properly with the soil and side dressed to avoid contact with seed tubers.
- Apply half of the nitrogen at planting and the second half at 45 days after planting.
- Apply the whole phosphorous during planting time.
- Apply well decomposed 5-10 t manure after plowing before harrowing

Fertilizer type	Kind of Fertilizers	Rate per ha	Time of application	Application method
inorganic	NPS	236 kg	At transplanting	Side dressing and incorporate with soil before transplanting
	Urea	140 kg	Half at planting and half 45 days after planting	Side dressing
Organic	Compost	10-12 ton	Before transplanting	Broadcasting and incorporate with soil two weeks before planting
	Vermi-compost	5-10 ton	Before transplanting	Broadcasting and incorporate with soil at planting
	Farm Yard Manure (FYM)	20-30 ton	Before transplanting	Broadcasting and incorporate with soil one month before plating

Table 2. Type and rate of blanket recommended rate of fertilizer

Mixing of NPS & UREA at planting

Side derssing of fertilizer for potato

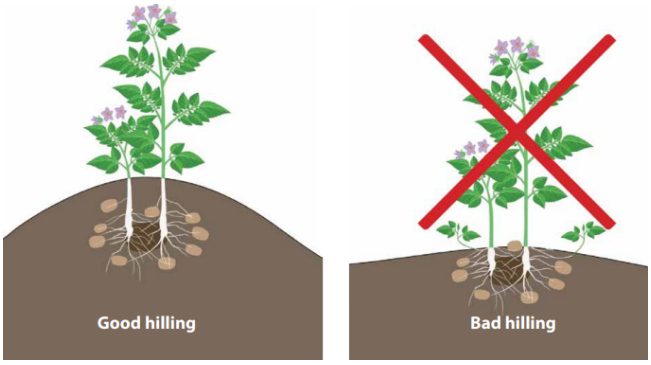
Manure ready for use

Manure spreading on potato field

2.7 EARTHING UP (RIDGING/ HILLING)

- Earthing up is the raising of loose soil from the inter row space when soil is not too wet
- Hilling or earthing up should be done 2-3 times
- The first earthing up is usually done when the potato reaches 10-15cm high with first weed
- The second hilling is 2-3 weeks after the first earthing up
- The second earthing up will help to:

1. Keeps the tubers cool and reduces the chances of brown spots associated with high temperature.
2. Provide more stolons and tubers to grow.
3. Prevent greening of exposed tubers by sunlight.
4. Prevent water logging in case of heavy rain.
5. Reduce chances of infection with diseases that washed from the foliage.



Potato Earthing up

Potato Earthing up by hand

Potato Earthing up by machine

2.8 IRRIGATION

- The most critical water requirements stages in potato seed tuber production are at the following stages: emergence, tuber setting and bulking stages.
- There are different types of irrigation: Drip, sprinkler, furrow etc
- Drip irrigation is more effective, but very expensive
- Sprinkler irrigation may not cover all parts of the field adequately
- Furrow irrigation is the least efficient method,
- Depending on the crop growth period, the right time to irrigate should be done either early in the

morning or late afternoon.

- At planting light irrigation to moisten the soil will help for good germination.
- During tuber initiation stage adequate soil water is very important.
- During tuber maturation stage the water requirements decline and should be stopped two weeks before dehaulming.
- However, production of seed potato tuber under irrigation needs critical care . It needs frost free as well as time before high temperature months. It is very challenging from disease transmission point of view too through irrigation water and soil transport if at all a slightest suspicion on presence of bacterial wilt problems. Water quality is also from a sanitary perspective needs due consideration if this system is employed

Well irrigated potato field

Poorly irrigated potato field

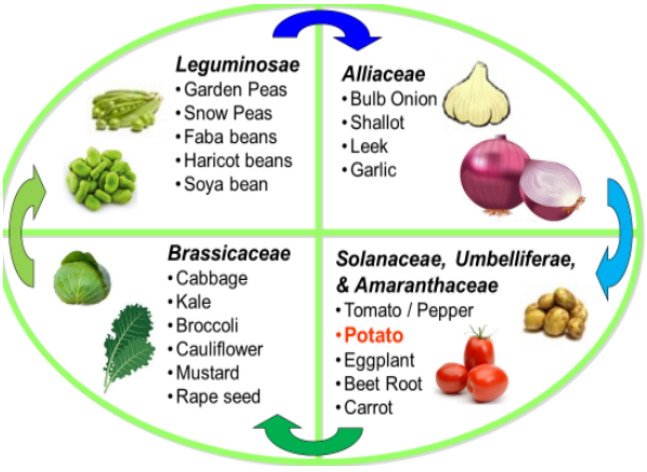
2.9 FIELD INSPECTION

- Field inspection will help to monitor the occurrence of disease and by taking control measures so timely that high quality seed tuber could be produced by controlling disease, weed and insect pests
- It is also good to make scouting and roughing out (removal of off types and diseased plants from the seed crop, not bacterial wilt except mixture or off-types and virus infected plants.
- It is also important for informing regulatory body for certification

2.10 CROP ROTATION

- Potatoes produced continually in the same fields year after year can cause buildup of diseases, insect pest and weed from volunteer tuber
- Crop rotation includes field hygiene and removing volunteers in the following crop.
- Used to diversify food and fodder supply and reduce risks of single crop failures.
- Ensure quality potato seed tuber production

- One of the most important strategies of IPM is crop rotation.
- Crop rotation prevents pest and disease build-up, and it replenishes soil health and fertility status.
- DO NOT plant after growing tomato, green pepper or eggplant since they are the same family with potato.
- Crop rotation is recommended with those from different families; an effective rotation program should last for 3 – 4 years.
- Seed multipliers must ensure that they have enough land



Potato rotation plan with other crops

Key message

Selection of appropriate site, appropriate land preparation, crop management, and rotation is very critical to maximize potato seed tuber production

Post assessment question

1. Why are quality seed potatoes needed in potato seed production?
2. What is the relevance of seed renewal in

potato seed tuber production?
3. What is the ideal size of seed potato tubers?
4. Why do we need to undertake crop rotation?

SECTION 3. POTATO CROP PROTECTION

Overview of the section

Overview of the module: The most important biotic factors that challenge potato seed tuber production are disease, insect pests and weed species. Production and productivity are highly governed by the infestation level of the crop particularly by these pests. Hence, this section addresses the major potato diseases, insect pests, and weed species, their symptoms as well as possible management options.

Learning outcome

At the end of this section participants of this training should know:-

1. Describe how potato pests affect potato tuber seed production
2. Identify and know major diseases and insects affecting potato tuber seed production
3. Observes and describe the best practices practiced to management potato diseases and insects within their locality
4. Identify and understand potato diseases and insect pest diagnosis methods
5. Know and advise methods of diseases and insects management practices

Duration: 3 hours

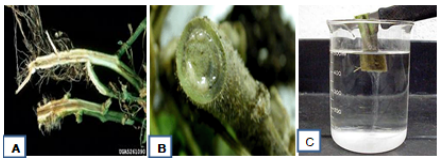
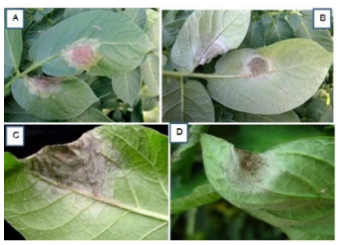
Learning question

What do you know about the effects of biotic and abiotic stress on potato seed tuber production?

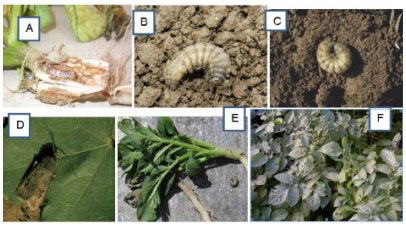
3.1 MAJOR POTATO DISEASE AND THEIR MANAGEMENT TECHNIQUES

There are several types of diseases that affect potato tuber production in Ethiopia

The most common disease of potato, their symptoms and management are summarized as follows (Table 3)

DISEASE	SYMPTOMS	MANAGEMENT PRACTICES
Potato bacterial wilt (BW) disease • Caused by Ralstonia solanacearum. • an economically serious problem • Has no well-defined mechanism of management. • Its management involves use of various practices as there is single curative solution to it • If a field is infected, the disease can remain in it for 5 or 6 years	**Leaves** • Wilting- like water stressed • Yellowing of leaves • Stunted plants • Green wilting and rapid collapse of plants happens  **Stem** • browning Inside the stem vascular • Bacterial slime oozing from the cut • Bacterial slime oozing from infected stem suspended in clear water in glass seems like a tread  **Tuber** • Brownish-grey near the point of attachment of the stolon • Bacterial ooze discharge through the eyes • soil may be stuck to the bacterial ooze • cut tubers, pockets of white to brown pus or browning of the vascular tissue which, if left standing, may discharge dirty white globules of bacteria 	• Use healthy seed tubers (certified seed from reliable sources). • Rotate crops with non-solanaceous families more than 4 years. • Clean farm implements • Inspect crops regularly and remove and destroy diseased plants, tubers • Plant in areas where bacterial wilt hasn't occurred previously. • Don't allow irrigation water to run freely over or below the soil surface • Removal volunteer plants • Awareness creation about the disease
Potato Late blight • Caused by Phytophthora infestans. • can result into crop failures in a short period	**Leaves** • Small water-soaked spots and lesions at the tips, margins or any other parts of the leaf which enlarge to form irregular dark brown lesions surrounded by a light green halo • During morning hours, a whitish mycelia growth of the pathogen is visible on the under surface of the leaves surrounding the lesion 	• Plant tolerant varieties • Use healthy seeds and planting materials, • crop and field sanitation and adjustment of crop planting dates. • Removal volunteer potato plants. • Earthing-up to protect tuber infection • Fungicide control: • Mancozeb, Ridomil, Matco • Ridomil Gold 2-3 kg/ha is the most frequently used and effective fungicide. • Spray the fungicide when the infection starts and repeated after 10 to 14 days interval depending

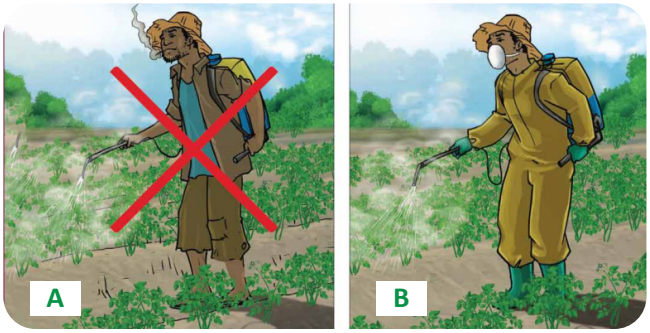
DISEASE	SYMPTOMS	MANAGEMENT PRACTICES
Potato bacterial wilt (BW) disease • Caused by Ralstonia solanacearum. • an economically serious problem • Has no well-defined mechanism of management. • Its management involves use of various practices as there is single curative solution to it • If a field is infected, the disease can remain in it for 5 or 6 years	**Stem** • The lesions appear on the stem near the growing point when the inoculum of the fungus comes from the infected plants. • The infection can also start at nodes and extend both up and down the stem and the plant topples down under congenial weather conditions. • The infected portions of the stem bear white fungal growth especially visible in early  **Tubers** • Infected tubers show irregular, shallow or sunken reddish-brown patches. • The lesions are dried and no smell 	 
Potato tuber moth • Is both field and storage pest. • Larva tunnels into foliage stem and tubers which lead to loss of leaf tissue, death of growing points and weakening or breaking of stems. • In tubers, irregular shaped galleries are seen with excrements near tuber eyes.	• Larva tunnels into foliage, stem and tubers • Galleries are formed near tuber eyes 	• Select healthy tubers • Avoid shallow planting of tubers. • Plant the tubers to a depth at 10- 15 cm deep • Collect and destroy infested tubers • Do not leave the harvested tubers in the field overnight • Adopt intercropping with chilies, onion or peas • Do earthing up • Cover the upper surface of potato tubers with the branches of Lantana and Eupatorium or Eucalyptus to repel the ovipositing moth. • Insecticide Spray (apply Aim 10% EC, Dimeto 40% EC, Karate 5% EC at the rate of factory recommendation). But in the DLS use 1 kg of insecticide for 1 ton (10 quintal) of tuber seeds.

DISEASE	SYMPTOMS	MANAGEMENT PRACTICES
Aphids • Feeding the crop • Transmit different viral diseases	• Adult aphids are prominent on the leaves and stems 	• Planting only certified seed • Avoid planting of cabbage and grass pea near to potato field • Rogueing of infested plants • Use Garlic and motor oil mixtures (100 gm garlic powder, half lite water, 10 gm of powder soap, 2 spoon of motor oil). Mix garlic powder and motor oil and stay for 24 hours. Then mix with water and soap. • After this dilute the mixture 1:20 ratio and spray it to the field (example 1 liters of mixture will be diluted with 20 liters of water). • Application of insecticide (Dimeto 40% EC, Actellic 50% EC, Agro-Thoate 40% EC, Closer 240 SC, Hunter 40 EC etc.. at the rate of factory recommendation) • Use fermented cow urine • Use Tobacco
Cutworms • Are polyphagous insects active at night. • Hibernation can occur either in the larval stage or as a chrysalis; egg laying can be abundant when the weather is favorable.	• Young larvae feed on the epidermis of the leaves. • Older larvae come out at night and feed young plants by cutting their stems. • They also damage the tubers by eating away part of them. 	• Deep plowing to expose the pupae to natural enemies and sun light • Remove alternate hosts • Kill the larva by digging the soil • Use wheat bran and molasses traps by mixing with chemicals to poison the larvae (mix 25 kg trap with 1 kg of Sevin 85% WP and small water to wet the mixture and spread it to the field uniformly so that the larvae can eat and poison them) • Apply insecticides (Diazinon 60% EC, Dursban 48% EC, Carbaryl (Sevin 85% WP etc at the rate of factory recommendation and apply starting at dusk to night to kill the larva)

Safety Caution during chemical sprays

- The person applying chemicals (the operator) must wear a mask, long-sleeved clothes, and solid shoes when spraying.
- Avoid putting trousers inside your high boots because this can create a flow of the chemical to your feet and the chemical may accumulate inside the boots.
- Read the first-aid instructions and always handle the chemical cautiously in a well-ventilated or open space.
- When mixing liquids, eye and hand protection are also required. A dust mask is required when mixing powder formulations. Wash gloves before removal to avoid potential contamination.
- Wash your hands after every contact with chemicals.
- Avoid touching the eyes. In case anything gets into the eye, rinse well for 5 minutes with running water and then get medical help. If you feel sick after applying or handling agrochemicals, contact your doctor immediately.
- Do not eat or smoke when handling chemicals.
- Do not mix chemicals before consulting the label and the chemical's database instructions.
- Use the recommended dose and avoid unnecessary use.
- Protect the natural enemies of the crop pests and other fauna.
- When to apply the pesticides and safety cautions
- Spraying should be done in the early morning or in the (late) afternoon.
- Spray should be undertaken following the first symptom is seen and timely where weather prediction unavailable

- Do not spray in strong sunlight hours as the spraying may scorch the plants (especially oil-based materials).
- Do not spray when rain is expected or soon after the rain, as the moisture on the plants may wash off the chemicals.
- Avoid spraying in days with strong winds and always spray in the wind direction
- (never against it).
- Prefer pesticides that are bee friendly.
- In any case, it is best to spray when the bees are not active (late in the afternoon), if possible, not during flowering, and always after informing neighbour beekeepers.
- Always respect the minimum days from the chemical application until the harvest of the product. Read the product label.



Safety during pesticide spraying; A) wrong safety; B) Somewhat right safety

3.3 WEED MANAGEMENT IN POTATO PRODUCTION

- Weeds compete directly with potato plant for light, water and nutrients.
- They restrict the growth of the potato and result in smaller and poor-quality tubers.
- Weeds also restrict air flow through the crops, which increases the potential for disease development.
- Weeds may also serve as alternate hosts for diseases and pests.
- Weeds also harbour pests and diseases
- 43% reduction observed in total potato yield compared to a weed-free control
- After emergence of the first potato shoots, it is important that the first weeding to be done
- Weed control is important from planting to the time of harvesting.
- The first step in weed control is repeated ploughing which helps to destroy weeds and prepare fine seedbed for plant growth

Weed infested potato field

Weed free potato field

Key message

Managing potato disease, insect pest and weeds reduces both field and post-harvest losses.

Post assessment questions

1. What is the difference between insect pests and pathogen pests?
2. What are the common field symptoms of potato bacterial wilt?
3. What are the spreading mechanisms of bacterial wilt?
4. What do we mean by healthy tuber seed?
5. What protection measures should one has to follow during chemicals spry?

SECTION 4. POTATO SEED TUBER HARVESTING AND POST-HARVEST MANAGEMENTS

Overview of the section

Improper harvesting and post-harvest handling of potato contributed to post harvest losses. In Ethiopia, post-harvest loss of horticultural crops on average ranged between 30-50% which is caused by temperature, moisture, pests of stored products, spoilage during handling and transportation.

The purpose of this section is to train youth and small business groups on proper harvesting and post-harvest handling practices of potato seed tuber. Hence, this section addresses proper methods of harvesting, postharvest handling, and storage the crop.

Learning outcome

At the end of this section participants of this training should know:-

1. Identify the importance of dehaulming for potato seed production
2. Identify the maturity indices of seed potato and determine their harvesting time
3. Identify the different harvesting techniques of seed potato
4. Identify how to sort, grade and pack seed potato tuber
5. How to handle harvested seed tubers properly?
6. How and where to store seed potato

Duration: 3 hours

Learning question

What do you know about potato seed tuber harvesting, transportation and storage methods?

4.1 DEHAULMING

Dehaulming is the removal or destruction of the haulm to allow the skin to harden and reduce the damage to the tubers during harvesting and transportation

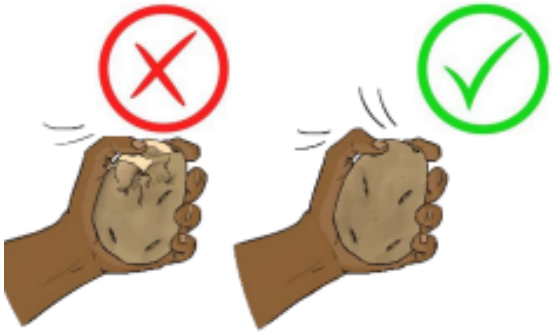
- It also improves the storability of potato tubers and prevents diseases from spreading
- It is usually done 2 weeks before harvesting, when the leaves turn yellow
- This can be done manually by cutting the foliage close to the ground.
- Dehaulming in seed tuber production is done to:
- Stop bulking and obtain a desirable tuber size.
- Reduce the risk of late season virus transmission by aphids
- To prevent diseases spreading
- Promote skin set and prevent bruising to improve storability.
- Pulling off stem and roots

Manual dehaulming

Haulm killing by chemical

4.2 HARVESTING AND CURING

- Potatoes tubers are highly perishable due to their high moisture content.
- To harden and dry more quickly it is best to harvest in clear and sunny weather
- Determine tuber maturing and skin set using Thumb Test pressure.
- Harvest when the soil is dry and relatively cool with cloud overcasts
- Avoid harvesting when the soils are wet.
- Potatoes harvested under wet soil conditions must be dried before storage



"Thumb Test" to check the skin set

- Potatoes can be harvested directly
- By hand but it takes longer time and labor intensive
- By mechanized harvesting, but it is expensive and cost effective
- Using oxen plough
- It is done 10-15 days after haulm cutting
- After harvesting, collect and destroy any leftover tubers

- Do not expose harvested tubers to sunlight for a long time
- Avoid greening of the white skin varieties
- Shield harvested tubers from rain to avoid the risk of rotting.
- Use of crates are better to avoid tuber bruising and for easy transporting

Manual dehaulming

Haulm killing by chemical

Harvesting potato seed with harvester machine

4.3 SORTING/GRADING

- Separate damaged and undamaged tubers
- Categorize them according to size or weight after harvesting
- Remove rotten, diseased, infected and cut tubers

Potato seed sorting/grading based on size

4.4 SEED TUBER TREATMENT

- Use Mancozeb at the rate of 4 g/l of water to control seed borne fungi
- Immerse the seeds tubers properly in the fungicide.
- The seed tubers treated should be dry under the shade.
- For proper seed tubers storage dip in Diazinon.
- Excellent store hygiene is an absolute prerequisite for healthy stocks.
- Keep the seed tuber dry: ventilate and avoid condensation.
- Keep a close eye on storage temperature.

Seed tuber treatment using chemicals

Dipping Seed tuber in Diaznion

4.5 POTATO SEED TUBER STORAGE

- Potato seed tubers are best stored at 2-4°C and 90-95% RH in cold stores on a commercial scale

Smallholder growers can store their potato seeds on:

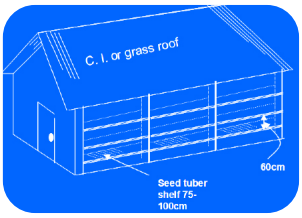
- The floor, granary
- Left on farm (unharvested) until next planting season
- Diffused light store (DLS),

DLS is low cost and sprouts rate is controlled

- It gives short and strong tuber sprouts
- It increased stem density and improved management of dormancy.
- Reduces rotting and weight loss of the tubers during storage
- Handling, inspection and diagnoses of storage problems is easy
- Allows storage of seed potato tubers for longer periods
- **Tubers are stored on shelves, trays or crates up to three layers deep for good sprout**
- **Basic characteristics of DLS**
- Waterproof roof to protect against rain and

moisture.

- Translucent walls to allow diffused light to enter.
- Adequate ventilation to ensure proper air circulation.
- The structure should be designed to allow for good ventilation and to prevent direct sunlight from entering.
- Shelves or trays should be arranged to allow for easy access to the potatoes stored.



DLS structure

Potato diffuse light store (DLS)

Internal view of DLS and tuber spread on the selves

Advantage of using DLS

- DLS is low cost and sprouts rate is controlled
- Is gives short and strong tuber sprouts
- It increased stem density and improved management of dormancy.
- Reduces rotting and weight loss of the tubers during storage
- Handling, inspection and diagnoses of storage problems is easy by farmers
- Allows storage of seed potato tubers for longer periods until ready for planting
- It controls sprouts growth, reduce a apical dominance and increases sprout number.

4.6 PACKAGING AND LABELING

Seed production field shall be inspected at least three times.

- The 1st inspection shall be at the vegetative stage.
- The 2nd visit shall be at 50% flowering.
- The 3rd inspection shall be made at post-harvest in the seed potato store.

After receiving certificate, according to seed demand,

- Seeds can be packed
- Labeled in plastic perforated bags or sacks of different sizes and
- Sold to the buyers.

All labeling requirements shall apply and be legibly and indelibly marked for formal potato seed multiplication

Potato seed packaging

Potato seed packing and Lebling

- Name and address of the producers
- Name of the crop
- Name of variety
- Competency assurance number
- Seed class
- Net weight/No in SI unit (25, 50 kg)
- Year of production
- Date of packaging
- Data of approval
- Expiry data
- Lot reference number
- Treated/untreated warning text if treated
- Name, logo and address of certifying bod

4.7 TRANSPORTING

- Clean and disinfect transport vehicle before use
- During transportation, potato should be protected from rain
- Transport loaded trucks at night when temperature is lower, and traffic is less
- Open the cover from time to time to ventilate the potato

Transport using back animal

Transport using trucks

- Off-loading: handle with
- Care to limit shocks causing bruising
- Avoid off-loading under the rain

Key message

Improper harvesting and postharvest handling contribute to more than 30% yield loss of potato tuber yield

Post assessment questions

1. When is the right time to harvest a seed potato tuber for maximum tuber yield?
2. Did you relate the importance of curing potato seed tubers towards the reduction of postharvest losses
3. What is the importance of dehaulming in potato seed production?
4. What care should be taken during harvesting, transporting and storing seed tubers?

SECTION 5. QUALITY CONTROL AND ASSURANCE

Overview of the section: Seed quality control and assurance is the combined efforts and activities undertaken to ensure that the seeds that are being produced for the end users (farmers) conform to minimum quality standards. This training section involves seed quality control, seed quality assurance, quality declared seed, and seed certification procedures for production, processing and marketing quality seed tubers

Learning outcome

At the end of this section participants of this training should know:-

1. Seed quality control and assurance mechanisms.
2. How to identify and carry out internal seed quality assurance mechanisms.

Duration: 2 hours

Learning question

Do you know about seed quality control procedure and standards to assure seed quality?

5.1 POTATO SEED QUALITY CONTROL OPERATIONS

- It is a systematic approach to achieving and maintaining minimum seed quality standards.
- Quality control operations include the following key points

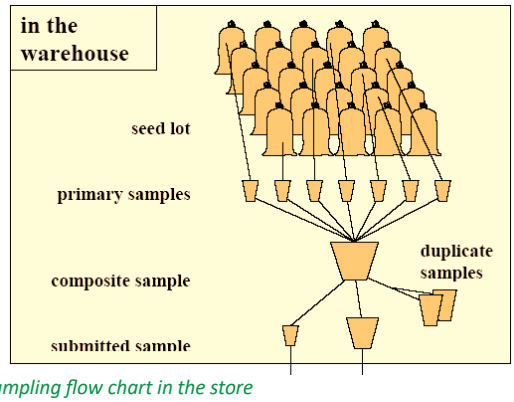
5.1.1 INSPECTING SEED PRODUCTION FIELDS

CHARACTERISTICS	PRE-BASIC SEED –A	BASIC SEED- B	CERTIFIED SEED-C1	CERTIFIED SEED-C2	CERTIFIED SEED-C3	CERTIFIED SEED-C4	COMMERCIAL/ EMERGENCY CLASS-E
Field standard							
Rotation (min year)	2	2	2	2	2	2	1
Isolation (min meters)	100	100	50	50	50	50	50
Off types & others cultivar (max %)	0.1	0.1	0.2	0.3	0.3	0.4	

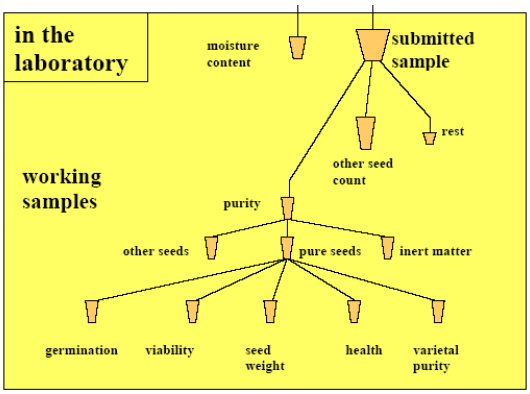
Table 3. Maximum and minimum seed field standard for potatoseed certification / Source: ESA, 2017

5.1.2 SAMPLING SEED LOTS

- Sampling is fundamental importance at all stages of seed quality evaluation
- A seed that passed the field inspection shall be subjected to laboratory test
- The sample should be drown by authorized professionals



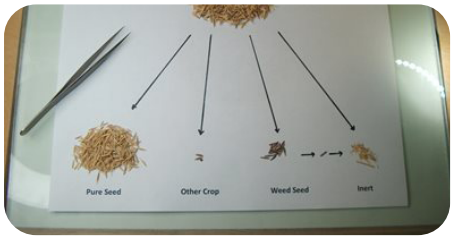
Seed sampling flow chart in the store



Seed sampling flow chart in the laboratory

5.1.3 LABORATORY TESTS

- Important components of seed quality testing parameters include:
- Purity analysis
- Composition of seed lot (pure seed, other seed, inert matter)
- Nature of contaminants in a lot
- Determination is based on weight



Seed purity analysis

Germination tests

- Hundred seeds of 4 replicates tested under favorable conditions and classified into:
- Normal seedlings
- Abnormal seedlings
- Fresh un-germinated /hard seeds
- Dead seeds

Potato seed germination test in laboratory

Seed health test

- Seed serves as a vehicle for dissemination of diseases and pests.
- Infected seeds may fail to germinate, reduce emergence or reduce productivity.

CHARACTERISTICS	PRE-BASIC SEED -A	BASIC SEED- B	CERTIFIED SEED-C1	CERTIFIED SEED-C2	CERTIFIED SEED-C3	CERTIFIED SEED-C4	COMMERCIAL/ EMERGENCY CLASS-E
Laboratory standards							
Pure seed (min %)	98	98	97	97	97	97	97
Other crop seed (max %)	N.S	0.05	0.1	0.2	0.2	0.2	0.3
Weed seed (max %)	N.S	0.05	0.1	0.2	0.2	0.5	0.5
Infected/ Infested/ seeds (max %)	N.S	0.1	0.5	0.5	0.5	0.5	0.6
Inert matter (max %)	N.S	N.S	2	2	2	2	2
Germination (min %)	85	85	75	75	75	70	70
Moisture content (max %)	10	10	10	10	10	10	10

Table 9. Maximum and minimum seed field standard for Potato seed certification
Source: ESA, 2017

5.2SEED QUALITY ASSURANCE

- It is an important aspect of seed production and marketing.
- Seed producers or seed traders distinguish themselves from ware potato producers or ware potato sellers by offering quality seeds.
- Among quality assurance mechanisms, Quality Declared Seed (QDS) and Certification are practiced in our country.
- Different quality assurance mechanisms were practiced in different countries which include, self-control, truthfully labelled, group control, Quality Declared Seed (QDS) and Certification. However, seed certification system is common quality assurance mechanism where QDS is rarely practiced in Ethiopia.

5.3 QUALITY DECLARED SEEDS (QDS)

- Form of quality assurance that was created to reduce the burden of rigorous conventional seed certification. Quality assurance is organized locally, through individual self-control or through group-based mechanisms.
- The national seed inspection services only routinely undertake a random sample of seed producers.
- Seed producers must be registered to produce QDS seeds.
- Cost of QDS-based quality assurance is lower than that of certified seed.

5.4 CERTIFICATION

- The general procedure for seed certification begins with.
- Verification of the source of the basic seed used for

production of certified seed,
- Verification of germination rates, grading, and other functions to assure quality.
- Crops are produced in accordance with regulations and standards set by ESA.
- Seed crops varieties are inspected throughout the season by a third-part inspector, to assure that regulations are being followed.
- A crop inspection report is forwarded to the Regional Seed Quality Control Agency office for appraisal.
- If the crop meets all certification requirements, the seed grower receives a crop certificate as proof of the variety of the seed crop and the field is harvested.
- After harvest, certified seed is cleaned by a registered seed establishment and tested for germination and purity in recognized lab to assure all seed quality requirements are met. This involved
    - Genetic purity,
    - Analytical purity,
    - Physiological quality and
    - Seed health.

Key message

The seed quality control and assurance are critical procedures in production and marketing of legally acceptable quality seed.

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 outcome

At the end of this section participants of this training should know:-

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

Duration: 4 hours

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

Table 5: 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

Table 6: 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				

Table 7: 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

Table 8: Template to estimate operating expenses for agri-business

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
Tolal 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 = Tolal production volume X unit selling price

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

Table 9: 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 10: 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		

Table 17: 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

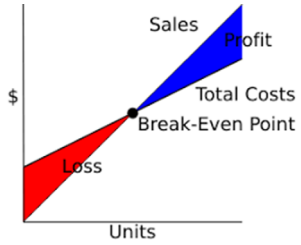
- **Example**
- Cash inflows include sale of seed/seedling, debt obtained from banks, members capital contribution, etc
- Cash out flow includes purchase of input, payment for construction, repayment of debt, payment for salary, etc

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 tirne 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

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

3.Which of the following is variable cost

a. Purchase of seed
b. administrative salary
c. Depreciation
d. 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 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 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	

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