JICA

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FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPI
MINISTRY OF AGRICULTURI

PEPPER PRODUCTION

SHEP

1. Introduction:
1.1 Background

Green Pepper (Kariya)

1. Introduction:
1.1 Background

- Peppers are grown extensively under various climatic and environmental conditions
- It is an important cash crop for smallholder farmers in Ethiopia
- Peppers are widely grown in different places in Ethiopia and the fruits are consumed as fresh, dried or processed products, as vegetables, as spices or condiments.
- The crop is exported as dried ripe fruit or as oleoresin extracted from the fruits

1.2 Some Common Varieties

“Marako Fana”

1.2 Some Common Varieties

“Marako Fana ”:

- grown in open field
- Has tolerante to viral diseases which include **Potato Virus Y (PVY)**, **Tomato Mosaic**, **Tobacco Mosaic** & **Pepper Mild Mottle**
- Fruit turns from **green** to **yellow**
- **Maturity Period: 120– 135 days** after transplanting
- **Yields:** Open field **150– 250 qt/ha**

1.2 Some Common Varieties

“Melka Zala”

“Melka Eshet”

1.2 Some Common Varieties

“Melka Zala ”

- grown in open field
- Has **tolerant to soil born diseases**
- Fruit color turns green to red
- Maturity Period: **130– 150 days** after transplanting
- Yields: Open field **200– 250 qt/ha**

“Melka Eshet”

- grown in open field
- Use **for processing**
- Fruit color turns green to full red
- Maturity Period: **100-120 days** after transplanting
- Yields: Open field **150– 200 qt/ha**

1.3 Optimal Ecological Requirements

Altitude	**1400 – 1900 meter above sea level**
Rainfall	**600 – 1,200 mm of rainfall annually**
Growing Temperature	**25 – 28 ℃ day temp.** **15 – 20 ℃night temp**
Soils	• **Well-drained loamy soils** • **pH 5.5 – 7** • **High organic matter**

1.3 Optimal Ecological Requirements

- **Altitude:** Green pepper can be cultivated up to **1,400 – 1,900 m** above sea level
- **Rainfall:** Greene pepper performs well in areas that receive **600 – 1,200 mm** of rainfall annually which is well distributed throughout the growing period is required
- **Temperature:** Green pepper performs well in **warm climatic conditions**. The optimal temperature range is **21-24 ℃.** Lower night temperatures result in greater branching and more flowers, while warmer night temp. induce earlier flowering
- **Soil:** Green pepper requires light- textured fertile and well-drained soils with a high level of organic matter. Good drainage is important because waterlogging is tends to cause leaf drop. The optimal soil pH range is **5.5 –7.0**

2. Pre-Cultivation Preparation:
2.1 Market Survey

Carrying out a market survey on green pepper

2. Pre-Cultivation Preparation:
2.1 Market Survey (GHCP&PHHT20: Q1)

How to conduct a market survey

- Identify major dealers of the target crops
- Introduce yourself what the purpose of a market survey
- Find the potential market nearby your area (local market, big market in town, hospital, University, boarding school)
- It is important to consider seasonal or religious event, such as Christmas or fasting
- People consume more vegetables during fasting season
- Continuous surveys are important in order to find new market opportunities and also establish business relationships with the market players.

Note: It is recommended to conduct a market survey when you go to local market during your local market day

2. Pre-Cultivation Preparation:
2.2 Market Survey

Market Survey Questionnaire

Date :_____

Region_____ Zone_____

Woreda_____ Name of Group:_____

Name & Contact of the Produce Dealer	Produce & Variety	Produce Quality Market Requirements	Peak Demand (months)	Quantity (kg) & Frequency (daily/weekly etc.) of Supply	Place of Production	Purchasing Unit Price (ETB/kg)	Mode of Payment	Terms of Payment	Marketing Challenges	Dealer's Willingness to Purchase the Produce from the farmers
Mr. Abdela Qasim (0917-xxxxxx)	Potato (Belete)	Medium size	February to March	120 qt/week (1qt = 100 kg)	Waliso	3.5 ETB/kg	Cash	Cash on Delivery	Poor quality (diseased)	Willing
Mr. Kernal Husen (0911-xxxxxx)	Onion (Adama Red)	Big size	April to September	50 qt/day (1 qt=110 kg)	Shewa robit	15 ETB/kg	Credit	Within a week	Poor quality (small size and not well cured)	Willing
Mr. Amir Yemane (0911-xxxxxx)	Head Cabbage (Copenhagen Market)	Medium size	April	4 qt/week (1qt = 70kg)	Dedo	250 ETB/qt	Cash	Cash on Delivery	Poor quality (damaged and not well matured)	Willing

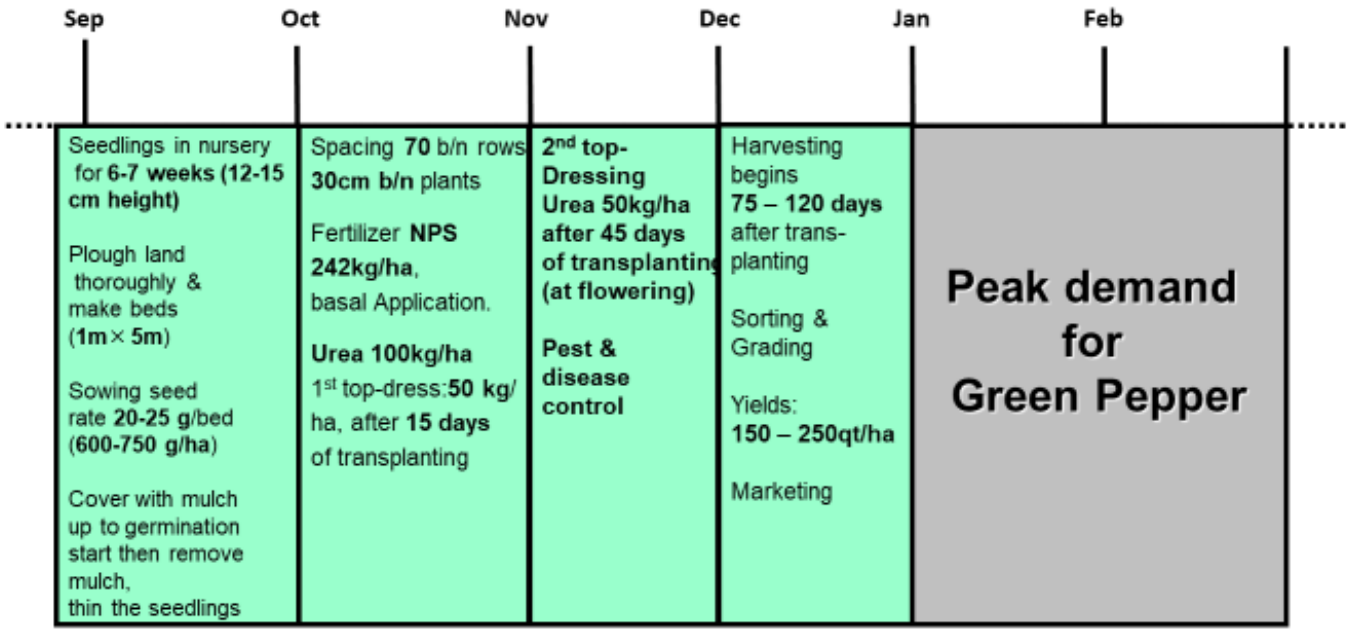
Market Survey Questionnaire

2. Pre-Cultivation Preparation:
2.2 Market Survey Questionnaire

Prepare sample questions to enable you gather the following information

- **When (month) is the peak demand for Green pepper**
- The price of Green pepper during the peak demand
- The variety(s) that has the highest demand
- Supply requirements (quantities and frequency)
- Quality market requirements
- Potential buyers and terms of payment etc.

2.2 Cropping Calendar



A Sample of a Green Pepper Cropping Calendar

2.2 Crop Planting Calendar (GHCP&PHHT20: Q2)

- A tool used by farmers to plan for production to ensure that marketing coincides with the period of the year when the market price of a produce is highest

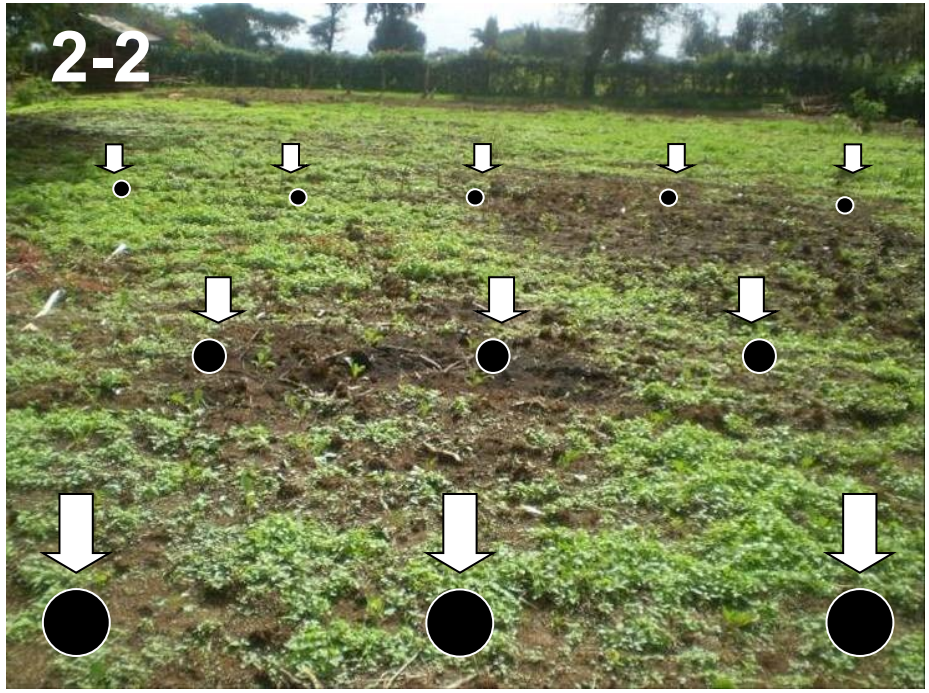
Procedure:

1. Determine from the market survey results (2.1) when there is peak demand for Capsicum
2. Work backwards from the month when there is peak demand to prepare a monthly farm activities preceding the peak period
3. Use the monthly activities preceding the peak as a procurement plan for farm inputs and a guide for farm operations

Notes:

- To meet the peak demand period of the market, there may be need of supplemental irrigation

2.3 Soil Sampling & Analysis



Depending on the farm, sample the soil using the most appropriate method

2.3 Soil Sampling & Analysis
(GHCP&PHHT20: Q3)

- It is recommended to have the soils analyzed for nutrient availability and other factors vital to crop production **after every 2 – 3 years**
- The results of the soil analysis can be used to determine fertilizer and manure requirement

2.4 Composting

Manure & compost preparation through composting

2.4 Composting (GHCP&PHHT20: Q4)

- During compost making, the organic matter need to be covered to prevent leaching of nutrients
- Green pepper requires well composed manure to avoid soil borne diseases
- Application rate of **100 – 120 qt/ha** of compost required depending on the soil organic matter content.
- This is equivalent to **1 – 2 handfuls of manure per sowing hole**
- It should be mixed thoroughly with the soil in the planting hole

2.5 Quality Seed/Planting Materials

Samples of certified seeds on sale

2.5 Quality Seed/Planting Material (GHCP&PHHT20: Q5)

- Like any other planting material, Capsicum seed should be of high quality and certified by Seed **quarantine Service** which is a government agency responsible for seed certification
- Ensure you purchase seeds from **certified seed companies**, **authorized dealers /stockiest** and **certified nursery**
- Farmers should pay attention to information on seed label such as **expiry date**, **spacing**, **storage** etc.

3. Cultural Practices:
3.1 Land Preparation

Preparing land by oxen plough for planting

3. Cultural Practices:

3.1 Land Preparation

Land Preparation Practices:
(GHCP&PHHT20: Q6)

- Preparation should be done **2 – 3 months before planting**
- Soils should be ploughed sufficiently to eliminate debris and clods
- The field should be deeply ploughed to a depth of **20 – 30 cm** and harrowed
- The field should not be planted with the same crop or related species (tomato, I/potato, hot/green pepper)
- For purpose of making field operations easy, beds are more convenient with closer spacing and bigger paths

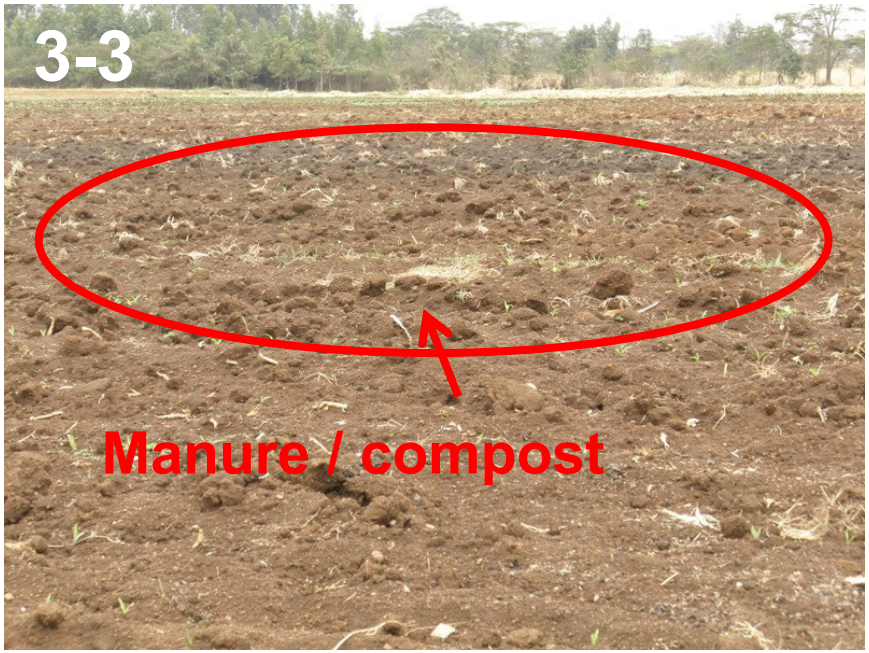
3.2 Incorporation of Crop Residues

Crop residues to be incorporated in a ploughed field

3.2 Incorporation of Crop Residues (GHCP&PHHT20: Q7)

- Incorporating crop residues in the farm land can significantly increase the soil organic content
- The crop residues should be thoroughly incorporated at a depth of about **30 cm** at least **1 – 2 months before** transplanting the green pepper
- This allows for proper decomposition
- However, if the crop residues belong to the *Solanaceae* family (such as tomatoes, potatoes, egg plant ,sweet peppers/ green pepper, chilli peppers, etc.),
- remove and burn the residue to avoid possible risk of disease build up

3.3 Basal Application



Manure & compost incorporation as a basal application

3.3 Basal Application (GHCP&PHHT20: Q8)

- Pepper thrive best if supplied with a generous amount of manure/compost
- Recommendation is to supply **100-120 qt/ha** of compost
- Field should be ploughed frequently and leveled, then make furrows or ridges by maintaining 75cm distance between rows
- Apply **242 kg/ha of NPS** fertilizer at sowing time

3.4 Raising Seedlings

Raising seedlings in seed bed

3.4 Raising Seedlings (GHCP&PHHT20: Q9)

- Green pepper is normally raised in nursery & transplanted but it can also be directly sown
- Seed Rate: **600 – 750 g/ha** for the nursery and **3 kg/ha** for direct sowing

Nursery Site Selection:

- The nursery should be sited in a plot that has not been planted with a member of ***Solanaceae*** **family** for the last **3-4 years**

Nursery Establishment:

- Prepare a nursery bed of **1 m width** and 5-10m length
- Make drills on the seedbed at a spacing of **10 – 15 cm apart**
- Thinly sow the seeds in the drills and cover lightly with soil
- Water the nursery regularly
- Prepare shade and cover with organic materials such as dry grass
- The shade protects young seedlings from exposure to sun

Management of Nursery:

- Water the nursery regularly
- Harden the seedlings **1 – 2 weeks before transplanting** by reducing the frequency of watering and gradually exposing the seedlings to direct sunlight
- Control of whiteflies is important since they transmit viruses to young green pepper plants
- These insects can be blocked from reaching the seedlings by using **an insect proof net**

3.5 Transplanting

Transplanting Seedlings

Transplanted pepper plants in the field

3.5 Transplanting

3.5.1 Appropriate Time

- Seedlings are transplant n the field **at the 4 – 6 true leaf stage(15-20 cm tall)**, usually **6 – 7 weeks after sowing**
- Hardy transplants can be produced by restricting water and removing shade protection **1 week before transplanting**
- It is recommended that transplanting should be done either **early in the morning** or **late in the evening**

3.5.2 Recommended Spacing (GHCP&PHHT20: Q10)

- **Plant Spacing: 60 cm × 45 cm** or **70 cm × 30 cm** depending on the variety
- Under irrigation, it can be planted in double row on flat-topped ridges. The distance between rows will be 80cm and 40cm between plants. Double row spacing is 40cm
- **Plant Population per ha:** range from 34,188 to **47,619** plants.
- Appropriate spacing produces short sturdy plants with good root system

3.5.3 Fertilizer Application Rates (GHCP&PHHT20: Q11)

- The type of fertilizer and amount needed depend on soil analysis results
- Apply **200 kg/ha of DAP Or 242kg/ha of NPS** during transplanting
- The fertilizer should be mixed thoroughly with the soil

3.6 Water Requirement

Watering by using furrow irrigation of pepper plants

3.6 Water Requirement (GHCP&PHHT20: Q12)

- Green pepper requires **adequate moisture during growing period**
- They can be grown under **rain-fed** or **irrigated conditions**
- Watering will encourage green pepper plants to produce **high quality** and **quantities** of fruit
- Avoid watering plants in the evening as wet plants are more likely to develop **disease**
- Soils should be **well drained**
- Root depth can extend up to 1.0m but under irrigation condition roots are mainly concentrated in the **upper 0.3 m soil depth.**

Irrigation Methods:

- **Furrow irrigation** are the most effective methods **minimizes** spread of diseases, such as **"Bacterial wilt "** as compared with overhead irrigation
- In the early growth stage, irrigate water 5-7 days interval
- At latter growth stage, it might extend up to 7-10 days interval

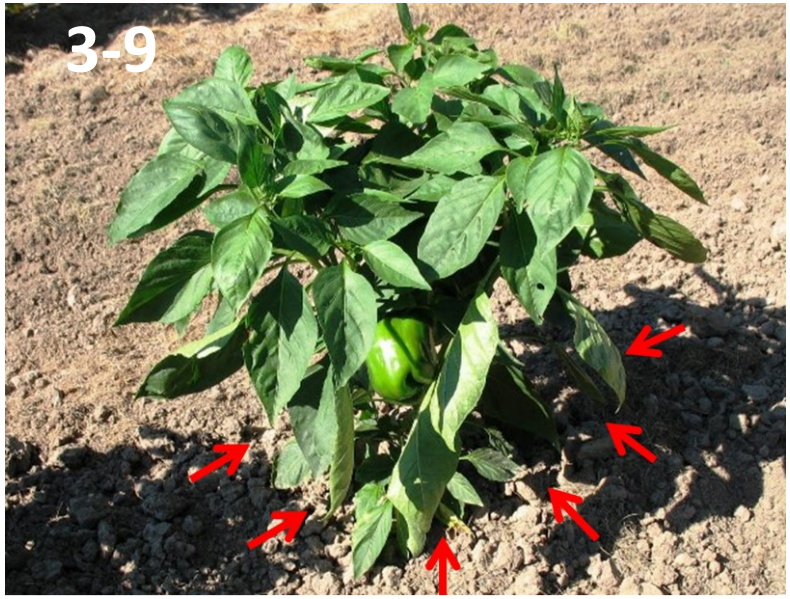
3.7 Managing of Weeds

Weed management of Pepper field using appropriate tool

3.7 Managing of Weeds (GHCP&PHHT20: Q13)

- Generally, keep the field weed free as much as possible to avoid competition for **nutrients**, **sunlight** and **moisture**
- Avoid bruising the roots during weeding
- This can be done through use of appropriate weeding tools
- Pepper is **susceptible to weed** competition, particularly at the early stage of growth
- To control weed and loosen the soil cultivating should be done **3-4 times** until flowering starts.
- 1st weeding: **after 20 days** of transplanting
- 2nd weeding: **after 40 days** of transplanting
- Organic mulches are very effective for weed control

3.8 Top-dressing



Top-dressing using the placement method

3.8 Top-dressing (GHCP&PHHT20: Q14)

- Green pepper crop should be top-dressed with organic and inorganic chemical fertilizers (Urea) to produce high yields
- **1st top-dressing** is done with urea **50 kg/ha, 2 - 3 weeks** after transplanting
- **2nd top-dressing** is done with urea **50 kg/ha, 6 weeks** after transplanting (at flowering
- During flowering high amounts of nitrogenous fertilizer should be avoided

3.9 Crop Management
3.9.1 Training & Staking

Well trained & staked Green pepper field

3.9 Crop Management
3.9.1 Training and Staking

- **Staking** keeps the plants upright and also keep the fruit away from the soil
- Staking materials: **Wood stakes**, **bamboo** or any **sturdy material**
- **Strings, plastic strips** or other material can be used for **training** the plant to the stake
- It keeps the canopy intact, thus preventing sunscald on the fruit
- It also prevents the plant from splitting during a heavy fruit load
- Staking can help minimize lodging

3.9.2 Pruning

Pruning of green pepper plant

After pruning

3.9.2 Pruning

- Green pepper plants initially develop **one single stem**
- Later more shoots develop
- Each shoot will branch further after one or two leaves, while producing flower buds at the point of division
- The most common way of growing Green pepper is to facilitate development of **two main shoots**
- If three or four main shoots are required, the third and fourth must normally be **taken from the second branching**
- Side shoots should have equal vigor

Note: whether farmer needs to practice pruning is depends on the variety and quality that farmers want to achieve.

3.9.3 Control Flower Load

Buds

Flower

3.9.3 Control Flower Load

- Green pepper starts flowering **about 2 – 3 weeks** after planting
- **The first flower can be removed**
- Later flowers may develop into fruit
- Sufficient leaf area must have developed for one to allow the plants to carry the fruits
- Plants with **3 or 4 axils** above the branching are big enough to be allowed to set fruit
- Young plants fruit load must be controlled by the grower, in order to achieve **a reasonable fruit weight**

3.10 Pests & Diseases Control
3.10.1 Control/Management Strategies

1.	Cultural Control
2.	Mechanical Control
3.	Biological Control
4.	Chemical Control
5.	Integrated Pest Management (IPM)

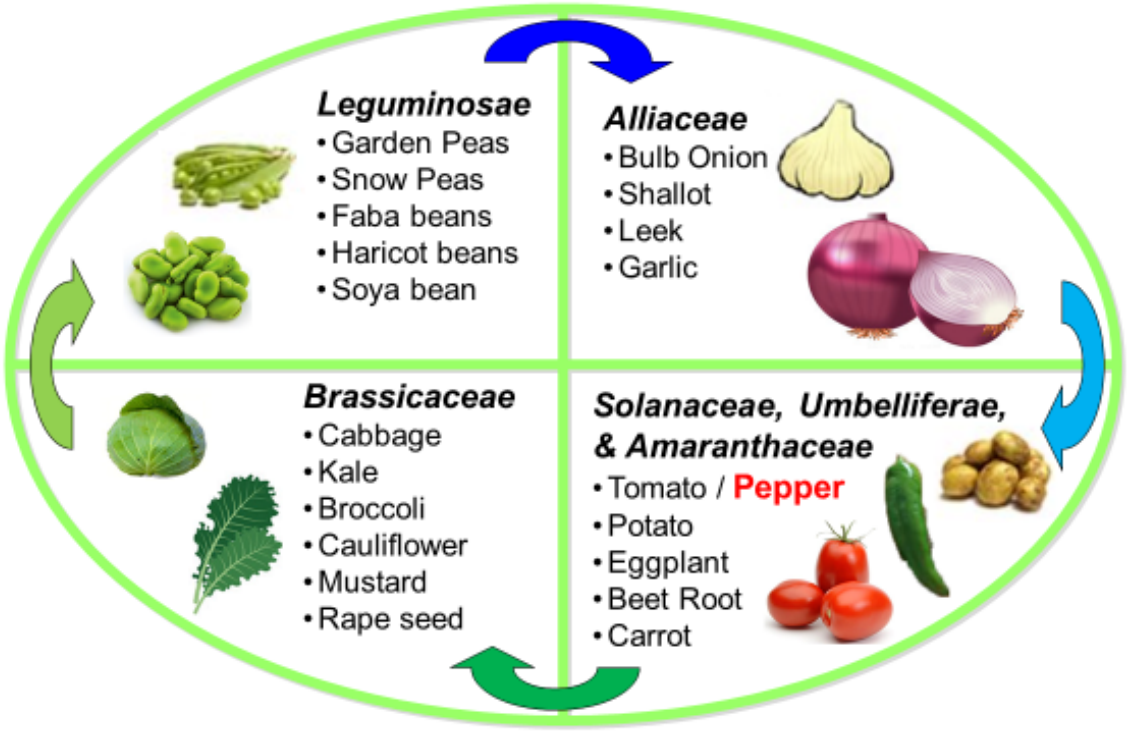
3.10 Pests & Diseases Control

3.10.1 Control/Management Strategies (GHCP&PHHT20: Q15)

- Pests and diseases can be managed through either single control strategies or an integration of two (2) or more methods. The single control strategies are: cultural; physical; biological; and chemical.

1. **Cultural Control:** This involves managing the environment in which the crop is growing/grows with a view of maintaining pest and disease below the harmful level. The cultural methods include: field sanitation/hygiene, intercropping, crop rotation, furrowing, flooding, solarization etc.
2. **Mechanical Control:** This involves use of insect traps, hand picking, screening house, weeding etc.
3. **Biological Control:** This involves use of natural enemies (predators and parasitoids), resistant/tolerant varieties, trap plants, push and pull system, and repellant plants
4. **Chemical Control (GHCP&PHHT20: Q16):** This involves use of pesticides. Pesticides are preferred because of the quick knock down effect; they have high efficacy. Pesticide usage has been linked to environmental degradation and should be used as last resort
5. **Integrated Pest Management (IPM):** Due to limitation of a single control strategy, use of IPM is a more recommended strategy. IPM integrates cultural, mechanical, biological and as a last resort, chemical control to minimize the crop loss caused by pests and diseases.

3.10.2 Crop Rotation

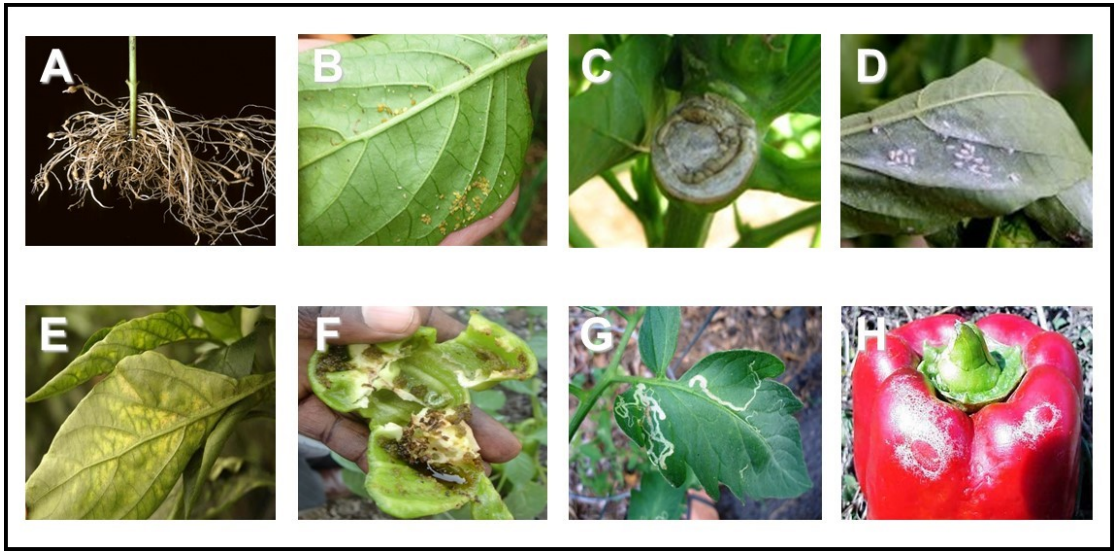


An example of a Crop Rotation

3.10.2 Crop Rotation

- One of the most important strategies of IPM is crop rotation
- Crop rotation prevents pest and disease build-up and in addition, it replenishes soil nutritional status
- It is recommended to rotate crops with those from different families; an effective rotation program should last for 3 – 4 years

3.10.3 Major Pests



3.10.3 Major Pests

- Pests damage causes a reduction in quality and quantity of produce
- The following are the major pests of green pepper in Ethiopia:

A. Root-Knot Nematode
B. Aphid
C. Cutworm
D. White Fly
E. Spider Mite
F. Fruit Borer
G. Leaf Miner
H. Thrips

3.10.3.A: Root-knot Nematode

Symptom of fruit damaged by "African Bollworm"

3.10.3.A: Root-knot Nematode

- Nematodes are **soil inhabitants** which are easily spread by infested seedlings, soil washed down the slopes or by farmers
- Root–knot Nematodes are most serious on **light sandy soils**

Identification:

- **Small lumps** or **galls** develop on the infected roots
- The galls on green pepper are much smaller than those on cucurbits or Tomato

Damages:

- Wilting of plants
- The plant roots can be seen to be **distorted**, **swollen** and bearing **galls** (**knots**)
- The infested roots eventually **rot** and **affected plants die**

Control:

- **Crop rotation**
- Mixed cropping with **African Marigold**
- Maintaining **high levels of organic matter** in the soil
- Use some bio products e.g.) **Neem extracts**

3.10.3.B: Aphid

Aphids on a leaf

3.10.3.B: Aphid

Identification:

- Aphids occur in **colonies** initially around tender plant parts and on the lower leaf surface
- When numerous, they can be found on all above ground parts of the plant

Damages:

- Aphids damage plants by sucking their sap, excreting **a sticky substance** (**honeydew**) that coats the plants, or/and by **transmitting viral diseases**
- **Curling**, **wrinkling**, or **cupping** of young leaves, **chlorotic spotting**, **mottling of older leaves**, **stunting** and **wilting** of plants
- Growth of sooty mould on honeydew excreted by aphids reduces photosynthesis and **affects fruit quality**

Control:

- **Naturally controlled by predators**, such as ladybird, beetles, hoverflies, anthocorid bugs, spiders and lacewings and by fungal diseases
- Spraying gelatin solution (before the population increased) is also effective.
- **Spray with insecticides**,
- such as :diamethoate 40% WP , cruser 240 SC(Sulafoxaflor),phonix 5% Ec

3.10.3.C: Cutworm

Cutworm on the stem

3.10.3.C: Cutworm

- Cutworms are **the caterpillars of various moths**
- They drop to the soil where they live until pupation
- They hide during the day in the soil around the base of the plants and climb into plants **at night**

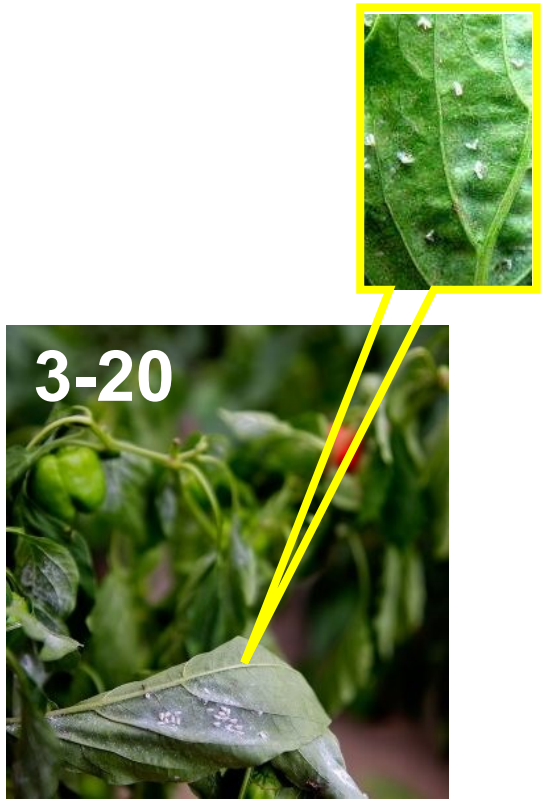
Damages:

- Young caterpillars feed on leaves making **small holes**
- **Cutting stems of young seedlings** at the level of the soil

Control:

- **Eliminate weeds early**, well before transplanting
- **Plough and harrow the field** to expose Cutworms to natural enemies and desiccation **3 – 4 weeks** before transplanting is done
- Dig near damaged seedlings and destroy them
- **Conserve natural enemies: Parasitic wasps** and **ants** are important in natural control of Cutworms
- Drench the soil with;
  - **Actara 25 WG ®** (a.i. **Thiamethoxam**)
  - **Alfa Cymba 10 EC®** (a.i. **Alpha-cypermethrin**)
  - **Alfacyper M®** (a.i. **Alpha-cypermethrin**)

3.10.3.D: White Fly



White Flies on a leaf

3.10.3.D: White Fly

Identification :

- Whiteflies are **soft-bodied**, **winged insects** closely related to aphids
- They can be as small as 1/12 of an inch, and are often found in **clusters on the undersides of leaves**
- They are **active during the daytime**
- Whiteflies are **capable of over wintering** and reproducing throughout the year **in warmer climates**

Damages:

- Whitefly immature stages (nymphs) and adults suck sap from leaves producing **chlorotic spots on infested leaves**
- Nymphs excrete **a clear sugary liquid** known as **honeydew**, which proliferate the growth of a **black sooty mould**, affecting photosynthesis
- Whiteflies are **vector of important viral diseases**, such as **Chili Leaf Curl**

Control:

- Keep the seedlings protected under **a fine meshed insect netting** until they are ready for transplanting
- Make sure the netting is always properly closed
- **Use of traps** with yellow polyethylene with a sticker to attract the insects
- **Conserve natural enemies:** Parasitic Wasps, Predatory Mites, Ladybird & Lacewings
- **Spray with insecticides**, such as
  - **Applaud 40%SC®** (a.i **Bufrofezin**)
  - **Actara 25 WG®** (a.i. **Thiamethoxam** 250 g/kg)
  - **Karate 2.5 WG®** (a.i. **Lambada Cyhalothrin** 25 g/kg)

3.10.3.E: Spider Mite

Source: https://www.sgaonline.org.au/red-spider-mite/

Symptoms of spider mites on a pepper leaf

3.10.3.E: Spider Mite

Identification:

- Adults are **oval** and have **eight legs**
- They are **very tiny** (0.5 mm) resembling **tiny moving dots**
- They **vary in colour** depending on the species
- Many of the species are bright red in colour, others are yellowish, greenish, pinkish, orange or reddish
- The Two-spotted Spider Mite has **a large dark blotch** on each side of the body

Damages:

- Spider Mites suck the sap of the plants, **causing mottling of the upper leaf surface**
- Infested leaves first show **a white to yellowing speckling**, and then eventually **turn bronze** and **fall off** as the infestation becomes heavy
- Spider Mites prefer **the lower surface of the leaves**, but in severe infestations occur on both leaves surfaces as well as on stems and fruits
- High infestations cause **defoliation**

Control:

- **Field hygiene** is important for the management of Spider Mites
- **Conserve natural enemies**, such as **Predatory Mites**
- Chemical sprays using **miticides**, such as
  - **Dynamic 1.8 E.C.®** (a.i. **Abamectin**)
  - **Agrimec 18 EC®** (a.i. **Abamectin**)
  - **Thiovit Jet®** (a.i. **Sulphur**) where possible while observing the pre-harvest interval

3.10.3.F: Fruit Borer

Pepper fruit showing Fruit Borer attack

Newly laid egg

Male adult moth

3.10.3.F: Fruit Borer

Identification:

- Fruits Borers (Bollworms) are **about 2 – 3.5 cm long**
- Moths are active at dusk and at night
- Moths of Fruit Borers, **feed on nectar** and **lay eggs on leaves**

Damages:

- Some species feed on leaves causing **defoliation** and **slow plant growth**
- Attack on flower buds results in **flower abortion**
- Caterpillars usually bore holes in fruits, causing **extensive damage** and **promoting decay** from secondary infection by diseases

Control:

- Check the crop regularly (**scouting**)
- **Plough the soil before planting**
- Handpick and destroy damaged fruits, eggs and caterpillars
- **Conserve natural enemies:** Parasitic Wasps, Ants, Pirate Bugs etc.
- Scouting the crop in order to detect eggs or larvae before they bore into the fruit
- **Use trap crops**, such as tasseling maize for ovipositing adult females
- Use bio-pesticides, such as **Bacillus thuringinesis (Bt)**, **neem products** or other plant extracts
- Spray **insecticides**, such as
  - **Karate 2.5 WG®** (a.i. **Lambda Cyhalothrin**)
  - **Halothrin 2.5 EC®** (a.i. **Lambda Cyhalothrin**) during fruit set

3.10.3.G: Leaf Miner

Leaf Miner damage on a leaf

3.10.3.G: Leaf Miner

Identification :

- Female flies make **numerous small**, **whitish tunnels (mines)** on the foliage when feeding and depositing eggs
- Full-grown maggots come out of the mines to pupate in the soil beneath the plants or on the foliage
- Maggots are **the most destructive stage**

Damages:

- The females lay eggs that hatch into **tiny yellow maggots** which feed on leaf tissues leaving **a wandering track** (**whitish tunnels**) known as **mines**
- The mines may **reduce photosynthetic activity**, affecting development of flowers and fruits
- These tunnels can serve as **entry points** for disease-causing organisms
- Completely mined leaves might **dry up** and **fall off prematurely**
- Wilting of plants leading to **fruit sunscald**, **death of the young plants** and **yield loss**

Control:

- **Ploughing and solarization** can help in exposing pupae to desiccation and natural enemies
- Conserve natural enemies
- **Neem products** are effective for controlling Leafminers
- Use of Systemic chemicals and observe PHI
- **Spray insecticides**, such as

– **Dynamic 1.8 E.C.®** (a.i. **Abamectin**)
– **Agrimec 18 EC®** (a.i. **Abamectin**)
– **Applaud®** (a.i **Buprofezin**)

3.10.3.H: Thrips

Thrips marks on Capsicum leaves and fruit

3.10.3.H: Thrips

Identification:

- Often concealed **under the calyx**
- Thrips usually feed on all above ground parts of plants preferring **the underside of young leaves**, **flowers** and **fruits**

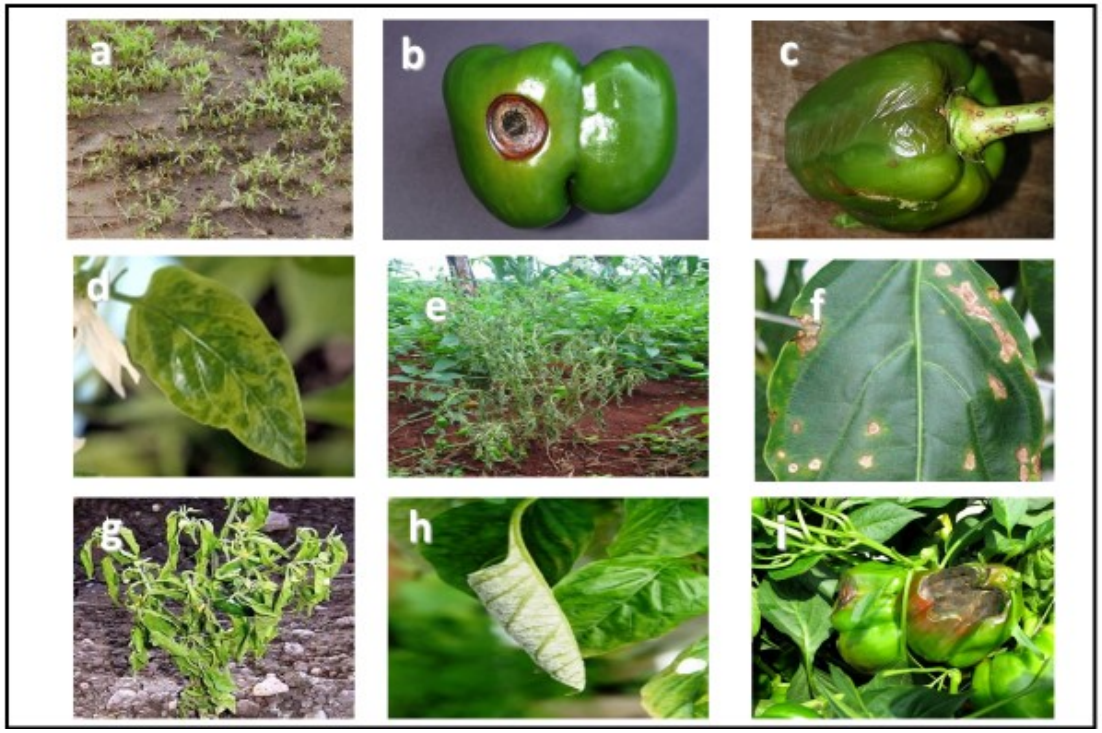
Damages:

- Thrips puncture leaves and suck the exuding sap
- At the initial stage of infestation, leaves have a **silvery sheen** and show **small**, **dark spots of faecal material** on the underside
- Later leaves **curl upward**, **wrinkle** and finally **dry up** leading to fruit sunscald
- Damaged leaves, buds and fruits turn **rusty in colour**
- **Wilting**, **retardation of leaf development** and **distortion of young shoots** resulting in stunted plants
- Attack on fruits causes **deformation** and **scarring** of the fruits
- Thrips transmit the **Tomato Spotted Wilt virus** and **Leaf Curl disease**

Control:

- **Conserve natural enemies**, such as **Anthocorid Bugs**, **Predatory Mites** and **Spiders**
- **Spray insecticides**, such as
  - **Tracer 480 SC®** (a.i. **Spinosad**)
  - **Achook®** (a.i. **Azadiractin**)
  - **Vendex 500 EC®** (a.i. **Lambda Cyhalothrin 5%EC**)
  - **Thunder OD 145®** (a.i. **Imidacloprid+Betacyfluthrin**)

3.10.4 Diseases



3.10.4 Diseases

- Disease infestation leads to reduction in quality and quantity of produce
- The following are the major diseases of Capsicum in Ethiopia:

a. Damping-off
b. Anthracnose
c. Bacterial Soft Rot
d. Viral Diseases
e. Bacterial Wilt
f. Leaf Spot
g. Fussarium Wilt
h. Powdery Mildew
i. Blossom End Rot

3.10.4.a: Damping-off

Green pepper seedlings showing symptoms of Damping-off

3.10.4.a: Damping-off

General Descriptions:

- This disease is **soil borne** caused by fungi
- There are **2 types** of Damping-off:
  - Seedlings fail to emerge (**Pre-emergence Damping-off**)
  - Small seedlings collapse (**Post-emergence Damping-off**)

Symptoms:

- Seedlings are **stunted** through **root rot** and/or **collar rot**
- Nursery beds show **irregular patches**
- **Leaves:** lesions, abnormal colours, abnormal forms, wilting, fungal growth
- **Roots:** lesions
- **Seeds:** rot, discolorations
- **Stems:** external discoloration, canker, abnormal growth, mycelium visible
- **Whole plant:** plant death, dieback, damping-off

Control:

- Growing certified disease-free seed
- Nursery beds be located on **well drained sites**, not previously under vegetable production
- **Proper watering regime**
- Use of **appropriate fungicides** as spray or soil drench, such as
  - **Ridomil Gold MZ 68 WG®** (a.i. **Metalaxyl + Mancozeb**)
  - **ApronStar 42 WS®** (a.i. **Thiamethoxam + Metalaxyl + Difenoconazole**)

3.10.4.b: Anthracnose

Anthracnose affected on the green pepper fruits

3.10.4.b: Anthracnose

General Descriptions:

- **Anthracnose** is caused by Colletotrichum spp.
- Spores dispersed by **water-splash**, **air currents**, **insects** or **other forms of contact**
- **Transmitted through seed**, but also through **infected plant parts**
- Persists on and in **seed**, **crop residues**, and **weed hosts**

Symptoms:

- **Dark**, **sunken spots** up to **2.5 cm** across on green pepper
- The **spots** on green and ripe fruits surface may be covered in moist weather with salmon-pink mass of spores

Control:

- Use certified disease-free seeds
- **Practice field sanitation** (removal of crop debris after harvest)
- Application of **registered fungicides**, such as
  - **Daconil 720 SC®** (a.i. **Chlorothalonil**)
  - **Bravo 720 SC®** (a.i. **Chlorothalonil**)
  - **Cuprocaffaro®** (a.i **Copper Oxychloride**)

3.10.4.c: Bacterial Soft Rot

Bacterial Soft Rot affected on green pepper fruits

3.10.4.c: Bacterial Soft Rot

General Descriptions:

- The bacteria are **soil-borne**
- Soft Rot is primarily **a post-harvest problem**
- The disease is **serious during rainy periods** because the bacteria are splashed from the soil onto the fruit, which are more susceptible due to their high moisture content
- The disease begins in the **peduncle** and **calyx tissues** of harvested fruit

Symptoms:

- Fruit infected on the plant **collapses** and **hangs on the plant** like **a water-filled bag**
- When the contents leak out, a dry shell of the fruit remains

Control:

- **Crop rotation** with pulses and cereals
- **Control of insects** that cause injury to fruits
- **Post-harvest decay** can be reduced by harvesting fruits when dry
- **Minimize injury** during handling
- **Store at cool temperatures**

3.10.4.d: Viral Diseases

Cucumber Mosaic Virus infection

Alfafa Mosaic virus infection

3.10.4.d: Viral Diseases

General Descriptions:

- **Cucumber Mosaic Virus (CMV)** is the most important world wide
- Other viral diseases include **Alfalfa Mosaic Virus (AMV)**, **Tobacco Mosaic Virus (TMV)**, **Tomato Spotted Wilt Virus (TSWV)**, **Pepper Mottle Virus (PeMV)**, **Potato Virus Y (PVY)**, **Tobacco Etch Virus (TEV)**
- Most of these viruses are **transmitted by insects such as aphids**, **infected seed** and **a few by mechanical**

Symptoms:

- Difficult to firmly diagnose by symptoms as they can be altered by factors like **cultivar**, **age of host plant**, **environmental conditions**, **host plant nutrition** and **viral strains**, not to mention the occurrence of virus mixtures
- Some symptoms are; **mosaic patterns on leaves**, **yellowing**, **ring spots**, **leaf deformation** or **distortion**, **curling of leaves**, and/or **stunting of plants**
- Also, **reduction of fruit size**, **distortion**, and/or **ring patterns** could be seen

Control:

- **Use barrier crops** to minimize virus spread
- **Use oil sprays** to reduce virus transmission by **Aphids**
- **Use reflective mulches (silver colored)** to repel **Aphids** and **Thrips**
- **Field hygiene** & **Crop rotation**
- Destruction of alternative hosts
- Control the insect vectors

3.10.4.e: Bacterial Wilt

Bacterial Wilt attacked on a green pepper plants

3.10.4.e: Bacterial Wilt

General Descriptions:

- The bacteria attack **a wide range of crops** and solanaceous weeds and **can survive in the soil for long periods**
- It is favored by **wet**, **warm conditions**
- Cross sections cut from roots and lower stems of diseased plants exude **milky streams of bacteria** from the vascular system when suspended in water

Symptoms:

- **Wilting of the entire plant** with no leaf yellowing
- Leaf spots of various shapes
- Grows as a sooty to **dark mold** on the underside of leaves. On very humid conditions, it appears on the top surface
- High infection causes **foliage to roll**, **wilt** and **fall off**

Control:

- **Rouging of infected plants**
- **Control Root-knot Nematodes** since they could facilitate infection and spread of **Bacterial Wilt**
- **Soil amendments** (organic manures)
- **Crop rotation** to avoid continuous planting of Solanaceous crops
- **Proper irrigation management**

3.10.4.f: Leaf Spot

A health leaf (left) & Cercospora Leaf Spot lesions on a leaf (right)

3.10.4.f: Leaf Spot

General Descriptions:

- The fungus survives **on seeds** and **in crop debris**
- The disease is favored by **prolonged periods of wetness**

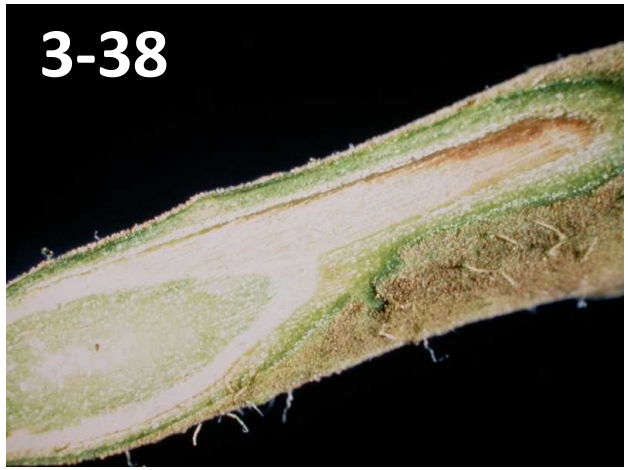
Symptoms:

- **Spots on leaves** are **brown** and **circular** with small to large light grey centers and **dark brown margins**
- **Spots on stems**, **petioles** and **peduncles** are typically elliptical with same characteristic color

Control:

- Use **certified seeds**
- **Maintain adequate soil moisture**, especially **at fruit development stages**
- **Carry out soil liming** in calcium deficient soils
- **Top-dress with CAN** and ensure adequate soil moisture
- **Spray the crop with calcium chloride**
- Practice **field sanitation**
- Spray **copper based fungicides**, such as
  - **Oshothane Plus WDG®** (a.i. **Mancozeb**)
  - **Penncozeb 80 WP®** (a.i. **Mancozeb**)

3.10.4.g: Fusarium Wilt



Fusarium Wilt distracted green pepper plants in the field

3.10.4.g: Fusarium Wilt

General Descriptions:

- The fungus lives **indefinitely in the soil**
- It is spread by **irrigation water**
- It is very susceptible to changes in temperature and soil moisture
- It is serious **in poorly drained fields**

Symptoms:

- **Drooping** and **yellowing** of lower leaves followed by **wilting** of the entire plant
- Leaves on infected plants remain attached and the vascular system of the plant is discoloured, particularly in the lower stem and roots

Control:

- Crop rotation
- **Lime the soil** (soil pH 7.0 – 7.5 reduces fusarium wilt disease)
- Ensure the soil has **a good drainage**
- Apply soil antagonist **Trichotech®** (a.i. **Trichoderma spp**)

3.10.4.h: Powdery Mildew

Leaves showing the initial sporulation

3.10.4.h: Powdery Mildew

General Descriptions:

- The disease is caused by **a fungus**
- It is favored by **warm**, **humid** and **dry weather**

Symptoms:

- **Yellowish blotches or spots** with **a white to grey powdery fungal growth** appear on the upper leaf surface
- The disease progresses **from the older to younger leaves** shedding the foliage
- Leaf defoliation leads to **reduction in size and number of fruits**

Control:

- Apply **preventive fungicides**, such as
  - **Thiovit Jet®** (a.i. **Sulphur**)
  - **Cosavet DF®** (a.i. **Sulphur**)
  - **Milraz WP 76®** (a.i. **Propineb + Cymoxanil**)
  - **Score 250 EC®** (a.i. **Difenoconazole**) at the onset of disease symptoms
- **Remove and destroy crop debris** after harvest

3.10.4.i: Blossom End Rot

Advanced Blossom End Rot symptoms on green pepper fruits

3.10.4.i: Blossom End Rot

Symptoms:

- The end of the fruit becomes **off-whitish** to **brown in color** and takes on a **"sunken in" appearance**
- As the fruit matures, these symptoms become **more pronounced** and the color of the rot becomes **dark brown** to almost black

Control:

- Boost the soil with calcium by adding **lime**, **CAN**, **dolomite**, **gypsum** or **composted animal manures** before planting the seedlings
- **Water regularly:** Green pepper continue to flower and bear fruit for prolonged periods of time, so ensure the soil around their roots is kept moist
- **Avoid fertilizers with a high nitrogen content:** Nitrogen fertilizers will promote leaf growth at the expense of fruit, allocating calcium to the leaves instead of to the fruit

4. Harvest

Harvesting of green pepper

4. Harvest

4.1 Harvesting Indices (GHCP&PHHT20: Q17)

- Maturity period range between **2 – 3 months** after transplanting
- Green pepper fruit can be harvested when they are **harvestable-green**
- Green fruit are incapable of ripening after removal from the plant
- The right stage for red fruit is when they have reached **full colour**, **filled out**, **still firm**, **sticky** and **thick walled**

Harvesting Method:

- Since green pepper have soft pliable thin flesh, **care should be taken during harvesting**
- Use clean **knife** or **scissors** to harvest the fruits
- Fruits should be harvested **early in the morning** when it is cool since the fruit temperature is low
- Harvested fruit should be kept in a **cool**, **shaded** and **ventilated area** in order to minimize heat gain
- **Yield on open field** : **150-250 qt/ha**

5. Post-Harvest Handling

Harvested green pepper in the field

5. Post-Harvest Handling

5.1 Containers & Packaging Materials (GHCP&PHHT20: Q18)

- Harvested green peppers are packed into plastic crates then transported to markets

5.2 Value Addition Techniques: Cleaning, Sorting, Grading, & Processing (GHCP&PHHT20: Q19)

Sorting:

- Eliminate all fruits harvested with defects

Grading:

- Grade green pepper based on its **uniform color**, **maturity**, **shape** and **size**

5. Post-Harvest Handling Cont'

Harvested green pepper packed into a box

5.3 Storage

- Harvested green pepper should be placed in the shade immediately to avoid **water loss**, **sunscald**, and **heat damage**

5.4 Transportation

- The cargo should be secured during transportation
- The container should be **clean**, **cool**, **dry** and with **good ventilation**

6. Cost & Income Analysis

Item	Quantity	Unit Price	Total (ETB)
Marketable Yield	30 qt	500 ETB/qt	1,500 ETB
Variable Costs			
Land Preparation	2 days	150ETB/day	300 ETB
Manure/Compost	20 qt	50 ETB/qt	1,000 ETB
Seeds	5qt	1500 ETB/qt	7,500 ETB/qt
Fertilizers	NPS 50kg, Urea 30 kg	1,000 ETB/qt 600 ETB/qt	1,600 ETB/qt
Fungicides	1 bottle	350 ETB	350 ETB
Insecticides	2 bottles	450 ETB	900 ETB
Others e.g.) selective Herbicides			
Labour			
Planting	5 people	150 ETB/person	750 ETB
Spraying/Weeding/Harvesting/Grading	6 people	120 ETB/person	720 ETB/person
Transportation/Packaging	1 isuzu truck	1,000 ETB	1,000 ETB

A sample sheet of items and activities to be considered for determining an enterprise's gross margin

7. Cost & Income Analysis

- Farmers are encouraged to keep accurate records of all enterprise activities **(GHCP&PHHT20: Q20)**
- This is vital in determining the enterprise profitability
- Record keeping is very important for farmers practicing commercial agriculture

There are 2 types of records:

- **Individual Records:**
  - Kept by individual farmers and include the cost of production and sales
  - Useful in analyzing whether the farmer is making profit or losses in his farming enterprise
  - Records are very important for traceability of produce
- **Group Records:**
  - Include activities such as group purchase of inputs, selling of produce etc.

7. Post-Training Evaluation Exercise

QUESTION	YES	NO
1. Green pepper fruits have a mild flavor and are rich in Vitamin A & C.		
2. “Mareko Fana” is the most popular variety in Ethiopia .		
3. Market survey enable buyers to understand the price of green pepper during the peak demand.		
4. Green pepper planting should time the peak market demand.		
5. Land preparation should be done 2 – 3 weeks before planting.		
6. Crop rotation prevents pest and disease build-up.		
7. Green pepper has very few pests.		
8. “Bacterial Soft Rot” is seed-borne and primarily a pre-harvest problem.		
9. Green pepper should be cooled immediately after harvest to avoid heat damage.		
10. Grading is one of the value addition techniques which farmers can do right after the harvest.		

7. Post-Training Evaluation Exercise

*** Please ask the farmers to appropriately indicate answers to each of the following questions.**

PAGE NUMBER	QUESTION	YES	NO
1/46	**1.** Green pepper fruits have a mild flavor and are rich in Vitamin A & C.	✔	
2/46	**2.** “Mareko Fana” is the most popular variety in Ethiopia .	✔	
5/46	**3.** Market survey enable buyers to understand the price of green pepper during the peak demand.		✔
6/46	**4.** Green pepper planting should time the peak market demand.	✔	
10/46	**5.** Land preparation should be done 2 – 3 weeks before planting.		✔
22/46	**6.** Crop rotation prevents pest and disease build-up.	✔	
23/46	**7.** Green pepper has very few pests.		✔
35/46	**8.** “Bacterial Soft Rot” is seed-borne and primarily a pre-harvest problem.		✔
42/46	**9.** Green pepper should be cooled immediately after harvest to avoid heat damage.	✔	
43/46	**10.** Grading is one of the value addition techniques which farmers can do right after the harvest.	✔	

[Note]

- If there is any question which half of the participants gave the wrong answer, you need to repeat the specific area regarding to question