

GARLIC PRODUCTION



SHERP

The logo for SHERP is displayed in a large, bold, stylized font. Each letter is a different color: 'S' is yellow, 'H' is green, 'E' is blue, 'R' is red, and 'P' is white with a red outline. The letters are set against a bright green background.

1. Introduction:

1.1 Background

1-1



Garlic bulbs

1. Introduction:

1.1 Background

- Garlic is one of the most **widely grown & consumed vegetables** in Ethiopia
- Cool weather in highland is suitable for garlic production
- It is originated from the arid and semi-arid areas of central Asia
- Garlic is an important spice for **traditional Ethiopian foods**
- Good source of vitamins and minerals including **Vitamin B & C, Calcium, phosphorus** and **magnesium**
- Allicin, the chemical released when clove is crashed, has function to lower blood sugar level, cholesterol and lipoproteins.
- It also has function to repel pest when crushed liquid sprayed

1.2 Some Common Varieties



“Tsedey”



“Bishoftu Netch”

1.2 Some Common Varieties

“Tsedey” and **“Bishoftu Netch”** are the most common varieties in Ethiopia

- Both cultivars are released from Debre Zeit Agricultural Research Center in 1999/2000

“Tsedey”:

- It takes about **138 days** to mature
- Optimum altitude is **1,900-2,400 masl**
- Farmer’s **Yield Potential is about 60-70 qt / ha** under optimum management with plant density of 333,000

“Bishoftu Netch”:

- It takes about **132 days** to mature
- Optimum altitude is **1,900-2,400 masl**
- Farmer’s **Yield Potential is about 55-85 qt / ha**

【Note】

* Local cultivars have about 4 months dormancy; therefore soon after harvesting bulbs, it is not recommended to cultivate again

* A clove which broke dormancy has a shoot that can be seen by naked eye

1.2 Some Common Varieties Cont'



“Kuriftu”



“Chefe”

1.2 Some Common Varieties

“Kuriftu”

Kuriftu is also another common variety grown in Ethiopia

- This variety was released from Debre Zeit Agricultural Research Center
- The color of the bulb is purple and is a vigorous variety
- Productivity of this variety is **75-85 qt/ha**
- Days to maturity is **140 days**

“Chefe”

Chefe is also another common variety grown in Ethiopia

- This variety was released from Debre Zeit Agricultural Research Center
- The color of the bulb is white
- Productivity of this variety is **66 qt/ha**
- Days to maturity is **120 days**

Other varieties includes;

- Holota, Chelenko I and Qoricho can grow in Ethiopia

1.3 Optimal Ecological Requirements

Altitude	1,800 - 2,500 meter above sea level
Rainfall	600 mm
Growing Temperature	12 – 24 °C
Soils	<ul style="list-style-type: none"> • Fertile and well drained sandy loam light soil • pH range 5.5 – 7.0

1.3 Optimal Ecological Requirements

- **Altitude:** Tropical highland climate is suitable for garlic production and the bulb growth, the adaptable altitude is depend on the variety. Ethiopia has high quality garlic production area in 1,800-2,500m.
- **Rainfall:** Garlic requires **well-distributed rainfall** of between **600 mm** during the growing period.
- **Temperature:** The optimum temperature for growth is **12-24 °C**. If the temperature exceeds **25 °C**, maturity is hastened & small bulbs are produced, consequently lowering the yields. When the temperature is continuously low, the growth is slow-down.
- **Soil:** Garlic requires **fertile** and **well-drained soil**. The optimum pH ranges from **5.5 up to 7.5**. The neutral range can be suppressed white rot disease. Tillage depth and furrow height should be carefully adjusted by each field conditions.

2. Pre-Cultivation Preparation:

2.1 Market Survey



Conducting a market survey on Garlic

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)	Garlic (Gojam)	Medium size	February to April	2 qt/week (1 qt = 100 kg)	Chare, Minjar	80 ETB / kg	Cash	Cash on Delivery	Poor quality (diseased)	Willing to buy at shop
Mr. Kernal Husen (0911-xxxxxx)	Garlic (Local)	Big size	February to May	5qt / day (1qt = 30kg)		250 - .300 ETB / qt	Credit	Within a week	Poor quality (not well dried, rotten)	Willing to buy at farm gate

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 Garlic
- The price of Garlic during the peak demand
- The Potato variety(s) that has the highest demand
- Supply requirements (quantities and frequency)
- Quality market requirements
- Potential buyers and terms of payment etc.

2.2 Crop Planting Calendar

Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
Land preparation Seed preparation: 8-10 qt/ha has to be ready before planting (vary in clove size and planting method)	Spacing: 40 x 20 x 5 cm Plant population 664,000 for double row plants/ha) Fertilizer rate NPS 242 kg/ha & Urea 108kg/ha	Urea top Dressing: 1 st 54kg/ha A week after Emergence and 2 nd 54kg/ha 30 days after the 1 st Application Cultivation or hoeing (2-3 times) Weed, pests & diseases control	Harvesting begins when The leaf tops begin to dry, discolor and bend toward the ground	Harvesting starts when 90% of the leaves begin to fall down Bulb curing Sorting & Grading Yields 66 – 85 qt/ha Marketing Linking with potential buyers	Peak demand for Garlic			

**A Sample of a Garlic Cropping Calendar:
Targeting a peak market demand beginning just after January**

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

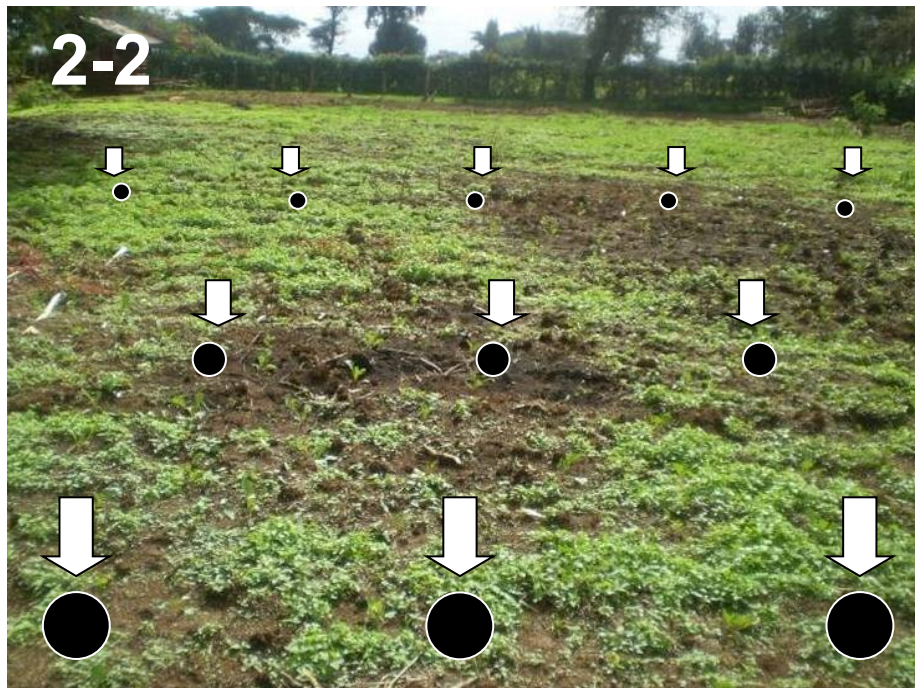
Procedure:

1. Determine from the market survey results (2.1) when there is peak demand for garlic
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



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

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

2.4 Composting



Compost preparation

2.4 Composting (GHCP&PHHT20: Q4)

- During compost making, the organic matter need to be covered to prevent leaching of nutrients
- Based on the results of the soil analysis, prepare adequate compost for application
- Well decomposed farmyard manure/compost is recommended
- Rate of applicatifon of compost is 100 - 120 qt/ha

2.5 Quality Seed/Planting Materials



Improved seeds from a research station and model farmers

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

- Use **disease-free** or **certified seed** (recommended to purchase from a research station and known quality Garlic production area)
- Seed garlic should be in plump with intact roots. It can be obtained by harvesting matured bulb and storing them as whole bulbs. (bulbs without roots might be infected by white rot disease)
- Plant big cloves. The larger the clove, the larger the garlic bulbs it produces (eat small cloves and plant larger cloves!)
- Garlic seeds can be propagated by farmers with carefully removing diseased and weak, unhealthy plants
- Disease control and quality production are the key of the priority for seed production.
- Garlic growers should obtain fresh planting seed every 3 seasons
- Positive selection of growing plants to obtain own seed for planting the following season is a good short term alternative

3. Cultural Practices:

3.1 Land Preparation



Well prepared Garlic Field

3. Cultural Practices:

3.1 Land Preparation

Land Preparation Practices:

(GHCP&PHHT20: Q6)

- The soils should be well tilled to provide a loose growing bed for bulb development; therefore soils should be **ploughed thoroughly** 3 – 5 times and leveled properly
- Land set aside for garlic production should **Not** have been grown with another **Alliaceae family (onions, shallots and leeks)** for **3 years** to control pest and diseases as well as maintain soil nutrients.
- The field is ploughed to the depth of **15-20 cm**
- Remove volunteer plants in the field in order to avoid spread of diseases

3.2 Incorporation of Crop Residues

3-2



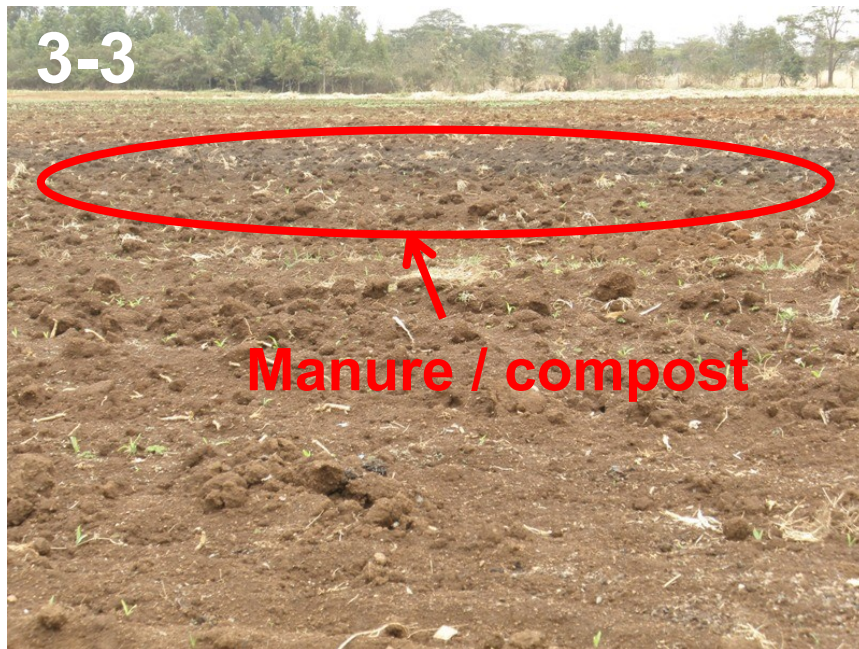
Crop residues to be incorporated in a field

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 ploughed in during land preparation
- Garlic grows best in well drained fertile soils that are high in organic matter
- Incorporating crop residues or well-rotted manure into heavy soils will result in the soil being suitable for production
- **However, if the crop residues belong to the Alliaceae family (onions, shallots and leeks), remove and burn the residue to avoid possible risk of disease build up**

3.3 Basal Application

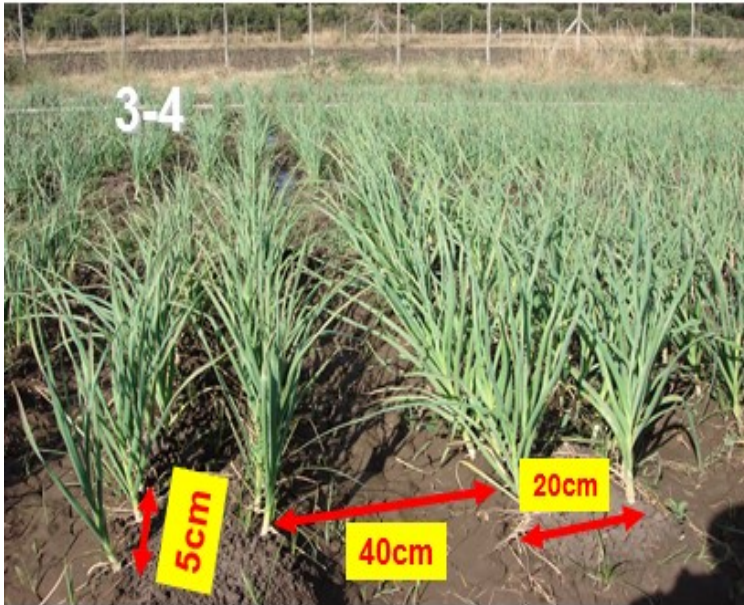


Compost incorporation as a basal application

3.3 Basal Application (GHCP&PHHT20: Q8)

- Applying manure/compost is vital for garlic production since garlic has longer growing period. Manure release their nutrients slowly which is suitable for garlic growth and can improve storability of garlic.
- As garlic is shallow rooted vegetable and has un-branched root system and low nutrient extraction capacity, it requires relatively high amount of nutrients for best growth and development
- Therefore, **basal application of manure/compost** is essential.

3.4 Planting



Garlic field showing plant spacing

3.4 Planting

3.4.1 Appropriate Time:

- Under rain-fed production, the beginning of the rainy season (June) is the preferable period. It is possible to plant in August under irrigation.
- **Seeding rate: 8-10 qt/ha** = depending on the planting method and clove size

3.4.2 Recommended Spacing (GHCP&PHHT20: Q10):

Single row: 20 cm (between row) and 5-10 cm (between plants)

- Make a 10cm trench and apply basal fertilizer and cover with 5cm of soil before planting.
- Planting depth is **5 cm** and the sprouts should be placed facing upwards & the seed covered by a layer of soil

Double row: 40cm between double rows on a ridge, 20 m between rows and 5-10 cm between cloves.

3.4.3 Fertilizer Application Rates (GHCP&PHHT20: Q11):

- **NPS 242 kg/ha and 108 kg /ha of Urea**
- Band application below or 5 cm to the side of a clove is recommended at planting.
- Fertilizer should thoroughly mixed to avoid scorching of sprouts
- Half rate of the Urea should be applied a week after emergence and the remaining half **is applied 4 weeks after the 1st application**

3.5 Water Requirement



Garlic crop under irrigation

3.5 Water Requirement (GHCP&PHHT20: Q12)

- Garlic has a rather sparse and shallow root system; therefore, it is **sensitive to water-stress** throughout the growing season
- Any period of dry soil conditions, especially **during bulbing period** will result in yield reductions
- Irrigate every 3-4 days from planting until more than 80% of planted cloves sprout
- Then it can be reduced to **once a week**.
- Irrigation should be stopped **3 weeks before harvest** or **at maturity stage** when leaves start senescing or turning yellow and necks become soft.
- **Mulching:** covering the soil surface with straw or any other materials to conserve soil moisture and suppress the weeds are essential. This method can also effective for rust disease control since mulch can protect soil from rain drop splash

3.6 Managing of Weeds



**Weed infested
garlic field**



Weed free garlic field

3.6 Managing of Weeds (GHCP&PHHT20: Q13)

- Garlic has shallow roots and sparse canopy; therefore it difficult to compete with weeds especially at the early stage of growth.
- Weeding is done **after germination** to avoid uprooting of garlic plants by hand
 - **1st Weeding:** 1 – 2 weeks after emergence
 - **2nd Weeding:** 4 – 5 weeks after crop emergence
- **Do Not weed when the soil is wet** to avoid compaction
- Deep cultivation close to the plants should be avoided
- Mulching is recommended in the following reasons:
 - 1) Suppressing weeds
 - 2) Maintaining soil moisture contents
 - 3) Disease control
 - 4) Mulching materials can be utilize as organic matter for next cropping

3.7 Top-dressing



**Strip/banding top-dressing
of garlic**

3.7 Top-dressing (GHCP&PHHT20: Q14)

- Soil characteristic should be considered to decide the amount and frequency of fertilizer application (high clay contents soil can hold nutrients longer)
- Strip/banding method is preferred over broadcasting as it is more effective
- Top-dress using UREA (**108 kg/ha**) in 2 splits
 - 1st Top-dressing: **a week** after emergence
 - 2nd Top-dressing: **4 weeks** after 1st application
- Top-dressing should be completed **before initiation of bulbing**
- Delayed application (when bulbs are beginning to enlarge) result in excessive leaf growth and reduce bulb size
- NPS or DAP fertilizer doesn't contain potassium even though it is one of the major macronutrients; therefore applying manure as basal dress is essential.
- In addition, **applying ash** as top dressing is recommended every two weeks.

3.8 Pests & Diseases Control

3.8.1 Control/Management Strategies

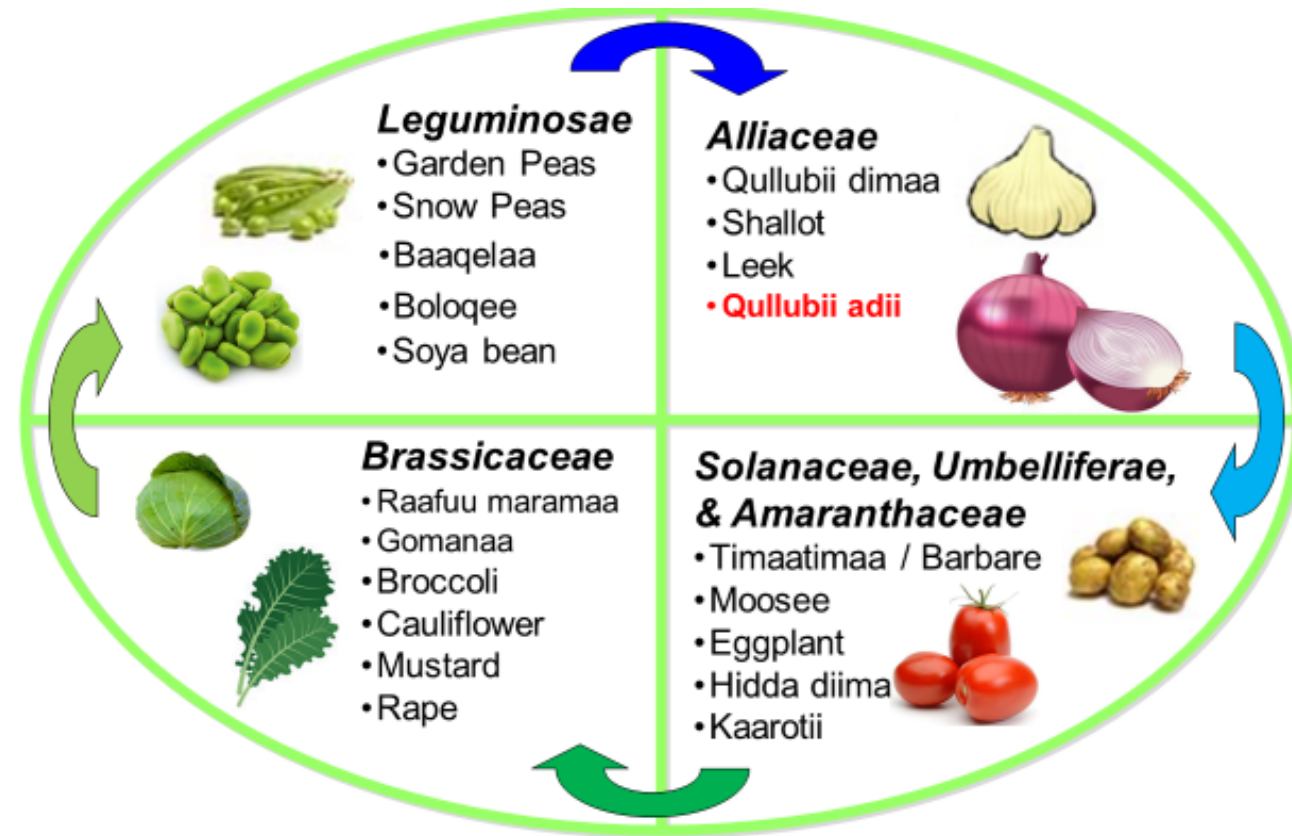
1.	Cultural Control
2.	Mechanical Control
3.	Biological Control
4.	Chemical Control
5.	Integrated Pest Management (IPM)

3.8 Pests & Diseases Control

3.8.1 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 repellent 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.

3.8.2 Crop Rotation



An example of a Crop Rotation

3.8.2 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

3.8.3 Major Pests and diseases



3.8.3. Major Diseases and Pests

- Disease infestation leads to reduction in quality and quantity of produce
- The proper understanding of each disease symptoms and characters can help to develop integrated disease control methods.
- The following are the major pest and diseases of garlic in Ethiopia:
 - a. **White rot**
 - b. **Thrips**
 - c. **Rust**

3.8.3.A: White rot



**White rot diseases
on garlic bulbs**

3.8.3.A: White Rot Disease

General Descriptions:

- The disease is caused by a soil borne fungus
- It may **survive 10 – 15 years** in soil without the presence of an *Allium* host. Only onion family (onion, leek and shallot) are attacked.
- Optimum soil temperature for the **fungus is 16-18°C**

Symptoms:

- Infected leaves show **yellowing, leaf dieback** and **wilting**
- **Leaf decay** begins at the base
- Older leaves collapse first
- Roots are **rotted**, and the plant can be pulled out from the ground easily

Control: (Integrated approach is needed)

1. If disease is observed, **cessation of irrigation** will minimize damage but not stop the disease
2. Follow a long-term (**over 5 years**) rotation schedule
3. Do not follow onion family with other onion family
4. **Clean farm tools** before moving from a field
5. Use clean planting materials or treat seeds by 45 °C **hot water for 15 minutes** (Apron Star 42 WS or tebuconazole is also effective for seed treatment)
6. Treat cloves with Sodium hypochlorate (berekina) at 1:100 dilution ratio (1 liter berekina with 100 liter of water)
7. Remove infected plants as early as possible from the field
8. Plant early maturing cultivars or **resistant cultivars**

3.8.3.B: Thrips



Thrips on garlic leaves

3.9.3.B: Thrips

Identification:

- The pest feeds on **the base of the plant** within the **leaf sheaths**
- Attacked leaves have **sunken silvery patches**

Life cycle

- Thrips have **maximum 8 generation** a year
- The life cycle from egg to adult would be completed in as short a time as **2 weeks**. (when the weather is warm)

Damages:

- Under severe attack, the entire plant appears **silvery** and later the leaves **wither, dry up** and **die**
- The pest excreta appears as **black spots** on the silvery leaves

Control:

- Keep plants well irrigated & avoid excessive applications of nitrogen fertilizer, which would invite more thrips
- Maintain weed-free plots
- **15 thrips per plant** would be a threshold for red onion
- **Spray with insecticides**, such as
 - **Achook EC®** or **Nimbecidine®** (a.i. **Azadirachtin**)
 - **Tracer®** (a.i. **Spinosad**)
 - **Marathon 50 EC®** (a.i. **Malathion**)
 - **Tata Alpha EC®** (a.i. **Alpha-cypermethrin**)

3.8.3.C: Garlic Rust



3.8.3.C: Garlic Rust

General Description:

- The disease is caused by a **fungus**
- **Need 4 hours of wet condition** to germinate and infect but do not survive when immersed in water.
- Optimum temperature for infection are **between 10 and 15°C**

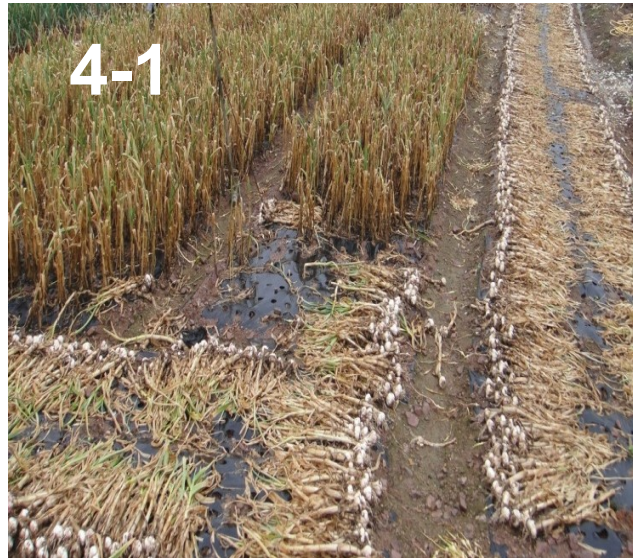
Symptoms:

The fungi infect foliage, producing yellowish orange flecks soon turn to bright orange, pustules on the undersides of leaves. Then start releasing spores.

Control:

- Avoid applying **too much nitrogen** which encourages soft, leafy shoots that are easily attacked by fungal diseases
- Plant bulbs at a **wider spacing** than before in order to improve air circulation and reduce humidity
- **Do NOT plant garlic** next year, if you have had a rust infection in the past.
- Avoid planting garlic after growing onion, leek or shallot
- Mancozeb can be effective on the very beginning of the symptoms found, otherwise apply tebuconazole every 2 weeks intervals.
- Other fungicides like Tilt, Axial , Natura, etc can also be effective against garlic rust

4. Harvest



Harvesting garlic

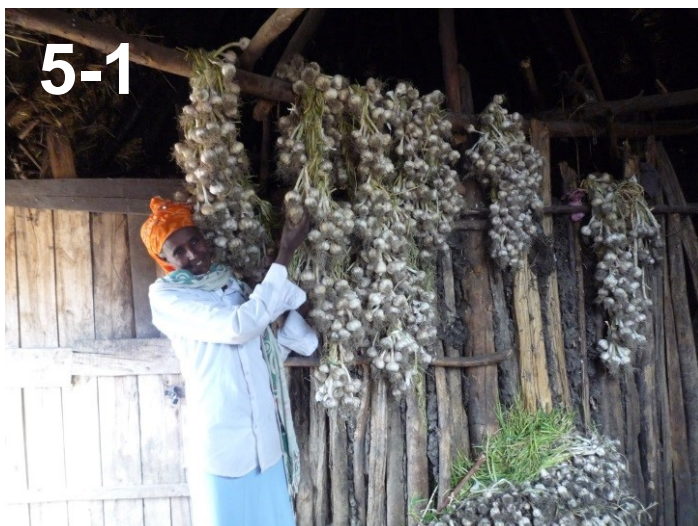
4. Harvest

4.1 Harvesting Indices (GHCP&PHHT20: Q17)

- Harvesting is done from **90-120 days** after sowing depending on the agroecology (temperature) of the growing area
- Increase in bulb size of garlic continues until the leaves of the plants begin to dry, turning tan brown from the tips toward the base of the leaves.
- Bulbs should be harvested when leaves turn yellow, necks soften and/or bend over.
- Those bulbs have distinct and well-formed cloves which can store well.
- Early harvesting results in bulbs which are immature and tend to shrivel when cured.
- Late harvesting may lead to stained bulbs, decayed wrapper leaves and loss of roots leading to splitting of cloves due to attack by black mold and sclerotium rot.

5. Post-Harvest Handling

5.1 Curing



5-1

Curing by hanging



5-2

Curing on DLS

5. Post-Harvest Handling

5.1 Curing

- The purpose of the curing is to store longer duration and prevent **diseases/pests**, hence **prolonging the shelf life**
- After harvesting, the plants should be moved from the field **into a dark, dry, well-ventilated area** for drying and curing of the bulbs.
- Bulbs should be moved **out of the sunshine** as quickly as possible after digging. (Do not dry by laying the plants in the sunshine).
- Tops and roots can be removed after several weeks when drying and curing are complete. (The top of a cured bulb is topped at **about 2.5cm above** the bulb)
- Hanging garlic bunches under ceilings of houses is also common practice to maintain planting material for next season in Ethiopia.
- In Ethiopia, bulbs are transported and stored in 25, 50, 120kg bags in dry stores by vendors.
- Storage life under appropriate conditions could be **5 – 8 months at room temperature** for seed purpose depending on the variety.
- Storage at 0C and 60% relative humidity can prolonged storage period.
- The higher the temperature, the shorter the storage life.
- Adequate air flow and proper storage containers are important to remove transpired heat and moisture. Otherwise, higher relative humidity provides suitable conditions for development of mold and root growth.

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. Garlic grows well under cool temperature and highland in Ethiopia		
2. Spacing between plant should be 15 cm depends on the size of cloves and variety, however, the position of the cloves are not important.		
4. Applying manure is important for garlic production since its has longer growing period.		
5. Applying ash can increase bulb size and quality		
3. Seed sterilization using hot water or Tebconazole, Apron star can reduce the infection of white rot disease.		
6. There is no problem to plant the field, which have seen severe white rot diseases, in the following year.		
7. White rot disease can survive 3 years in soil without the presence of <i>Allium</i> host		
8. It is important to start controlling when you find 15 thrips per plant		
9. Garlic can be dried under direct sunlight to improve bulb qualities		
10. Garlic should be kept inside the room without any ventilation		

7. Post-Training Evaluation Exercise

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

PAGE NUMBER	QUESTION	YES	NO
1/27	1. Garlic grows well under cool temperature and highland in Ethiopia	✓	
2/27	2. Spacing between plant should be 15 cm depends on the size of cloves and variety, however, the position of the cloves are not important.		✓
13/27	4. Applying manure is important for garlic production since its has longer growing period.	✓	
17/27	5. Applying ash can increase bulb size and quality	✓	
21/27	3. Seed sterilization using hot water or Tebconazole, Apron star can reduce the infection of white rot disease.	✓	
21/27	6. There is no problem to plant the field, which have seen severe white rot diseases, in the following year.		✓
21/27	7. White rot disease can survive 3 years in soil without the presence of <i>Allium</i> host		✓
22/27	8. It is important to start controlling when you find 15 thrips per plant	✓	
25/27	9. Garlic can be dried under direct sunlight to improve bulb qualities		✓
25/27	10. Garlic should be kept inside the room without any ventilation		✓

[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