Smallholder Horticulture Empowerment & Promotion Project for Local and Up-Scaling (SHEP PLUS)

“Changing Farmers’ Mindset from “Grow and Sell” to ”Grow to Sell””

CABBAGE PRODUCTION

Prepared by SHEP PLUS

Photos: SHEP PLUS
To provide basic information on production, post-harvest handling, and marketing of Cabbage

Contents:
1. Introduction: Background, Common Varieties and Optimal Ecological Requirements
2. Pre-Cultivation Preparation 1 – 5
3. Cultural Practices 1- 9
4. Harvest
5. Post-Harvest Handling
6. Cost & Income Analysis
7. Post-Training Evaluation Exercise

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Preface
- This training material applies the fundamental practices essential for crop production and successful marketing to put into perspective the case of horticultural crop production.
- The fundamental practices are categorized into seven (7) broad topics and twenty (20) sub-topics; the twenty sub-topics are referred to as the General Horticulture Crop Production and Post-Harvest Handling Techniques (GHCP & PHHT20). This categorization is based on the Smallholder Horticulture Empowerment & Promotion Unit Project (SHEP UP) experience in mitigating production and marketing challenges facing smallholder horticultural farmers.
- The seven (7) broad topics are: Pre-Cultivation Preparation; Land Preparation; Crop Establishment (Planting/Transplanting); Crop Management; Harvest; Post-Harvest Handling; and Cost and Income Analysis.
- The sub-topics under each topic are as follows: Pre-Cultivation Preparation (market survey, crop planting calendar(s), soil sampling & analysis, composting, and quality seed/planting material(s)); Land Preparation (land preparation practices, incorporation of crop residues, and basal application); Crop Establishment (raising seedlings, planting/transplanting, fertilizer application); Crop Management (water requirement, managing of weeds, top-dressing, pests & diseases management practices, and safe & effective use of pesticides); Harvest (harvesting indices); Post-Harvest Handling (appropriate containers/standard packaging materials, and value addition techniques); and Cost and Income Analysis (cost and income analysis).
- The issues outlined in the twenty (20) sub-topics might not necessarily be applicable in all cases. But where applicable, it is recommended that the instructions issued be given due consideration.

Disclaimer
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1. Introduction:

1.1 Background

Cabbage (Kabeji)
1. Introduction:
1.1 Background

Cabbage is a member of the **Brassicaceae (Cruciferae) family** which includes crops such as **Kale, Cauliflower, Broccoli** and **Radish**.

- Three main types: **Green, Red** and **Savoy**
- One of the most **widely grown, popular and nutritious vegetables** in Kenya mainly for the domestic market.
- Grown by both small and medium scale farmers.
- Contains **Calcium, Iron, Vitamin A, C & E, Minerals, Riboflavin, Nicotinamine and Ascorbic Acid**.
- Cabbage has a cleansing effect on the stomach and intestinal tract if consumed raw without salt due to high sulphur and chlorine content.

Cabbage (Kabeji)
1.2 Common Varieties

“Gloria F1”

“Copenhagen Market”

Photos: http://thekenyan.co.ke/farming/cabbage-growing-in-kenya/
1.2 Common Varieties

1.2 Some Common Varieties

• The following are the common varieties grown in Kenya

“Gloria F1”

• A medium-late maturing variety ready for harvesting 90 days after transplanting. Has solid blue green color and thick waxy layer. It is not prone to splitting and keeps well after harvesting.

• Tolerant to Black Rot and resistant to Fusarium yellows

• Plant Spacing: 60 cm x 60 cm

• Maturity: 90 days after transplanting (medium-late maturing)

• Plant population: 11,111 per acre

• Average head weight 3-5 kg

• Yield: 30,000-50,000 kg per acre

“Copenhagen Market”:

• Requires a cool/warm climate

• Plant Spacing: 60 cm x 45 cm

• Plant population: 14,800 per acre

• Maturity: 65 – 70 days after transplanting (early maturing)

• Head: small to medium round shape with uniform size, weighing 2 – 2.5 kg

• Yield: 20,000 – 30,000 kg per acre

Photos: http://thekenyan.co.ke/farming/cabbage-growing-in-kenya/
1.2 Common Varieties Cont’

“Blue Dynasty F1”


“Baraka F1”

Photo: http://www.easeed.com/index.php/2015-07-16-12-56-29/vegetables/cabbage-baraka-f1
1.2 Some Common Varieties Cont’

“Blue Dynasty F1”
- Good tolerance to **Black Rot, Cabbage Ring Spot, Diamond Back Moth (DBM) & Fusarium Yellows**
- Can do well in warm areas
- **Plant Spacing:** 60 cm x 60 cm
- **Plant population:** 11,111 heads per an acre
- **Maturity:** 80 – 85 days after transplanting (**medium-late maturing**)
- **Head:** round compact shape, weighing 4 – 5 kg
- **Yield:** 45,000 – 68,000 kg per acre

“Baraka F1”:
- High yielding bluish green round heads weighing 4 – 6 kg
- **Maturity:** 75 days
- Good field holding capacity
- High tolerance to **Black Rot, Ring Spot & Cabbage Yellows**
- Good ground clearance
- **Yield:** 40,000 – 50,000 kg per acre
1.2 Common Varieties Cont’

“Green Challenger F1”

“Pruktor F1”

Photo: http://www.seminis.com/global/in/products/Pages/Green Challenger.aspx

1.2 Some Common Varieties Cont’

“Green Challenger F1”
- Blue green colour with rich creamy internal colour
- Tolerance to Diamond Back Moth (DBM), Black Rot & Fusarium Yellows
- Plant Spacing: 30 x 30 cm/60 x 60 cm
- Plant Population: 11,111-44,444 per acre
- Maturity: 60 days after transplanting (early maturing)
- Head: round shape with compact size, weighing 2.5 – 3 kg
- Yield: 40,000 – 50,000kg per acre

“Pruktor F1”:
- Plant Spacing: 60 cm x 60 cm
- Population: 11,111 per acre
- Sweet flavor
- Tolerant to Black Rot and Diamond Back Moth (DBM)
- Tolerant to low night temperatures
- Maturity: 80 days after transplanting
- Head: uniform size, weighing 5 – 6 kg
- Yield: 50,000 – 60,000kg per acre
1.2 Common Varieties Cont’

“Riana F1”

Information Source: http://egv.aparte.dk
1.2 Some Common Varieties Cont’

“Riana F1”
- **Plant Spacing:** 60 cm x 60 cm
- Both heat and cold tolerant, blue green, white internal color
- Resistant to splitting when irrigated or rain fed
- **Maturity:** 90 – 100 days after transplanting
- **Head:** Round and compact, weighing 1.5 – 2.5 kg
- Tolerant to **Black Rot** and **Tip Burn**
- **Yield:** 15,000 – 30,000 kg per acre

“Amigo F1”:
- Tolerant to **Black Rot** and **Diamond Back Moth (DBM)**
- Green and semi round heads 4 – 6 kg
- Requires warm/cool areas, **Maturity:** 90 – 100 days
- **Yield:** 45,000 – 68,000 kg per acre

Other varieties grown in Kenya are:
- Prize Drumhead
- Glory of Enkhuizen
- Golden Acre
- Sugar Loaf
- Fortuna
- K-Y Cross
- Early Market F1
- **Super Master F1**
- **Oxylus**
- **Star 3308 F1**
- **Santa F1**
- **Rotan F1**
- **Field Winner F1**
- **Globe Master Hybrid F1**
- **Queen F1**
- **Fanaka F1**
- **Tristar**
1.3 Other types of Cabbages

“Red Acre”

“Savoy Cabbage”
1.3 Other types of Cabbages

1. Red Type
- Red Cabbage (*Brassica oleracea var. capitata fruiticosa rubra*) is just another form within same species and has much in common with Green Cabbage
- Red Cabbage has *twice* as much *Vitamin C* as Green Cabbage
- Grown varieties in Kenya are “Mammoth Red Rock (1.2-2.0kg/ head)”, “Red Acre (1.2-2.0kg/ head)”, “Red Dynasty (4-5kg/ head, 45-56t/ acre)” “Ruby Ball” etc.

2. Savoy Type
- **“Savoy Cabbage”:**
  - Savoy Cabbage (*Brassica oleracea var. sabauda*) has *deeply crinkled and ruffled textured leaves*
  - Savoy Cabbage is milder and tastier than Red and Green Cabbages and has *beta-carotene*
## 1.3 Optimal Ecological Requirements

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<tr>
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<td><strong>Altitude</strong></td>
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<td><strong>Growing</strong></td>
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<td><strong>Temperature</strong></td>
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<td><strong>Soils</strong></td>
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|                   | • High organic matter content      |
|                   | • pH range 6.0 – 6.5              |

1.3 Optimal Ecological Requirements

- **Altitude:** Cabbage can be grown in altitudes ranging from **700 – 2,200 m** above sea level. At low altitude the crop should be grown during the cool months of the year.

- **Rainfall:** Cabbage has a **high water requirement** and at least **500 mm** of rainfall well distributed throughout the growing period is required.

- **Temperature:** Cabbage performs better under **cool temperatures** and the **optimum temperature** range for production is **16 – 20 ºC**. Temperatures above **25 ºC** hamper head formation.

- **Soil:** Cabbage requires **well drained sandy** or **silty loams** with high organic matter content and high water holding capacity. The optimal soil pH range is **6.0 – 6.5**.
2. G20 technologies

1. Market survey
2. Crop planting calendar
3. Soil testing
4. Composting
5. Use of quality planting materials
6. Recommended land preparation practices
7. Incorporating crop residues
8. Basal application of compost/manure
9. Recommended practices of seedling preparation/seedlings from registered nursery
2. G20 technologies

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[G20 Technologies]
Make sure to support farmers carry out G20 techniques for any crop
2. G20 technologies

10. Recommended spacing
11. Recommended fertilizer application rate
12. Supplementing water
13. Timely weeding
14. Top-dressing
15. IPM practices
16. Safe and effective use of pesticides
17. Use of harvesting indices
18. Appropriate post harvest handling containers
19. Value addition techniques
20. Keeping farm records
2. G20 technologies

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[G20 Technologies]
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### 2.1 Crop Planting Calendar

#### A Sample of a Cabbage Planting Calendar

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<th>Control of damping-off diseases &amp; cutworms</th>
<th>Transplant 30 days after seed germination</th>
<th>Weeds, pests &amp; diseases control</th>
<th>2nd top-dress 200 kg CAN per acre (20 g/hole = 4 bottle tops/hole)</th>
<th>Harvesting starts 75 – 120 days after transplanting</th>
<th>Weeds, pests &amp; diseases control</th>
<th>Sorting &amp; grading Small 1-2 kg Med. 3-4 kg Large &gt; 5 kg</th>
<th>Yields 16 – 68 tons/acre</th>
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Peak demand for Cabbage
2.1 Crop Planting Calendar

A Sample of a Cabbage Planting Calendar: Targeting a peak market demand beginning just after November

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<td>Transplant 30 days after seed germination</td>
<td>Spacing: 60cm x 45-60cm</td>
<td>Fertilizer (DAP) application: 80 kg/acre (10 g/hole = 2 bottle tops/hole)</td>
<td>Manure application: 9 tons/acre (2 – 3 handfuls/hole)</td>
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<tr>
<td>Weed, pests &amp; diseases control</td>
<td>1st top-dress: 100 kg CAN per acre (10 g/hole = 2 bottle tops/hole)</td>
<td>2nd top-dress: 200 kg CAN per acre (20 g/hole = 4 bottle tops/hole)</td>
<td>Harvesting starts: 75 – 120 days after transplanting</td>
<td>Sorting &amp; grading: Small 1-2 kg, Med. 3-4 kg, Large &gt; 5 kg</td>
<td>Yields: 16 – 68 tons/acre</td>
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Peak demand for Cabbage

2.1 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 Cabbage
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
2.2 Composting

Manure preparation through composting
2.2 Composting

• Cabbage, like most leafy vegetables, is a heavy feeder and does well in soils with high organic content

• Based on the results of the soil analysis, prepare adequate compost for application

• During compost making, the organic matter need to be covered to prevent leaching of nutrients

• The recommended rate of application ranges from 5 – 8 tons/acre
3.1 Basal Application

Manure prepared for basal application
3.1 Basal Application

The manure/compost should be broadcasted (5 – 8 tones/acre) then worked into the soil (incorporated) preferably using a hoe.

Manure/compost should be applied 1 – 2 weeks before transplanting.

Manure prepared for basal application
3.2 Raising Seedlings

A Cabbage nursery

Photo: SHEP PLUS
3.2 Raising Seedlings

- Use certified seed with special attributes, such as tolerance/resistance to pest and diseases and high yielding
- The seed rate is about 100-120 g/acre (depending on variety (F1/OP) and spacing)

Nursery Site Selection:
- Avoid setting up the nursery in fields previously having a Cabbage crop

Nursery Establishment:
- Prepare a seedbed of 1 m width and of a convenient length
- Make drills on the seedbed at a spacing of 10 – 20 cm apart
- Thinly sow the seeds in the drills and cover lightly with soil

Management of Nursery:
- Water thoroughly after transplanting and regularly
- However, avoid over-watering which can lead to “Damping-off” disease
- Start hardening the seedlings 1 – 2 weeks before transplanting by reducing the frequency of watering and the shade over the nursery
- Mulching is important to provide favourable environment for seedlings
3.3 Transplanting

Cabbage crop 2 weeks after transplanting
3.3 Transplanting

3.3.1 Appropriate Time
- Seedlings are transplanted 30 days after seed germination
- It is recommended that transplanting should be done either early in the morning or late in the evening

3.3.2 Recommended Spacing (GHCP&PHHT20: Q10)
- The recommended spacing is 60 cm between rows and 45 – 60 cm between plants depending on the variety
- Plant population: 11,000 – 14,800 plants/acre

3.3.3 Fertilizer Application Rates (GHCP&PHHT2: Q11)
- Apply 2 – 3 handfuls of manure per planting hole (8 tons/acre) and 2 half-litre water bottle tops (10 g) of DAP per planting hole (80 kg/acre)

[Note]
- DAP should not be applied on acid soils, use DSP, TSP or NPK
- Only thoroughly decomposed manure should be used to avoid possible introduction of cutworms in the field
- The DAP fertilizer should be mixed thoroughly with the soil to avoid possible scorching of the seedlings

Cabbage crop 2 weeks after transplanting

Photo: SHEP PLUS
3.4 Water Requirement

Cabbage under drip irrigation

Photo: © Victor Omari HCD 2019
3.4 Water Requirement

• The optimal amount of rainfall required for Cabbage during the growing period is 500 mm.

• Regular watering ensures uniform head formation, prevents head splitting and increases the size of the head.

• Watering should be reduced as crop matures.

• Excessive watering increases water logging hence deficiencies of Magnesium and Phosphorus.

• Use potable water for irrigation for food hygiene.

Irrigation Methods:
• Irrigation can be overhead, drip or furrow.
3.5 Top-dressing

Top-dressing using the placement method
3.5 Top-dressing

The crop should be top dressed with CAN fertilizer in 2 splits to avoid nutrient loss through leaching as well as excessive soil salinity.

- The first split is applied at a rate of 10 g/plant (100 kg/acre) 2 – 3 weeks after transplanting.
- The second split is applied at a rate of 20 gm/plant (200 kg/acre) at the onset of head formation (KARI & The Rockefeller Foundation, 2005).
- Placement method is preferred over broadcasting as it is more effective and economical.

Cabbage top-dressed with CAN using the placement method.
3.6.1 Major Pests

Photo: SHEP PLUS

Photo: © A. M. Valera, icipe

Photo: R.J. Reynolds Tobacco Company Slide Set, R.J. Reynolds Tobacco Company, Bugwood.org (CC BY 3.0 US)

Photo: © A. M. Valera, icipe (CC BY-NC-SA 3.0)
http://infonet-biovision.org/PlantHealth/Pests/Cutworms#
3.6.1 Major Pests

- Pest damage causes a reduction in quality and quantity of produce

- The following are the major pests of Cabbage in Kenya:

A. Diamond Back Moth (DBM)
B. Cabbage Sawfly
C. Aphids
D. Slugs
E. Cutworms
3.6.1.A: Diamond Back Moth (DBM)

Cabbage plant damaged by the DBM larvae

Photo: A. M. Varela, icipe (CC BY-NC-SA 3.0)
3.6.1.A: Diamond Back Moth (DBM)

Identification:
- Male adult is small grayish moth with diamond pattern on its back when wings are closed
- Eggs laid on upper surface of leaves (one female can lay 400 eggs)

Damages:
- The pale green larvae feed on the underside of leaves making "windows"
- Pupation takes place into a silken gauze-like cocoon at underside of leaf
- Infestations are normally serious in drier months
- Failure to form heads if infested early

Control:
- Use of bio-insecticides such as *Bacillus thuringiensis* (Bt) (DELFIN 6.4W.G® and HALT 50WP®)
3.6.1.A: Diamond Back Moth (DBM) Cont’

“Indian Mustard”: Trap Crop to reduce DBM destruction on Cabbage
3.6.1.A: Diamond Back Moth (DBM) Cont’

Control Cont’:
- **Intercropping with other crops** which act as repellants (e.g. Tomato) or **trap crops** (e.g. **Indian Mustard**) reduces DBM destruction on Cabbage
- When Tomato is used as a repellant, Cabbage is planted **30 days after Tomato**
- **Use of parasitic wasp** (*Diadegma spp.*)
- Use of neem products, such as **azadirachtin** (**Neemraj Super 3000®**) etc.
- **Use of pesticides**, such as
  - Chlorantraniprole 200g/L (**CORAGEN 20 SC®**)
  - Indoxcarb (**AVAUNT 150 EC®**)
  - Malathion (**FEDOTHION 50 EC®**)
  - Flubendiamide 480g/L (**BELT 480 SC®**)
  - Methoxyfenoxide (**RUNNER 240 SC**)

“Indian Mustard”: Trap Crop to reduce DBM destruction on Cabbage

Photo: By Indiaphotoblog at en.wikipedia. CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=17047173
3.6.1.B: Cabbage Sawfly

A “Cabbage Sawfly” larva and damage on a Cabbage leaf

Photo: © A. M. Valera, icipe
3.6.1.B: Cabbage Sawfly

Identification:
• Adult is a wasp with dark thorax and blight yellow abdomen
• Adults fly slowly above the crop
• Eggs laid singly inside the leaf
• The grayish green larvae with fleshy warts along the body feed on the blade of the leaves: often leaving only the main veins and midrib
• Larvae drop to the ground if there is slight disturbance
• Pupation takes place inside the soil
• Spin tough silken cocoons

Control
• Destruction of wild plants of the Brassicaceae family
• Use of pesticides, such as
  – Methoxyfenozide (RUNNER 240SC®)
  – Imidacloprid (MURCLOPRID 25 WP®)
  – Trichlorfon (DIPTEREX 95 SP®)

A “Cabbage Sawfly” larva and damage on a Cabbage leaf
3.6.1.C: Aphids

Underside of a Cabbage leaf infested with Aphids

Photo: SHEP PLUS
3.6.1.C: Aphids

Important Types:
- Mealy Cabbage Aphid
- False Cabbage Aphid
- Green Peach Aphid

Identification of Mealy Cabbage Aphid:
- They are pale green and usually covered with a light dust of mealy powder
- They suck plant sap from the central part of the plant and near the base of leaves

Damage:
- Aphid attack results in curled and distorted leaves which in turn leads to poor head formation

Control:
- Field hygiene through removal and destruction of crop residue
- Natural enemies (Parasitic Wasps)
- Use of Biopesticide products, such as
  - Azadiractin (NEEMRAJ SUPER®, ACHOOK 0.15% EC®)
- Use of insecticides, such as
  - Imidacloprid (EMERALD Gold®)
  - Lambdacyhalothrin (KARATE 2.5WG®)
  - Thiocyclam 50% w/w of thiocyclam-hydrogenoxalate (EVISECTS®)
3.6.1.D: Slugs

Photo: R.J. Reynolds Tobacco Company Slide Set, R.J. Reynolds Tobacco Company, Bugwood.org (CC BY 3.0 US)

Cabbage plant damaged by slug
3.6.1.D: Slugs

**Identification:**
- Found under the leaves

**Damage:**
- Reduced quality and marketability

**Control:**
- Cultural control by drowning the slugs in water (bury tins at ground level and fill with water) and **add yeast** to attract the slugs
- **Use slug pellets**

Cabbage plant damaged by slug
3.6.1.E: Cutworms

A Cutworm larva

Photo: © A. M. Valera, icipe (CC BY-NC-SA 3.0) http://infonet-biovision.org/PlantHealth/Pests/Cutworms#
3.6.1.E: Cutworms

Identification:
- They are **grayish black larvae** that partially or completely bite the stem at ground level **causing the plant to fall over**
- They are often found hiding in soil near the cut seedlings

Control:
- **Hand removal** since the pest is easily found near the damaged plant, especially at the beginning of infestation
- **Early weeding** destroys sites for egg laying
- **Ploughing** exposes the pest to its predators and desiccation
- **Use of appropriate insecticides**, such as
  - Beauviera bassiana/ biological insecticide  (BIOPOWER 1.5®)
  - Lambda Cyhalothrin (TATA UMEME 2.5EC®)
  - Acephate (ASATAF SP®)  
    *(Drenching should be done in the evenings)*
3.6.2 Major Diseases
3.6.2 Major Diseases

- Disease infection leads to reduction in quality and quantity of produce
- The following are the major diseases of Cabbage in Kenya:
  a. Damping-off
  b. Bacterial Black Rot
  c. Black Leg (Dry Rot Canker)
  d. Ring Spot
  e. Alternaria Leaf Spot
  f. Bacterial Soft Rot
  g. Club Root
3.6.2.a: Damping-off

Symptom of “Damping-off”
3.6.2.a: Damping-off

Symptom of “Damping-off”

General Descriptions:

• The disease is caused by the fungi
• Common problem at the nursery stage
• More likely prevalent during rainy season
• Too much moisture will dispose the crop to the disease

Symptoms:

• Seedlings rot at the base of the stem thus falling over to the ground

Control:

• Avoid dense sowing which cause damp conditions
• Avoid excessive watering and fertilization, particularly with nitrates
• Avoid fields with a history of the disease
• Practice crop rotation
• Use certified disease-free seed
• Solarization of seedbed where feasible
• Use of appropriate fungicide such as Metalaxyl-M+Mancozeb (AMIDIL 68WG®)
3.6.2.b: Black Rot

Early symptom of “Black Rot” on the edge of a Cabbage leaf
3.6.2.b: Black Rot

General Descriptions:

- This is a seed-borne bacterial disease, spread through soil + Infected debris
- Black rot infection and spread is favored by wet conditions and high temperatures (26 – 30 °C)
- Crowded plants provide conditions that are ideal for bacterial spread to nearby plants

Symptoms:

- Yellow V-shaped lesions on the leaf margins which later turn brown as the leaf veins in the affected area become black
- A cross sectional cut of infected stem reveal a characteristic black ring
- In later stages, affected heads turn black and soft
- The rotten heads give a characteristic offensive odour

Control:

- Use certified seeds
- Field sanitation (burn crop residues)
- Use of resistant/tolerant varieties, e.g.) Green Challenger, Amigo F1
- Crop rotation (at least 3 years)
- Use of copper based fungicide such as AMICOP 50WP® (should be sprayed at early stage of disease infestation)
3.6.2.c: Black Leg (Dry Rot Canker)

A stem infected with “Black Leg” (Left) and Blackleg infected kale wilting (Right)

Photo: © Jack Kelly Clark, courtesy University of California Statewide IPM Program

Photo: © Infonet-Biovision http://www.infonet-biovision.org/PlantHealth/Crops/CabbageKale-Brassicas (CC BY-NC-SA 3.0)
3.6.2.c: Black Leg (Dry Rot Canker)

General Descriptions:
- This is a seed borne fungal disease
- Spread through movement of infected seedlings, garden tools and crop debris
- It is destructive in wet soil

Symptoms:
- Leaves have light brown spots which may be circular and which later develop ash grey centres with many black spots
- Stem has dark cankers extending below the soil level that kills the roots
- Destroys the fibrous root system
- Affected plants wilt abruptly and die or topple over as heads enlarge

Control:
- Use of certified seed
- Field sanitation (hygiene)
- Crop rotation for 1-2 years
- Good drainage
- Diseased plant parts should not be fed to animals if manure is to be used on fields
- Ploughing
- Application of Iprodione (ROVRAL 250 FLO ®) (spray on the base of the plants. Do not apply more than twice)
3.6.2.d: Ring Spot

A Cabbage leaf infected with “Ring Spot”

Photo: © Malcolm Storey CC BY-NC-SA 2.0 UK
3.6.2.d: Ring Spot

General Descriptions:
- This is a seed borne fungal disease
- Spread by wind or use of compost made from infected crop residues

Symptoms:
- Circular brown grey spots on the leaves which are often bordered by a green margin and with black – specked concentric zones

Control:
- Use of certified seeds
- Crop rotation for at least 2 years
- Use of fungicides, such as
  - Tebuconazole (ORIUS 25EW, WARRIOR 25EW)
- Maintain field hygiene

A Cabbage leaf infected with “Ring Spot”
3.6.2.e: Alternaria Leaf Spot

Symptom of *Alternaria* Leaf Spot

Photo: Penn State Department of Plant Pathology & Environmental Microbiology Archives, Penn State University, Bugwood.org (CC BY-NC 3.0 US)
3.6.2.e: Alternaria Leaf Spot

General Descriptions:
- A fungal disease that can severely damage cabbage if uncontrolled

Symptoms:
- Initial symptoms are small, circular dark spots on older leaf surfaces
- As the spots enlarge, concentric rings develop within lesions surrounded by a yellow halo
- The lesions eventually fall out, producing a hole or under wet conditions, may be covered with masses of black spores
- In storage, spots enlarge and soft rot bacteria may enter lesions

Control:
- Use disease free transplants
- Remove infected plant debris or destroy it after the season
- Crop rotation
3.6.2.f: Bacterial Soft Rot

Symptom of the “Bacterial Soft Rot” on Cabbages
3.6.2.f: Bacterial Soft Rot

General Descriptions:
- It is a soil borne disease
- High temperature (32 – 33 °C) favour disease development
- The disease is spread rapidly by rain splash on lower leaves
- It is mainly a post-harvest problem

Symptoms:
- The head becomes soft and has watery rot which develops an offensive smell
- When the stem of the affected plant is cut, a very bad smell is generated

Control:
- Maintain field hygiene
- Crop rotation with legumes, cereals
- Avoid harvesting when it is wet
- Remove from the field or plough crops deeply immediately after harvesting so that the residues decompose as quickly as possible
- Handle produce carefully and store in a cool, well-ventilated area
- Foliar sprays with copper based fungicides such as Copper Oxychloride 50% metallic copper (COBOX 50 WP®) and (ISACOP®) at early stage of head formation
- Use of bactericide such as Bronopol 27% w/w (ENRICH BM)
3.6.2.g: Club Root

Galls on root of Cabbage affected by the fungus

Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org (CC BY 3.0 US)
3.6.2.g: Club Root

General Descriptions:
• Extensive galling, swelling and distortion of roots

Symptoms:
• Galled roots often invaded by secondary rot organisms, such as soft rot bacteria resulting in rapid decay of roots
• Fungus persists as thick walled viable spores for over 10 years
• Fungus dispersed by surface water, movement of infected plant or soil

Control:
• Crop rotation
• Field hygiene
• Lime application creates soil condition unfavorable for spore formation

Galls on root of Cabbage affected by the fungus
4. Harvest

Cabbage crops ready for harvest
4. Harvest

4.1 Harvesting Indices (GHCP&PHHT20: Q17)

- **Maturity Period**: 2.5 – 4 months after transplanting depending on variety and location
- **Maturity**: When the *head* becomes firm
- Harvest the heads *before* they pass the prime stage to avoid *cracking* or *splitting*
- Cut heads at the base and leave the *outer leaves* to protect the head and keeping it fresh
- Avoid bruising the head as it encourages rotting
- **Yields**: 15 – 68 tons per acre (depending on the variety and crop husbandry)
- **Varieties with firm solid heads** have good storability

Cabbage crops ready for harvest
5. Post-Harvest Handling

Use of appropriate crates in post-harvest handling
5. Post-Harvest Handling

5.1 Containers & Packaging Materials

(GHCP&PHHT20: Q18)

- Packed in clean well ventilated containers/crates and transported in covered vehicles

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

- Sorting: Damaged and diseased heads are discarded
- Grading: Cabbages are graded depending on the head size: small (1 – 2 kg), medium (3 – 4 kg), large (over 5 kg)

Use of appropriate crates in post-harvest handling