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

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

POTATO PRODUCTION

Prepared by SHEP PLUS
MOALF/SHEP PLUS

Training Title: Potato Production

Objective: To provide a guideline on production of Potato

Specific Objective:

• To provide basic information on production, post-harvest handling, and marketing of Potato

Contents:

1. Introduction: Background, Common Varieties and Optimal Ecological Requirements
2. Pre-Cultivation Preparation 1 – 5
3. Cultural Practices 1- 8
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

Irish Potato Production, First published by SHEP in 2009, revised by SHEP PLUS in 2019 (Ver.6)
Contributors: Grays Kiplagat, Thomas Munu, Sarah Ndewga, Antonina Luta, Peter Orangi, Florence Wambua, Raymond Chelule, Murage Henry, Omari Victor, Jacob Keror, Musah Samuel, Carolyne Mwenze

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This publication was prepared under the Smallholder Horticulture Empowerment and Promotion Project for Local and Up-Scaling (SHEP PLUS) on behalf of Ministry of Agriculture, Livestock and Fisheries (MOALF), and Agriculture and Food Authority (Horticultural Crops Directorate (HCD)) of the Republic of Kenya and Japan International Cooperation Agency (JICA). The cited agrochemicals are in accordance with “Pest Control Product Registered for Use in Kenya 11th Edition, 2018”. The registered agrochemicals are subject to change. Please refer to the latest registered agrochemicals by Pest Control Product Board.
1. Introduction:

1.1 Background

Photo: SHEP PLUS

Potato (Viazi)
1. Introduction:
1.1 Background

- Herbaceous perennial cultivated as an annual crop
- The crop is grown for its tuber - an underground stem
- Rich in starch (8 – 28 %) but low in protein (1 – 4 %)
- It is also rich in Vitamin C
- 2nd most important food crop after maize; and a valuable cash crop to many smallholders
- Can be utilized boiled, baked, mashed or fried into chips or crisps among other uses

Potato (Viazi)
1.2 Common Varieties

“Tigoni”  “Asante”

Photo: © A.A. Seif (CC BY-NC-SA 3.0) http://www.infonet-biovision.org/PlantHealth/Crops/Potato-Seed-Production
1.2 Some Common Varieties

Released varieties (1998 by KARI-Tigoni):

“Tigoni”:
- Tall variety with upright stem
- Produces white flowers and tubers are long oval with white smooth skin
- Has poor tuber storage and short tuber dormancy
- Optimal production altitude: 1,800 – 2,600 m
- Maturity Period: 3 – 4 month
- Tolerant to Late Blight
- Has high dry matter content
- Yield: 14,000 – 18,000kg per acre
- Use: chips, mashing, boiling, baking, roasting

“Asante”:
- Stems are upright to semi-upright of medium height
- Tubers are round and have pink smooth skin
- Tuber dormancy is short
- Optimal production altitude: 1,800 – 2,600 m
- Maturity Period: 3 – 4 month
- Has high dry matter content
- Fairly tolerant to Late Blight
- Yield: 14,000 – 18,000kg per acre
- Use: chips, mashing, roasting, baking
1.2 Common Varieties Cont’

![Shangi Variety Field]

Photo: © International Potato Centre Sub Saharan Africa (CC BY-NC-SA 2.0)

Shangi
1.2 Some Common Varieties Cont’

Other Indeterminate varieties grown in Kenya:
“Shangi”
- Highly prolific, versatile use
- About 1m high, upright growth
- Broad leaves, light in colour
- Abundant flowers,
- Oval tubers, uniform in grading, white flesh
- Medium to deep eye with pink pigmentation
- Very short dormancy
- Matures in 3-4 months
- Yield 30,000-40,000kg per acre
- Moderately susceptible to late blight
- Good for mashing, boiling, Roasting, chips
- Altitude range 1500-2800m asl

Released varieties (2010 by KARI-Tigoni):
“Kenya Mpya”:
- Tall plant (about 1 m) with good ground cover
- Flowers are white
- Tubers have Cream white skin color with pink shallow eyes
- Optimal production altitude: 1,400 – 3,000 m
- Resistant to Late Blight
- Early tuberization: large size, oval/round tubers
- Good storability
- Short dormancy
- Maturity Period: 3 – 3.5 month
- Yield: 14,000 – 18,000kg per acre
- Use: boiling, roasting, mashing, chips

“Sherekea”:
- Medium sized plant which produces abundant light purple flowers
- Tubers are oblong/round and have red skin
- High number of tubers per plant
- Good storability
- Long tuber dormancy
- Optimal production altitude: 1,800 – 3,000 m
- Maturity Period: 3.5 – 4 month
- Yield: 16,000 – 20,000kg per acre
- High resistant to Late Blight and viruses (PVY and PLRV)
- Use: boiling, roasting, mashing, chips, crisps

“Purple Gold”:
- Medium sized plant with purples flowers
- Tubers are round and have dark purple skin with white flesh eyes
- Has long tuber dormancy
- Has excellent crisping quality
- It is predominantly grown in Narok but can be grown in other areas
- Moderate resistance to late blight, PLRV but susceptible to PVY
- Tolerant to most soil borne diseases
- It is resistant to greening and has good storability
- Yields 10,000 – 14,000kg per acre
- Uses: mashing, boiling, roasting and chips
1.2 Common Varieties Cont’

Other Varieties

Photo: © A.A. Seif (CC BY-NC-SA 3.0) http://www.infonet-biovision.org/PlantHealth/Crops/Potato-Seed-Production
1.2 Some Common Varieties Cont’

Other varieties grown in Kenya:
“Kerr’s Pink” (also known as “Mew Pink”)
- Tall plant with white flowers
- Tubers have oval shape with red skin
- Tolerant to drought but susceptible to late blight
- Maturity: 2-3 months
- Yields: 10,000-12,000kg per acre

“Dutch Robijn”
- Medium plant height with upright stem which produces white flowers
- Tubers are round and red skin in colour with good storage and long dormancy
- Yield: 14,000-16,000kg per acre

“Nyayo”, “Roslin Tana”
Varieties released in 2002 with yield potential of 14,000 – 18,000kg per acre include Kenya Sifa, Kenya Karibu, Kenya Faulu and Kenya Mavuno

Other varieties include: Ambition, Annet, Arizona, Arnova, Caruso, Desire, Destiny, Mayan Gold, Saviola, Toluca

Note:
- Maturity period is dependent on the cultivar and climatic conditions
- The national average yield is 3,100kg per acre
- With use of disease free-seed and good management, yield potential can rise to 8,000kg per acre
### 1.3 Optimal Ecological Requirements

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Altitude</strong></td>
<td>1,500 – 2,800 meters above sea level</td>
</tr>
<tr>
<td><strong>Rainfall</strong></td>
<td>850 – 1,200 mm of rainfall</td>
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<tr>
<td><strong>Growing Temperature</strong></td>
<td>15 – 20 °C</td>
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<tr>
<td><strong>Soils</strong></td>
<td>• Well drained medium loams</td>
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</table>

- **Altitude:** Potatoes are cultivated between 1,500 – 2,800 m.a.s.l.
- **Rainfall:** Well distributed rainfall of between 850 – 1,200 mm is required during the growing period.
- **Temperature:** Potatoes perform well in cool climatic conditions and the optimum temperature range is 15 – 20°C. The temperature for tuberization is 15°C.
- **Soil:** Free draining fertile medium loams are preferred since heavy clays restrict tuber growth. The optimal soil pH range is 5.5 – 7.5.
1.4 Growth Stage

The Potato Plant

- Flower
- Inflorescence
- Fruit
- Leaflets
- Compound leaf
- Main stems
- Lateral stem
- Mother tuber
- Stolons
- Tubers
- Roots

Source: http://cipotato.org/potato/how-potato-grows/
1.4 Growth Stage

Growth Stage 1:
- **Sprout development**: Sprout develop from the eyes using energy from the seed tuber (pinch off the first sprout to remove apical dominance)

Growth Stage 2:
- **Vegetative growth**: Development of leaves, branches and stolons (Right time for earthing-up)
- Growth stage 1 and 2 takes roughly 4 – 10 weeks depending on environmental conditions, physiological age of the tubers & kind of variety

Growth Stage 3:
- **Tuber set (initiation)**: Tubers begin to form at the stolon tips but with little enlargement
- Flowering starts at the end of this stage and takes 2 weeks

Growth Stage 4:
- **Tuber bulking**: Tuber enlargement caused by accumulation of water, nutrients & carbohydrates
- Critical stage for yield & quality
- This stage is the longest and can last **up to 3 months**

Growth Stage 5:
- **Maturation**: Vines turn yellow & tuber growth slows down
- Decline in photosynthesis
- Dry matter content is at maximum
- Dehulm to harden the skin at this stage (very important to ensure good quality produce)
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
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[G20 Technologies]
Make sure to support farmers carry out G20 techniques for any crop
# 2.1 Crop Planting Calendar

**A Sample of a Potato Planting Calendar**

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<thead>
<tr>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
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</thead>
<tbody>
<tr>
<td><strong>Bed Preparation:</strong></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Plough land thoroughly &amp; make furrows</td>
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<tr>
<td>Fertilizer (DSP): 200 kg/acre</td>
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<tr>
<td>Planting: 800-1,000 kg of seed tubers/acre</td>
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<td>Spacing: 75 x 30 cm</td>
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<td>Depth: 10 cm</td>
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<tr>
<td>Sprouts should face upwards</td>
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<tr>
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<tr>
<td><strong>Sorting &amp; grading</strong></td>
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<tr>
<td><strong>Yields 3,000 – 16,000 kg per acre</strong></td>
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<tr>
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Peak demand for Potato
## 2.1 Crop Planting Calendar

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<td>Fertilizer (USP): 200 kg/acre</td>
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<tr>
<td>Spacing: 75 x 30 cm Depth: 10cm</td>
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### A Sample of a Potato Planting Calendar: Targeting a peak market demand beginning just after February

**Peak demand for Potato**

### 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 Potato
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

**Note:**
- To meet the peak demand period of the market, there may be need of supplemental irrigation
2.2 Quality Seed/Planting Materials

A sprouting seed potato

Photo: By ZooFari - Own work, Public Domain, https://commons.wikimedia.org/w/index.php?curid=8870305
2.2 Quality Seed/Planting Materials

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

- Use disease-free or certified seed
- Certified seed potatoes have 3 grades:
  - **Size I**: Small sized seed potatoes (25 – 35 mm diameter)
  - **Size II**: Medium sized seed potatoes (35 – 45 mm diameter, egg sized tubers). This is the preferred size since it produces a good balance of big sized & small sized seed tubers
- Number of sprouts should be at least 4
- Seed tubers are kept in diffuse light to allow development of short strong sprouts: this is to ensure a uniform stand
- Production of basic seed is undertaken by KARI Tigoni
- Bulking of basic seed is done by various organizations such as ADC Farm in Molo, Kisima Farm in Meru and selected individual farmers
3.1 Basal Application

Manure incorporation as a basal application
3.1 Basal Application

- Potatoes respond well to high soil fertility and manure or compost is needed if the land has been continuously cropped.
- However, to prevent excessive production of vegetative part at the expense of tubers, it is recommended to add compost or manure on the crop preceding the potato.
- Well-decomposed animal manure or compost is recommended.

Manure incorporation as a basal application.
3.2 Planting

Planting seed tubers

Photos: SHEP PLUS
3.2 Planting

3.2.1 Appropriate Time:
- Planting is done at the onset of the rains (long & short) since most production in the country is rain fed and is done twice a year.
- Seeding rate: 800 – 1,000 kg/acre

3.2.2 Recommended Spacing (GHCP&PHHT20: Q10):
- 20-30cm (intra row) and 60-90cm (inter row)
- Planting depth is 10 cm and the sprouts should be placed facing upwards & the seed covered by a layer of soil

3.2.3 Fertilizer Application Rates (GHCP&PHHT20: Q11):
- DAP at 200 kg per acre (about 1 kg of DAP for 25 m of furrow)
- On acidic soils, DSP/ TSP 80kg per acre & CAN 120kg per acre should be used, depending on the result of soil analysis

Note:
- Use of excess nitrogen should be avoided as it encourages vegetative growth at the expense of tuber formation
3.3 Water Requirement

Vigorous potato crop
3.3 Water Requirement

3.5 Water Requirement (GHCP&PHHT20: Q12)

- Potatoes require 850 – 1,200 mm rainfall during the growing period
- Low and fluctuating moisture contribute to scab, hollow heart, low dry matter & low tuber set
- Production in Kenya is mainly rain fed and is timed to coincide with the 2 rainy seasons (long & short rains)
- Some farmers use furrow irrigation while others use sprinkler irrigation in their Potato crop

Vigorous potato crop
3.4 Crop Management: 3.4.1 Ridging/Earthing-up

Potato crop that has been earthed up /ridged properly
3.4 Crop Management
3.4.1 Ridging/Earthing-up

- Ridge or earth-up the rows as the potatoes grow (1st at when crop grows 15-20cm tall with weeding, then every after 2 weeks for 3 times), with the final ridging done before plant starts to bloom.
- Do Not earth-up when the soil is wet to avoid compaction.
- A well built hill helps to control weeds, prevents greening of tubers, reduces attack by the potato tuber moth.

Potato crop that has been earthed up / ridged properly.
3.5.1 Major Pests

A: Photo: Merle Shepard, Gerald R. Camer, and P.A.C Ooi, Insects and their Natural Enemies Associated with Vegetables and Soybean in Southeast Asia, Bugwood.org

B: Photo: © Magnus Gammegaad (CC BY-NC-SA 3.0) http://www.infonet-biovision.org/PlantHealth/Crops/Potato

C: Photo: Bonsak Hammeraas, NIBIO - The Norwegian Institute of Bioeconomy Research, Bugwood.org Licensed under a Creative Commons Attribution-Noncommercial 3.0 License

D: By CSIRO, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=35432952

E: Photo: © Whitney Cranshaw, Colorado State University, Bugwood.org (CC BY 3.0 US)

F: Photo: © A.M. Varela, icipe

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

- Pests damage causes a reduction in quality and quantity of produce
- The following are the major pests of Potato in Kenya:
  A. Potato Tuber Moth
  B. Aphids
  C. Root-knot Nematode
  D. Spider Mites
  E. Millipedes
  F. Mealy Bugs
  G. Cutworms
3.5.1.A: Potato Tuber Moth

**3-8**

*Gelechiidae Phthorimaea operculella*

Photo: By Caroline Harding, MAF - This image is found here at PaDIL, a source of images designed for Biosecurity and Biodiversity. This tag does not indicate the copyright status of the attached work. A normal copyright tag is still required. See Commons: Licensing for more information. PaDIL, CC BY 3.0 au, https://commons.wikimedia.org/w/index.php?curid=16228830

**3-9**

Photo: Merle Shepard, Gerald R. Carner, and P. A. C Ooi, Insects and their Natural Enemies Associated with Vegetables and Soybean in Southeast Asia, Bugwood.org

**Adult Moth**

**Potato tuber moth larva and pupa**
3.5.1.A: Potato Tuber Moth

Identification:
- The moth is small, brownish grey in color with narrow fringed wings
- The moths are active mainly at dusk
- The female lays eggs singly or in batches on leaves, stems & near eye buds on exposed tubers in the field or in the store
- The caterpillars are up to 12 mm long, whitish to pale greenish in color

Damages:
- Caterpillars burrow in the tubers making long irregular tunnels filled with excreta exposing tubers to secondary bacterial and fungal infection
- These tunnels make the potatoes unfit for human consumption
- The pest is transferred with the harvested tubers to the potato store, where it can reproduce and infest other tubers

Control:
- Use healthy & clean seed, since infested seed tubers are the main cause of re-infestation in the field
- Plant as deeply as possible (10cm deep) and ridge at least 3 times during the growing season
- Ensure compact hilling: very important to prevent moths reaching the tubers to lay eggs
- Store all harvested tubers before dusk to avoid moths laying eggs on them
- Don’t leave harvested tubers in the field overnight during dry season
- Spray using appropriate insecticides Dimethoate (AGROTHOATE 40 EC®)
3.5.1.B: Aphids

Aphid on the leaf of a Potato Plant

Photo: © Magnus Gammegaad (CC BY-NC-SA 3.0) http://www.infonet-biovision.org/PlantHealth/Crops/Potato
3.5.1.B: Aphids

Identification:
- Many aphid species attack the potato including the **green peach aphid**, **potato aphid**, and **cotton aphid**
- Aphids are mainly found on young shoots and on the underside of leaves

Damages:
- Feeding by aphids causes **irregular curling of young potato leaflets** and **hinders growth of the leaflets**
- Direct damage caused by aphids sucking sap from the plant is usually of little importance
- Most damage is caused by **honeydew production on foliage** and **virus transmission**
- Aphids are important pests as **vectors of potato viruses**, such as the **Potato Leaf Roll Virus**, a serious disease affecting potatoes

Control:
- Use appropriate pesticides e.g. Thiamethoxam (**ACTARA®**) incorporate a sticker/spreader e.g. **Zipper®** or **Agral 90®**, Imidacloprid 200g/L (**NUPRID 200SC**)
- Control aphids in potato planted for **seed production**
- Keep seed production areas **separated from** commercial potato production
3.5.1.C: Potato Cyst Nematode

3-11a

Right: Potato cyst nematode damage on potato tuber
Left: Symptoms
3.5.1.C: Potato Cyst Nematode

Identification:
• Potato Cyst Nematodes (PCN) or potato root nematodes (Globodera rostochiensis) are 1-mm long roundworms belonging to the genus Globodera.
• They live on the roots of plants of the Solanaceae family, such as potatoes and tomatoes.

Symptoms:
• PCN cause growth retardation and, at very high population densities, damage to the roots and early senescence of plants.
• Reflect those of plants with an inefficient roots system i.e. poor growth, wilting during periods of water stress, early senescence, reduced tuber size and reduced tuber yield up to levels in excess of 80%.

Control:
• Plant certified seed purchased from recognized, certified seed producers.
• Avoid sharing equipment with other growers. The most common way of spreading PCN is in soil or on equipment.
• Thoroughly clean all equipment.
• Practice crop rotation.
• Regularly examine your crops for patches of poor or yellow potato plants.

3-11a: Potato cyst nematode damage on potato tuber
3-11b: Symptoms
3.5.1.D: Spider Mites

Photo: By CSIRO, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=35432982

Two spotted spider mites & eggs on leaf
3.5.1.D: Spider Mites

**Identification:**
- To the naked eye, spider mites look like tiny moving dots but can be seen using a hand lens.
- They live in colonies, mostly on the **under-surface of the leaves** and spin a silk-like web.
- Adults have 8 legs and an oval body with two eye spots on the head end of the body.
- Immatures are similar to adults except that newly hatched larvae have 6 legs.
- Eggs are spherical & translucent becoming **cream colored** before hatching.
- The pest is destructive **during dry weather**.

**Damages:**
- Mites cause damage by sucking cell content from leaves.
- At first, the damage shows up as **light dots** on the leaves which at times take a **bronze colour**.
- As the feeding continues, the leaves turn **yellow** and **drop off**.
- Often, leaves and stems are covered by **a large amount of webbing**.
- Damage is usually worse when compounded by **water stress**.

**Control:**
- Grow healthy crops; avoid water and nutrient stress. Apply mulch and incorporate organic matter into the soil to improve the water holding capacity and reduce evaporation.
- Keep perennial hedges such as pigeon peas, they are said to encourage predatory mites, which predate on spider mites.
- Uproot and burn infested plants. This can be successful during the early stages of infestation when the mites concentrate on a few plants.
- Keep the field free of weeds.
- Spray Sulphur 80% w/w (KUMULUS DF®).
3.5.1.E: Millipedes

Photo: © A.M. Varela, icipe (CC BY-NC-SA 3.0) https://www.infonet-biovision.org/PlantHealth/Crops/Potato

Potato tubers damaged by millipedes
3.5.1.E: Millipedes

Damages:
• They tunnel into potato tubers

Control:
• Clear hiding places
• Remove volunteer plants, crop residues, decaying vegetation, dead leaves, grass, compost piles, excess mulch or other similar debris.
• Avoid planting wet areas

Photo: © A.M. Varela, icipe (CC BY-NC-SA 3.0)
https://www.infonet-biovision.org/PlantHealth/Crops/Potato

Potato tubers damaged by millipedes
3.5.1.F: Mealy Bugs

Mealybugs on a potato plant

Photo: © Whitney Cranshaw, Colorado State University, Bugwood.org (CC BY 3.0 US)
3.5.1.F: Mealy Bugs

Damages:
- Mealybugs suck sap from plant phloem, reducing plant vigor
- They excrete sticky honeydew and wax, which reduces plant and fruit quality, especially when black sooty mold grows on the honeydew.

Control:
- Pruning and destroying affected parts.
- Removing and destroying heavily infested plants.
- Ensuring soil fertility. In most cases healthy plants are able to withstand some mealybug attack.

Photo: © Whitney Cranshaw, Colorado State University, Bugwood.org (CC BY 3.0 US)
3.5.1.G: Cutworms

A Cutworm larva

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

3.5.1.E: Cutworms
Identification:
- The larvae of cutworms stay buried in the soil and cut stems during the night
- The pest is destructive during dry weather

Damages:
- Cutworms feed on tubers and roots, boring a wide shallow hole
- They are also serious pests of newly sprouted potato plants, and can leave great empty patches in a potato field

Control:
- Ploughing and hand picking
- Prepare field and destroy vegetation and weeds 10 – 14 days before planting
- Ploughing exposes caterpillars to predators and desiccation by the sun
- Flooding of the field for a few days before planting can help kill cutworm caterpillars in the soil
- Use appropriate insecticide e.g. Thiamethoxam (Actara®): used to drench when damage by cutworm is evident

A Cutworm larva
3.5.2 Major Diseases

Photo: https://commons.wikimedia.org/wiki/File%3ALate_blight_on_potato_3.jpg
By Howard F. Schwartz, Colorado State University, United States [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons

Photo: © Musah S.M., Nakuru County, 2019

Photo: Howard F. Schwartz, Colorado State University, Bugwood.org (CC BY 3.0 US)

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

Photo: Eugene E. Nelson, Bugwood.org (CC BY 3.0 US)

Photo: © Carol Mwenze, Nyeri County, 2019
3.5.2 Major Diseases

3.8.4 Major Diseases

- Disease infestation leads to reduction in quality and quantity of produce
- The following are the major diseases of Potato in Kenya:
  
  a. Late Blight
  b. Bacterial Wilt
  c. Early Blight
  d. Bacterial Soft Rot
  e. Potato Leaf Roll Virus (PLRV)
  f. Common Scab
3.5.2.a: Late Blight

Leaves and stem of potato plant infected by Late Blight

Photo: https://commons.wikimedia.org/wiki/File%3ALate_blight_on_potato_3.jpg
By Howard F. Schwartz, Colorado State University, United States [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons
3.5.2.a: Late Blight

This is a fungal disease which is favored by cool, cloudy wet conditions. It is one of the most destructive diseases of potatoes.

**Symptoms:**
- Water soaked spots on leaves which enlarge and turn brown
- Below the leaf, the fungus produces white mouldy growth seen clearly at the edge of the spot
- The affected leaves wither, yet frequently remain attached to the stem

**Control:**
- Resistant varieties, such as “Tigoni”, “Kenya Baraka”, “Roslin Eburu”, “Annet” & “Asante” are claimed to have some resistance
- Practice Crop Rotation with non-solanaceous crops
- Practice good field hygiene by rouging
- Select only certified, disease-free seed potatoes
- Spray with appropriate fungicides both protective & curative, such as
  - Antracol WP70® (a.i. Propineb)
  - Dithane M45® (a.i. mancozeb)
  - Nando 500SC® (a.i. Fluazinam) Ridomil Gold MZ68® (a.i. metalaxyl + mancozeb)
  - Milraz WP76® (a.i. Propineb 70% + Cymoxanil 6%)
  - Victory 72WP® (a.i. metalaxyl + mancozeb)
3.5.2.b: Bacterial Wilt

Potato leaves wilting due to Bacterial Wilt infection

Photo: Plant Protection Service, Bugwood.org (CC BY 3.0 US)
3.5.2.b: Bacterial Wilt

The disease is caused by a bacteria known as *Pseudomonas solanacearum*. It is soil borne and the most serious disease which can destroy an entire field. The bacteria survives in the soil for a long time and enters into the host plant through wounds on the roots and the base of stems. The disease is spread by infected tubers, crop residues, contaminated surface water, contaminated soils, and tools.

**Symptoms:**
- Affected plants wilt even when there is adequate moisture in the soil.
- Wilting is rapid and wipe out the entire fields in few days.
- Slimy continuous white discharge emanate from the eyes of the affected tubers.

**Control:**
- Use of certified seed.
- Practice Crop Rotation (5 – 7 years) roguing volunteer potato plants during rotation.
- Destruction of infected plant debris by burning.
- Avoid contaminating the field with soil from an affected field.
- Avoid cutting of seeds as a way of multiplying seeds when having insufficient seed potato.
- Spot treatment with 10% of Sodium hypochlorite (bleach).
3.5.2.c: Early Blight

Early Blight on Potato Leaf

Photo: Howard F. Schwartz, Colorado State University, Bugwood.org (CC BY 3.0 US)
3.5.2.c: Early Blight

This is caused by a fungus: *Altenaria solani*. The fungus persist in debris of affected plants for several years. Early Blight thrives best under warm wet conditions.

**Symptoms:**
- First, oval or angular dark brown to black “target” spots appear on leaflets.
- Usually, a narrow chlorotic zone is around the spot which fades into the normal green.
- Lowest, oldest leaves are infected first, and they droop and dry as the disease progresses and eventually fall off.

**Control:**
- Use certified seeds.
- Good field sanitation by rouging.
- When using own seeds, carry out hot water treatment.
- Practice Crop Rotation.
- Destroy all infected crop residue.
- Spray with appropriate fungicides, such as:
  - Antracol WP70® (a.i. Propineb)
  - Dithane M45® (a.i. mancozeb)
  - Nando® (a.i. Fluazinam)
  - Ridomil Gold® (a.i. metalaxyl + mancozeb)
  - Milraz WP76® (a.i. Propineb 70 % + Cymoxanil 6 %)
  - Victory 72WP® (a.i. metalaxyl + mancozeb)
3.5.2.d: Bacterial Soft Rot

Potato tubers infected by Bacterial Soft Rot

Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org (CC BY 3.0 US)
3.5.2.d: Bacterial Soft Rot

The disease is caused by the bacteria: *Erwinia* spp.
- It enters the plant through wounds on leaves or stems near the soil surface and young tubers
- The disease development is favoured by high temperatures and humidity
- The bacteria is spread by rain splash
- In poorly drained fields, tubers decay
- The infected tubers and soils acts as a source of inoculum in subsequent years

**Symptoms:**
- Stems and leaves develop lesions which are water soaked, dark green and eventually develops to a soft rot with a foul odour
- On tubers, reddish brown spots form at the lenticels
- The inner parts of the tubers shows a soft rot and a creamy exudate is seen and may decay during transportation or storage in poorly ventilated, high temperature and humidity

**Control:**
- Practice crop rotation with crops such as cereals
- Use of healthy seed tubers
- Improved field drainage
- Store and transport tubers in dry, well ventilated conditions
- Field hygiene
- Crop rotation
- Sorting before storage
3.5.2.e: Potato Leaf Roll Virus (PLRV)

PLRV-infected plant next to an uninfected potato plant

Photo: Eugene E. Nelson, Bugwood.org (CC BY 3.0 US)
3.5.2.e: Potato Leaf Roll Virus (PLRV)

This is an important potato disease which occurs in all potato growing areas. It is transmitted by aphids. The virus is also spread through infected tubers and diseased volunteer plants.

**Symptoms:**
- In plants infected through aphid transmission, the apical leaves roll upwards and occasionally become pinkish in colour.
- In plants infected through use of infected seed tubers, the lower leaves roll upwards (after sprouting) and becomes spoon-like.
- Severely affected leaves develop a tubular shape.
- Plants are stunted and plants develop small tubers.
- If these tubers are used as seeds, plants are stunted and crop produces very low yields.

**Control:**
- Use of chemicals to control aphids which can transmit the virus to potato plants, such as:
  - Nuprid 200 SC (a.i. Imidacloprid)
  - Karate 2.5WG (a.i. Lambda Cyhalothrin)
- Use of virus-free seed tubers.

PLRV-infected plant next to an uninfected potato plant.
3.5.2.f: Common Scab

Common scab on a tuber

Photo: © Carol Mwenze, Nyeri County, 2019
3.5.2.f: Common Scab

Affects the potato skin with pimple-like lesions. It may not quantitatively affect yield but the quality of tubers which makes them less attractive in the market and their storability.

Symptoms:
- Lesions are a superficial cork-like layer (russet scab)
- They may be erumpent or cushion-like (raised scab)
- The lesions may extend deep into the tubers (pitted scab)
- Lesions may be circular or irregular in shape - Affected potato skin tissue may be tan or brown

Control:
- Avoid planting scab-infected seed tubers
- Increase the rotation period (2 years or more) for potato planting
- High moisture levels at tuber formation and bulking reduces scab incidence
- Do not reduce the acidity of the soil too much by liming as scab is reduced in acidic soils.
4. Harvest

Farmers harvesting and bagging Potatoes
4. Harvest

4.1 Harvesting Indices (GHCP&PHHT20: Q17)

- **Maturity Period**: Range between 3 – 4 months after planting depending on the variety
- Tubers harvested while still immature tend to have **low dry matter content** and to suffer **more skin damage**, resulting in easier infection by **fungal and bacterial pathogens**
- However, **seed potatoes are often harvested early**, to avoid virus infection that may occur during the latter part of the growing season

**Important Notes:**
- Tubers should be **completely covered with soil to reduce greening and entry of potato tuber moth**
- Cutting vegetative material **2 weeks before harvesting** hardens the skin of tubers (**dehaulming**).
- Hardening of skin tuber reduces **damage of tubers** during harvesting & post-harvest handling
- Dug potato tubers should be stored **clean, dry** with mature skins free from **wounds, insect pests** and **diseases**

**Yields:** Average yield in Kenya: **3.2 tons/acre** (Yields potential: **16 tons/acre**)
- **Proper husbandry** and use of clean planting material can increase yields to **6 – 8 tons/acre**
- Depending on **variety and degree of maturity at harvesting**, potatoes can be kept for **1 – 2 months** before sprouting at room temperature
- Mature Potato can be **dehaulmed** and left in soil for **1– 2 months**
5. Post-Harvest Handling

Sorting potatoes

Photo: Brochure/G.O.K. STRATEGY ON POTATO DEVELOPMENT INDUSTRY
5. Post-Harvest Handling

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

- Potatoes are supposed to be sold in the standard 50kg units in the markets

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

Sorting:
- Diseased and cut tubers are sorted out to avoid losses in storage due to rotting

Grading:
- Potatoes are graded depending on size and shape of tuber
- Malformed tubers are removed
- Tubers of are graded into:
  - Ware: beyond 60 mm gauge
  - Seed: 28 – 60 mm gauge
  - Chatts: Less than 28 mm gauge

(SEEED POTATO PRODUCTION AND CERTIFICATION GUIDELINES, KEPHIS 2016)

Storage:
- Ware Potatoes
  - Ware tubers should be kept in a dark store to prevent greening
  - The store should be cool and well ventilated
- Seed Potatoes
  - Seed potatoes are kept in a cool store with diffuse light for coloured, short sprouts to develop, however, avoid direct sunlight