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Japan International Cooperation Agency

Agriculture and Food Authority
Horticultural Crops Directorate

Ministry of Agriculture, Livestock and Fisheries
State Department for Crop Development & Agricultural Research

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

Photos: 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:

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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)

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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

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

1.2 Common Varieties

1-2

1-3

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“Tigoni”

“Asante”

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

1.2 Common Varieties Cont'

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

Shangi

"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’

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

Other Varieties

1.2 Common Varieties Cont'

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

Altitude	**1,500 – 2,800 meters above sea level**
Rainfall	**850 – 1,200 mm of rainfall**
Growing Temperature	**15 – 20 ^{0}C**
Soils	**• Well drained medium loams** **•pH range 5.5 – 7.5**

1.3 Optimal Ecological Requirements

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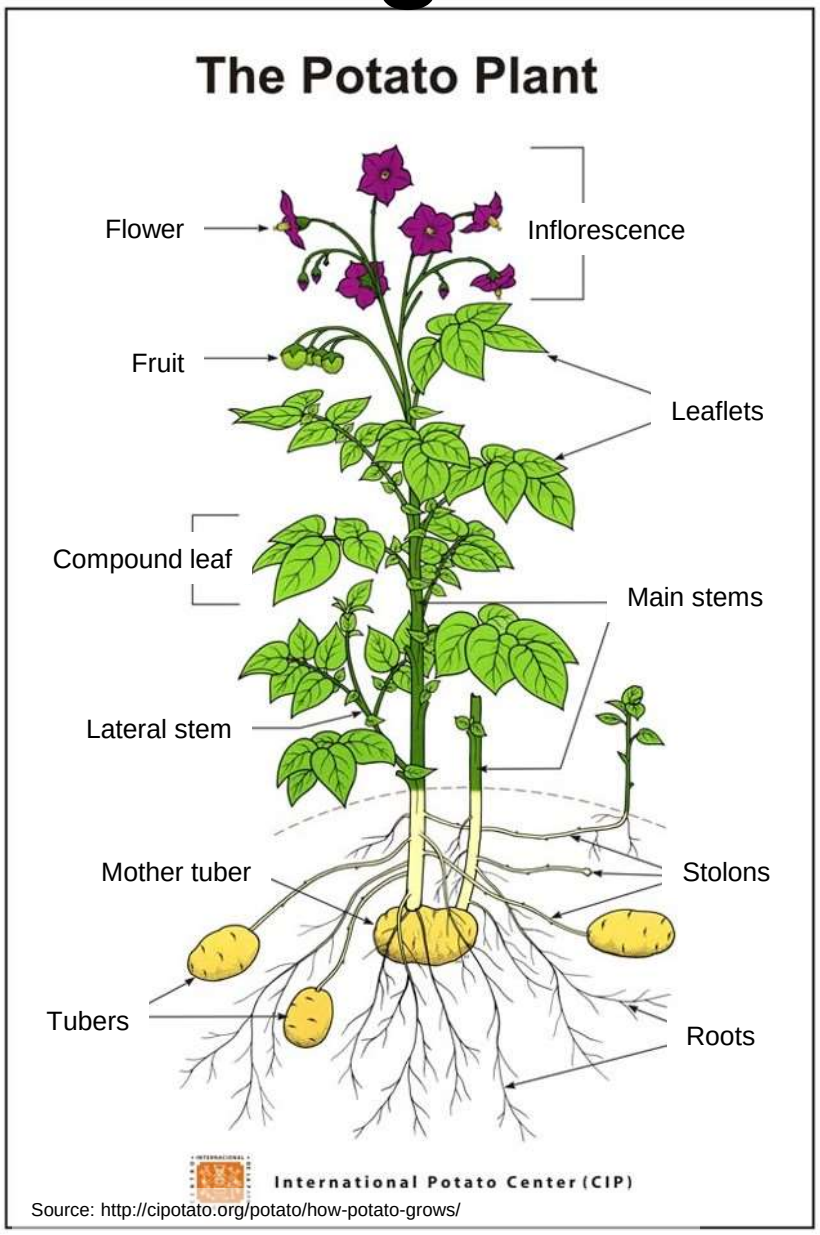
Rainfall	**850 – 1,200 mm of rainfall**
Growing Temperature	**15 – 20 ^{0}C**
Soils	• **Well drained medium loams** • **pH range 5.5 – 7.5**

1.3 Optimal Ecological Requirements

- **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^{o}C**. The temperature for tuberization is **15^{o}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

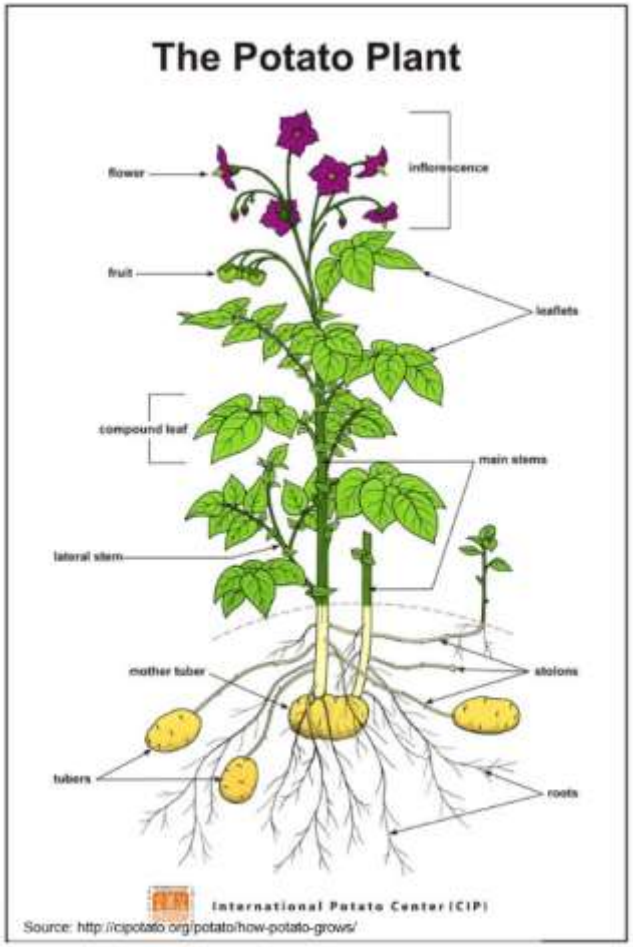
1-5



Source: http://cipotato.org/potato/how-potato-grows/

1.4 Growth Stage

1-5



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

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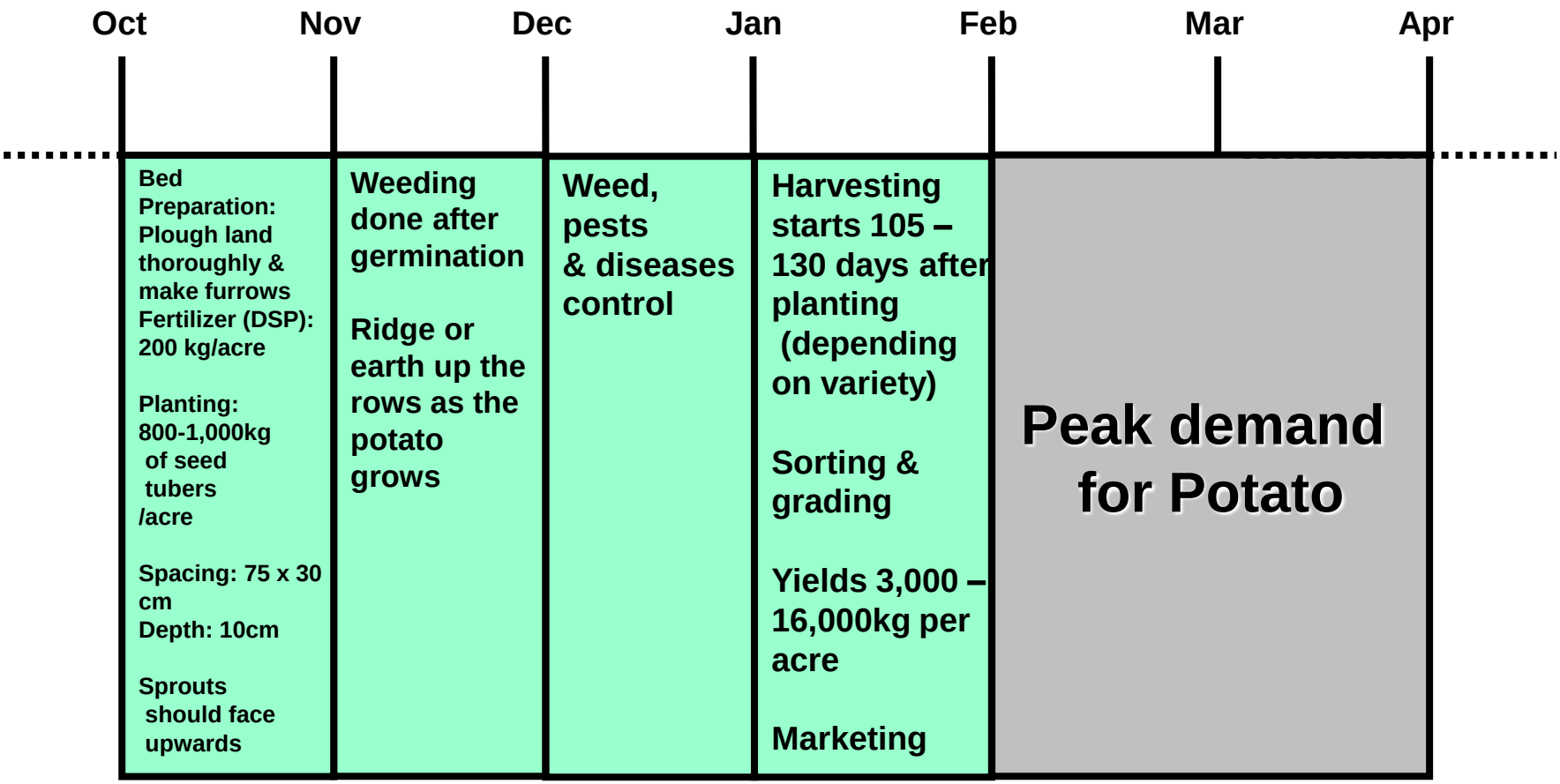
[G20 Technologies]
Make sure to support farmers carry out G20 techniques for any crop

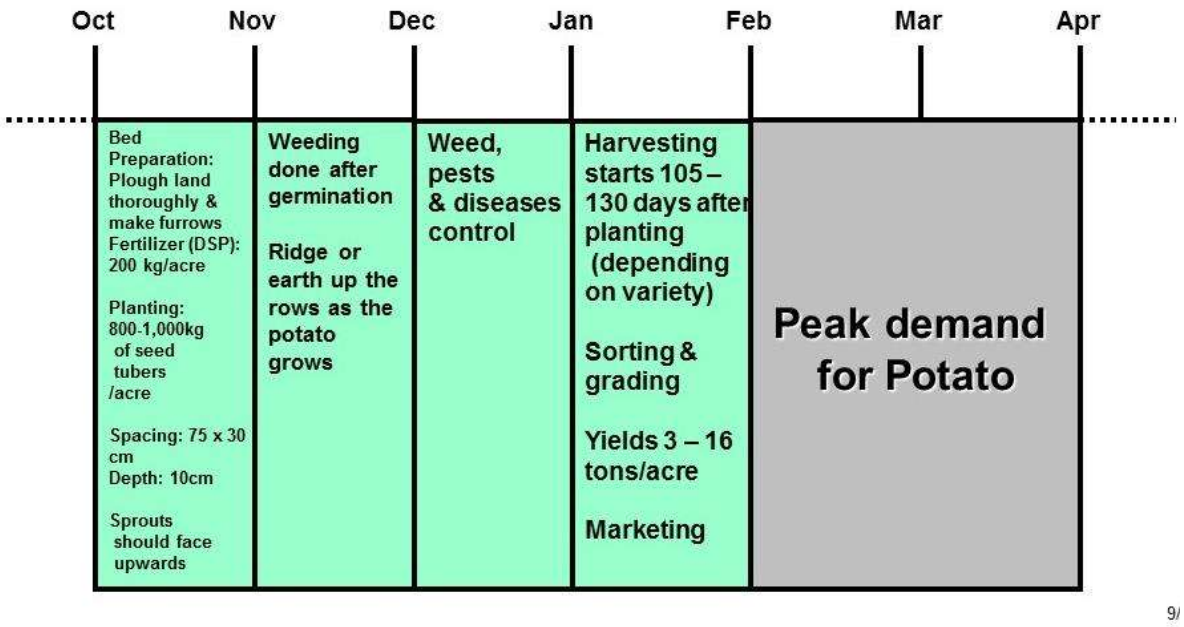
2.1 Crop Planting Calendar

A Sample of a Potato Planting Calendar



2.1 Crop Planting Calendar

A Sample of a Potato Planting Calendar



A Sample of a Potato Planting Calendar: Targeting a peak market demand beginning just after February

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:

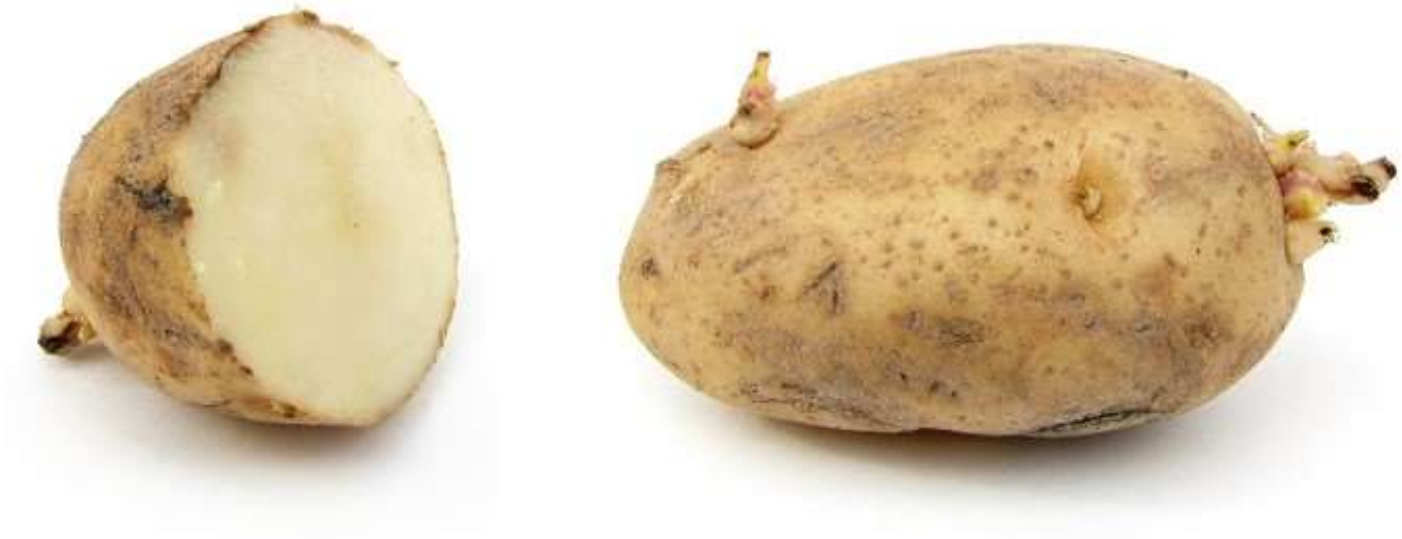
1. Determine from the market survey results (2.1) when there is peak demand for Potato
2. Work backwards from the month when there is peak demand to prepare a monthly farm activities preceding the peak period
3. Use the monthly activities preceding the peak as a procurement plan for farm inputs and a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

2-4



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A sprouting seed potato

2.2 Quality Seed/Planting Materials

2-4

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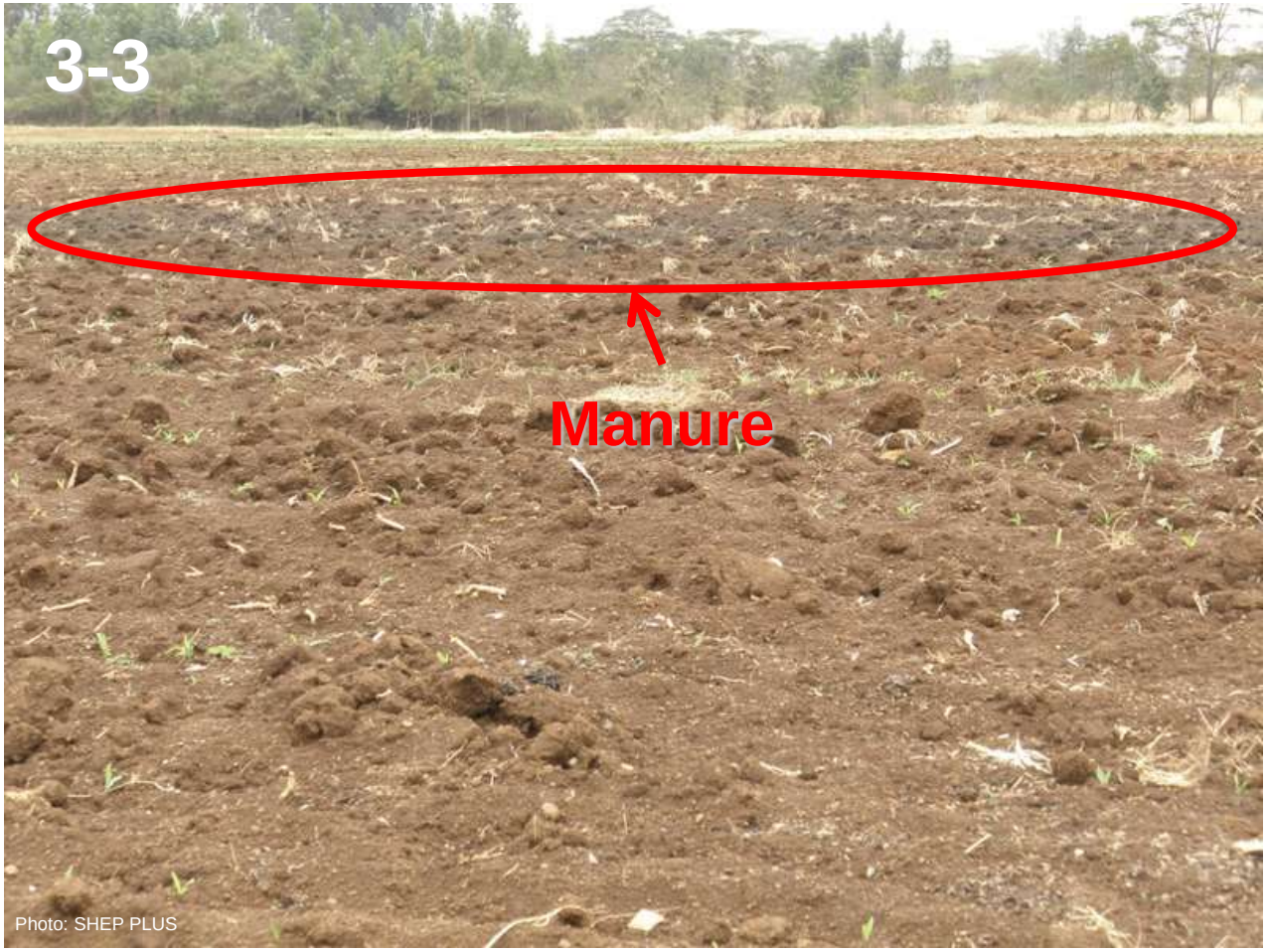
A sprouting seed potato

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

Manure incorporation as a basal application

3.1 Basal Application (GHCP&PHHT20: Q8)

- 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

3.2 Planting

Photos: SHEP PLUS

Planting seed tubers

3.2 Planting

Photos: SHEP PLUS

Planting seed tubers

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

Vigorous potato crop

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

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

Potato crop that has been earthed up / ridged properly

3.7 Crop Management

3.7.1 Ridging/Earthing-up

- **Ridge** or **earth-up** the rows as the potatoes grow(1st at when crop grows15-20cm tall with weeding, then every after 2weeks for 3times), 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

3.5.1 Major Pests

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

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

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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

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Adult Moth

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

Potato tuber moth larva and pupa

3.5.1.A: Potato Tuber Moth

Adult Potato Moth

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

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

3.5.1.B: Aphids

Source: © Magnus Gennergaad (CC BY NC SA 3.0) http://www.infonet.biovision.org/Plant-health/Crops/Potato

Aphid on the leaf of a Potato Plant

3.5.1.B: Aphids

Identification:

- Many aphid species attack the potato including the **green peach aphid**, **potato aphid** & **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

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3-11b

Photo: Bonsak Hammeraas, NIBIO - The Norwegian Institute of Bioeconomy Research, Bugwood.org
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Right: Potato cyst nematode damage on potato tuber
Left: Symptoms

3.5.1.C: Potato Cyst Nematode

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3-11a: Potato cyst nematode damage on potato tuber
3-11b: Symptoms

3.5.1.C: Potato Cyst Nematode
Identification:

- Potato Cyst Nematodes (PCN) or potato root nematodes (*Globodera rostochiensis* and 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** r**etardation** 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.

3.5.1.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

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

Potato tubers damaged by millipedes

3.5.1.E: Millipedes

Potato tubers damaged by millipedes

3.5.1.F: 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

3.5.1.F: Mealy Bugs

Mealybugs on a potato plant

3.5.1.F: Mealy Bugs

Mealybugs on a potato plant

3.5.1.G: 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

3.5.1.G: Cutworms

A Cutworm larva

3.5.1.G: Cutworms

A Cutworm larva

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

3.5.2 Major Diseases

Photo:
https://commons.wikimedia.org/wiki/File%3ALate_blight_on_potato_3.jpg
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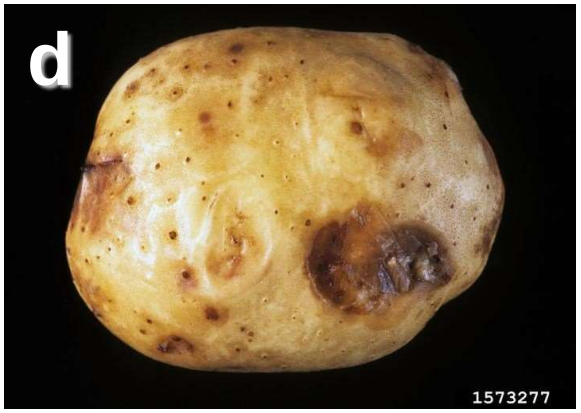

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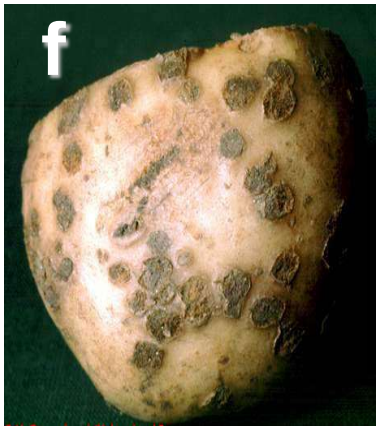
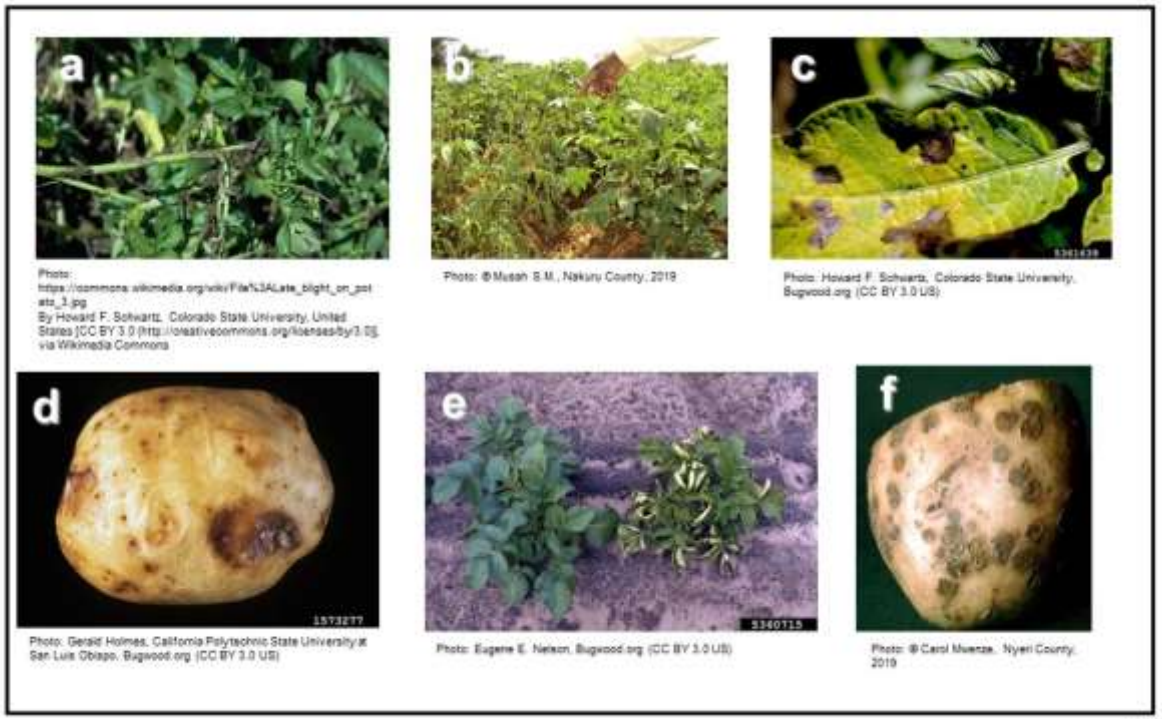


Photo: © Carol Mwenze, Nyeri County, 2019

3.5.2 Major Diseases



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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

Photo: https://commons.wikimedia.org/wiki/File%3ALate_blight_on_potato_3.jpg
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Leaves and stem of potato plant infected by Late Blight

3.5.2.a: Late Blight

Leaves and stem of potato plant infected by Late Blight

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 disease of potato

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-*solanaceaous* 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

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Photo: Plant Protection Service , Plant Protection Service, Bugwood.org (CC BY 3.0 US)

Potato leaves wilting due to Bacterial Wilt infection

3.5.2.b: Bacterial Wilt

Photo: Plant Protection Service , Plant Protection Service, Bugwood.org (CC BY 3.0 US)

Potato leaves wilting due to Bacterial Wilt infection

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

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

Early Blight on Potato Leaf

3.5.2.c: Early Blight

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

Early Blight on Potato Leaf

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

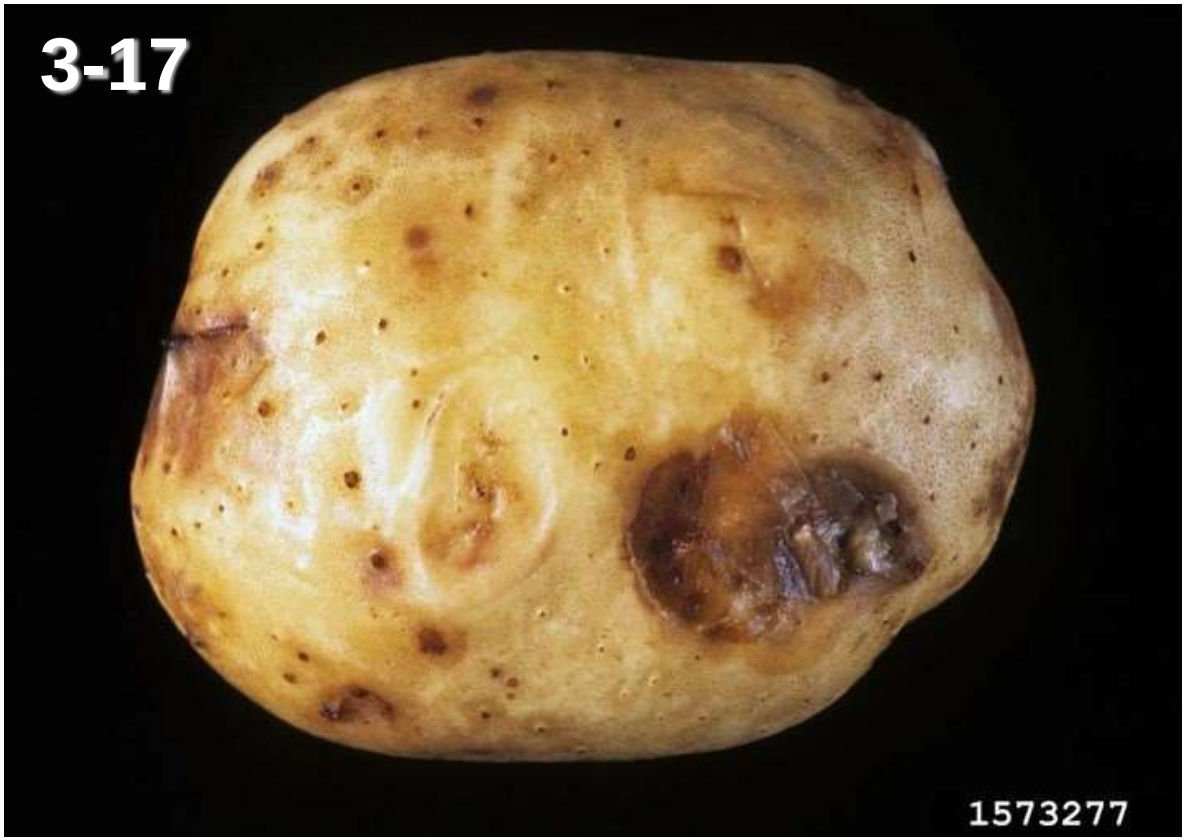

Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org (CC BY 3.0 US)

Potato tubers infected by Bacterial Soft Rot

3.5.2.d: Bacterial Soft Rot

Potato tubers infected by Bacterial Soft Rot

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)

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

PLRV-infected plant next to an uninfected potato plant

3.5.2.e: Potato Leaf Roll Virus (PLRV)

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

PLRV-infected plant next to an uninfected potato plant

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**

3.5.2.f: Common Scab

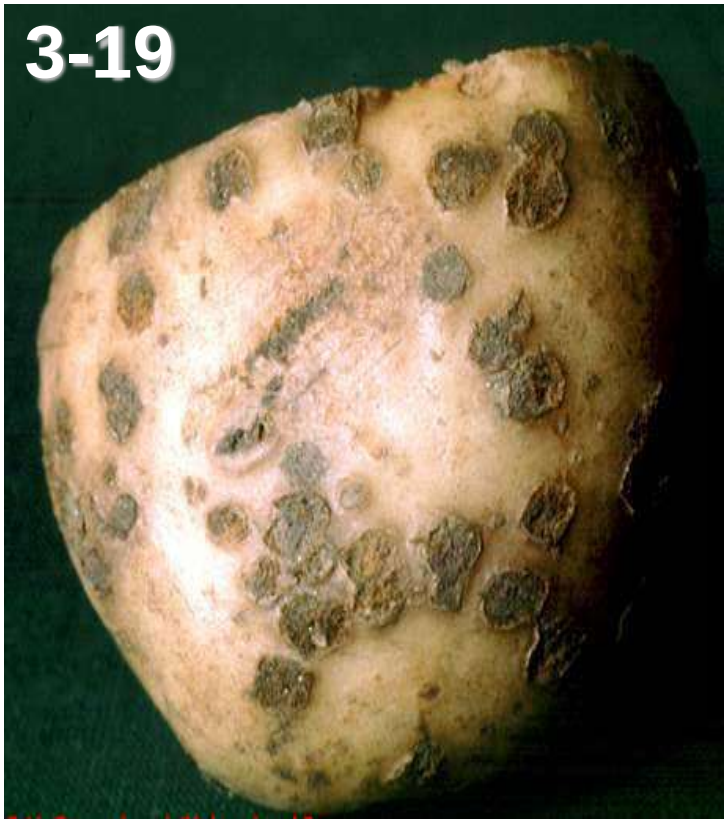

Photo: © Carol Mwenze, Nyeri County, 2019

Common scab on a tuber

3.5.2.f: Common Scab

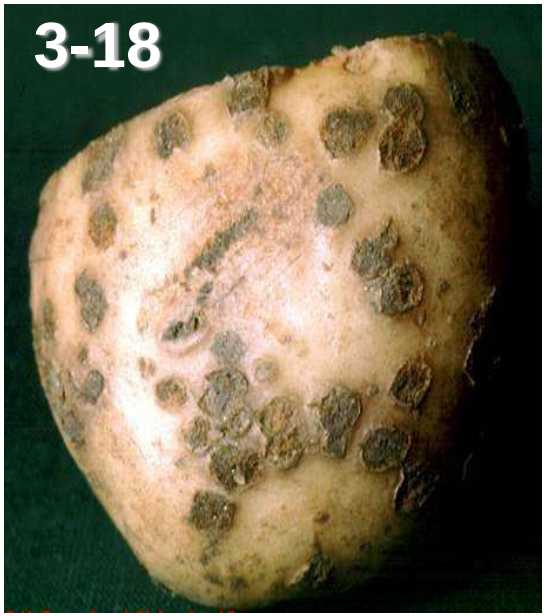

Photo: © Carol Mwenze, Nyeri County, 2019

Common scab on a tuber

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 (pittedscab)
- 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

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

Photo: Brochure/G.O.K. STRATEGY ON POTATO DEVELOPMENT INDUSTRY

Sorting potatoes

5. Post-Harvest Handling

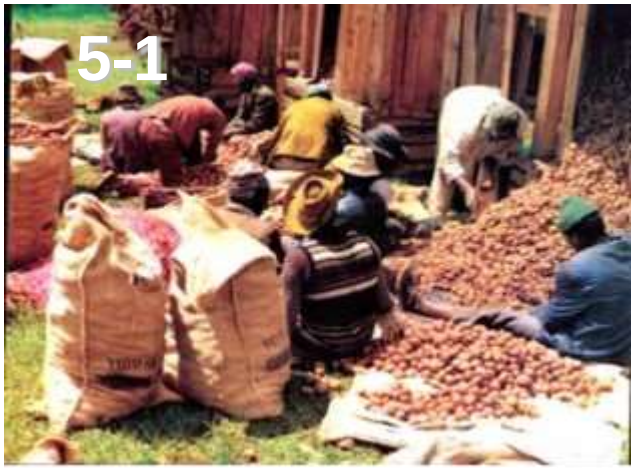

Photo: Brochure/G.O.K. STRATEGY ON POTATO DEVELOPMENT INDUSTRY

Sorting potatoes

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

  (SEED 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**