Good agricultural practices for ware potato production in Rwanda

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1 Importance of the potato crop

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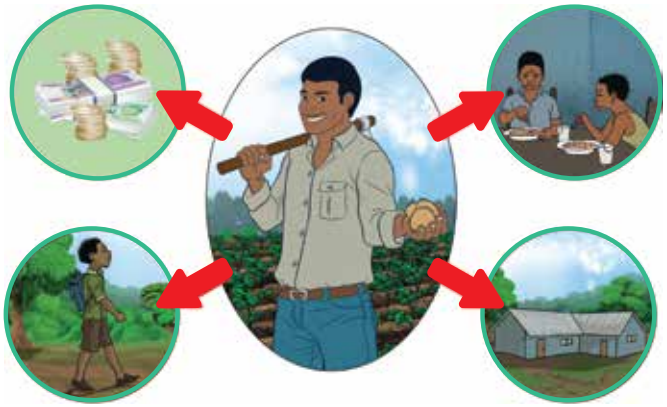
- The potato crop comes from the highlands of **South America**.
- The crop is currently the **third food crop** in the world, after wheat and rice.
- Potato produces **more calories** per unit of area and time than any other crop grown in cool climates.
- Potato is an important **cash crop** in Rwanda. The income generated from potato enables smallholder farmers to improve their living conditions.



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* Where does the potato crop come from?
* Name the only two crops that are produced more than potato for food production in the world?
* Why is the potato considered to be an important crop?

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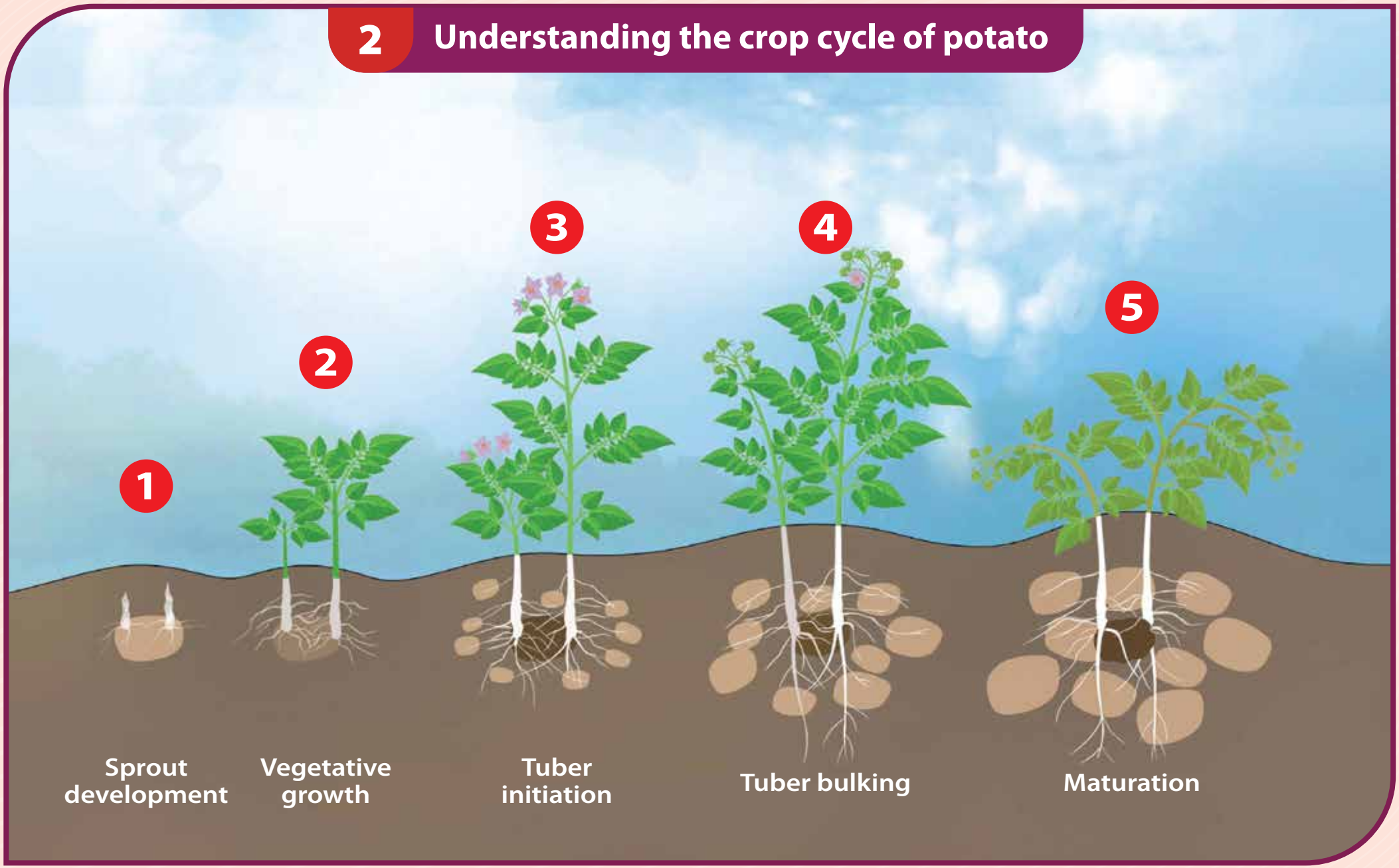
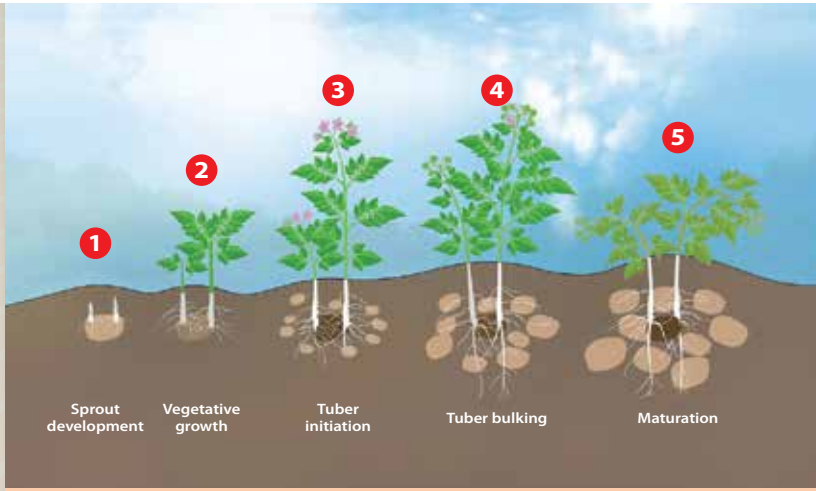
The income generated by growing potatoes is often higher compared to the one obtained from other food crops.

2 Understanding the crop cycle of potato



2 Understanding the crop cycle of potato

- **Growth stage 1 • Sprout development and emergence**
  - Duration depends on soil type and moisture, seed age, planting depth and soil temperature.
  - Plant well sprouted tubers with 3 or more strong sprouts to get more stems and higher yields.
- **Growth stage 2 • Vegetative growth**
  - Duration depends on the variety.
  - Protection against diseases like late blight is very important at this stage.
- **Growth stage 3 • Tuber initiation**
  - Short stage coinciding with the flowering stage and the end of leaf growth.
  - Make sure proper hilling has been done and continue to protect against pests and diseases.
- **Growth stage 4 • Tuber bulking**
  - Tubers become bigger and leaves turn yellow and later die.
  - Chemical applications (fungicides and insecticides) must stop at 3 weeks before harvest.
- **Growth stage 5 • Maturation**
  - No more crop growth.
  - Tuber skins harden.



- What are the five stages of the potato crop cycle?
- Which factors affected the length of the growth stages?
- When is it appropriate to harvest the potato field?

This stage of sprout development and emergence is critical because the harvest is strongly related to the number of stems per seed.

3 Land selection and crop rotation

3 Land selection and crop rotation

- Potatoes like a **cool environment** (15-20°C).
- **Soil** should be deep, well drained and loose for proper development of tubers.
- Select a site where potato has not been grown for at least the last **2 seasons.**
- Plan a 3-seasons **rotation** scheme, alternating potato with a season of beans/soybean/peas followed by a season of maize/wheat. Avoid planting maize before potato in fields with a history of infestation by nematodes or low soil fertility.
- Potatoes should not follow potatoes or other crops of the same family (eggplant, pepper, tomato, tobacco) as they may carry potato diseases.

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- What are the suitable climatic conditions for growing potatoes?
- Is it advisable to plant potatoes where you have harvested potatoes or crops of the same family during the previous season? Why?
- What are the crops of the same family as potato grown in your area?

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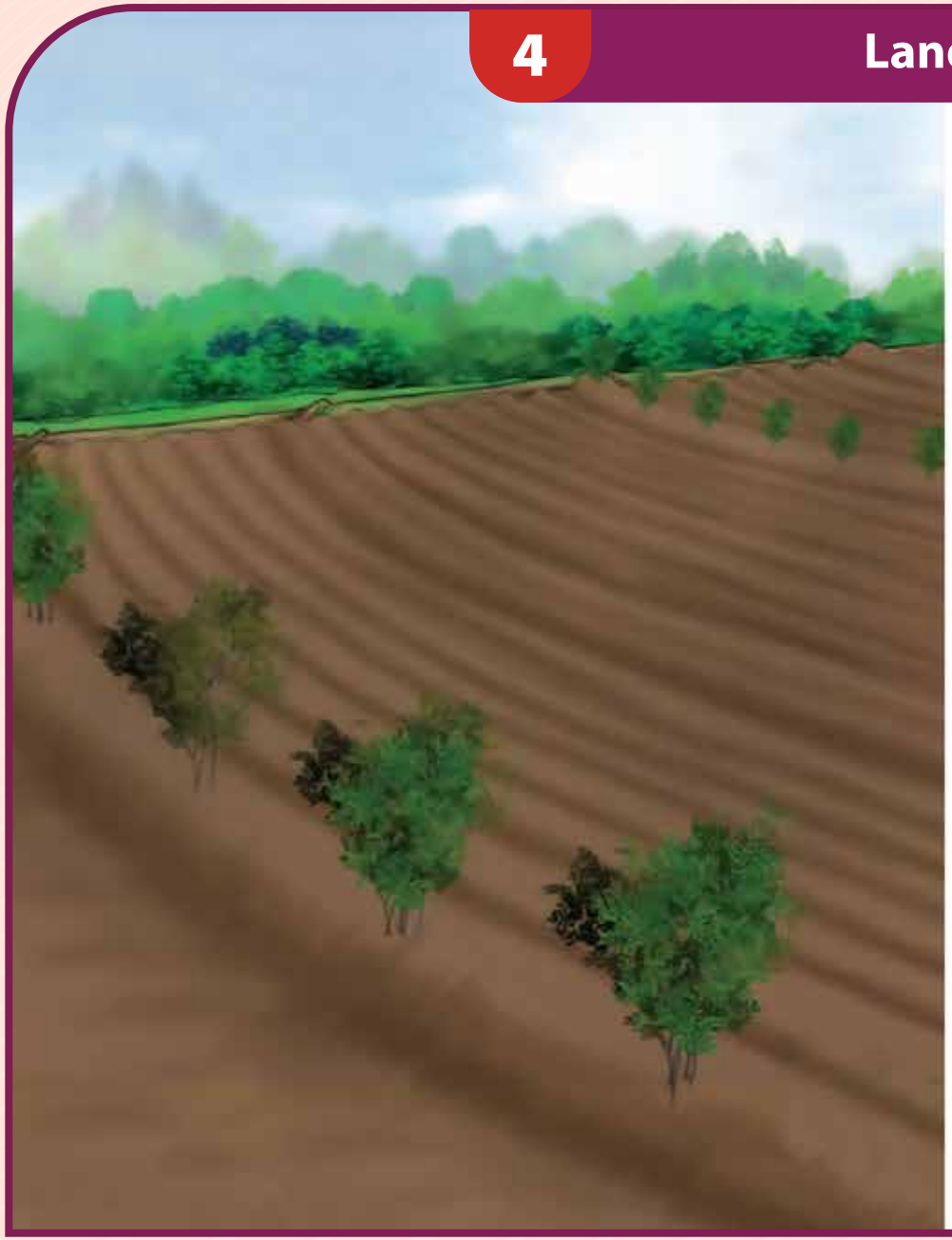
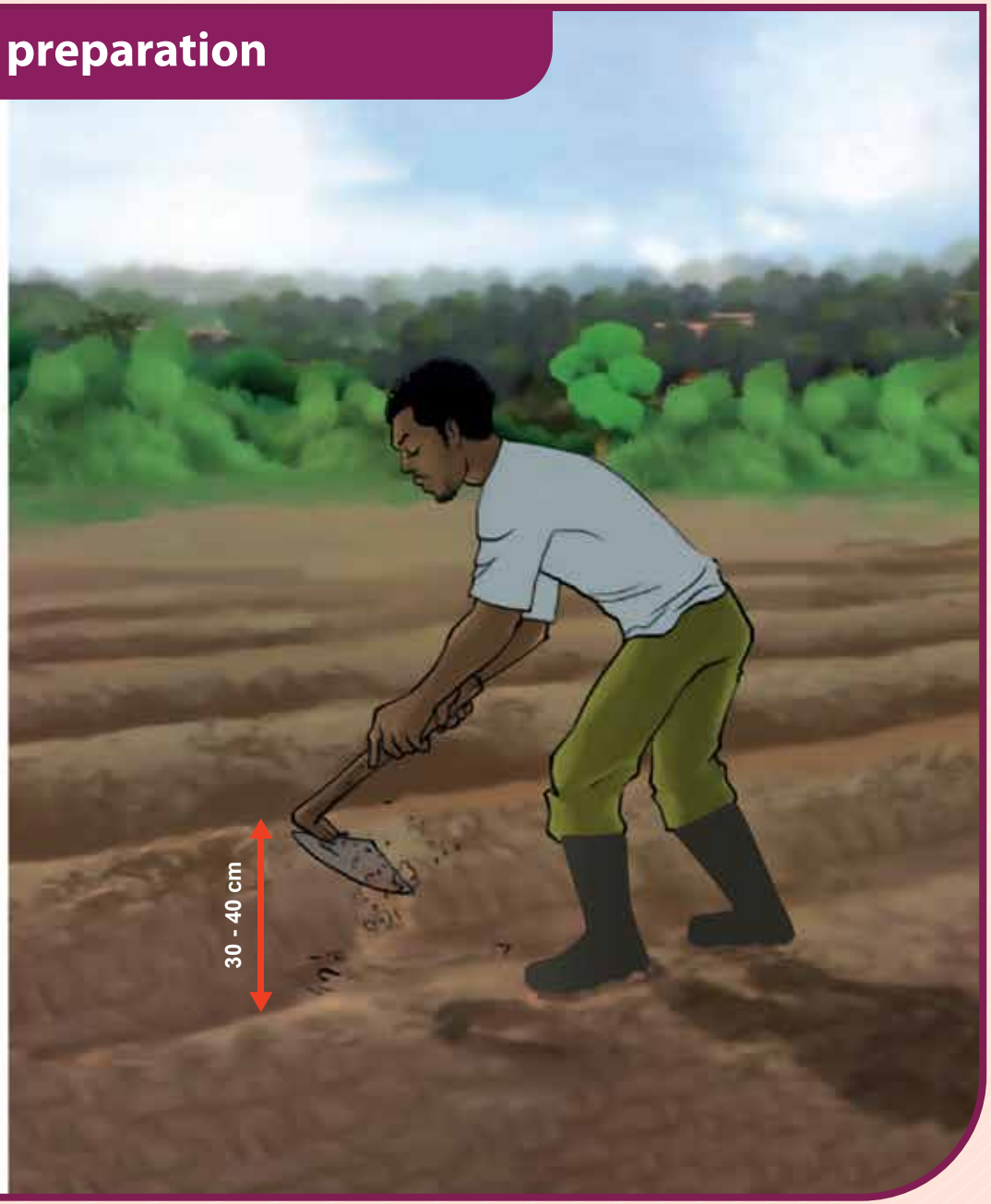
It is highly recommended to wait at least 2 seasons before you plant again potatoes or alike in the same field.

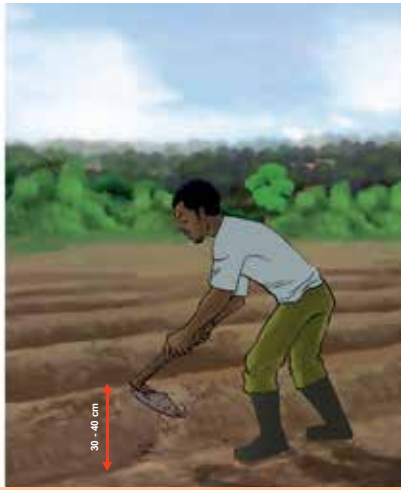
4 Land preparation





4 Land preparation

- Prepare soil early in the season, **at least two weeks before planting**, when the soil is still partially dry to prevent soil compaction.
- Prepare land until the ground becomes soft, free from clods, to a depth of **at least 30 cm.**
- Ploughing can be done using a hoe, motocultivator or animal- or tractor-drawn plough plough.
- In case of risk of erosion or poor drainage, **ridging** should be carried out.



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* Up to what depth (at least) do you need to dig the soil during land preparation and why?
* What are the different steps in land preparation for potato cultivation?
* Under which conditions should ridging be considered?

!

The use of motocultivators or tractors can reduce the burden of land preparation.

5 Application of manure, compost and mineral fertilizers

5 Application of manure, compost and mineral fertilizers

- Ideally, fertilizer rates should be based on soil characteristics and field history. This is called **site-specific fertilizer management.**
- Mineral fertilizers should be applied in **two applications,** at planting and at first weeding and hilling.
- In the absence of a site-specific fertilizer recommendation, apply 3 kg NPK 17-17-17 per are divided in two applications. In practical terms, apply 1 water or soda bottle cap of **NPK 17-17-17 at planting** per two seed tubers. Apply 1 more cap of NPK 17-17-17 **at first weeding** and hilling up per two plants.
- In addition to mineral fertilizer, apply up to 2 handfuls of well-decomposed **manure or compost** for each seed tuber at planting (equivalent to 200-300 kg of manure or compost per are).
- At planting, apply the manure or compost first, then add the fertilizers, and **cover** with 5-10 cm of soil. Then place the seed potato.
- After emergence, apply fertilizers in a hole at 10-15 cm of the plant base.
- Fertilization with high amounts of N depresses tuber growth and yield and should be avoided.
- If the soil is acidic (below pH 5.5), apply 25-50 kg of **lime** (travertine or dolomitic lime) per are during land preparation.

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* Why is it important to get a site-specific fertilizer recommendation?
* What are the mineral fertilizers that are recommended for the potato crop in your area? At which dose?
* What is the quantity of organic manure recommended to fertilize potatoes on an area of 1 are (100 sqm)?

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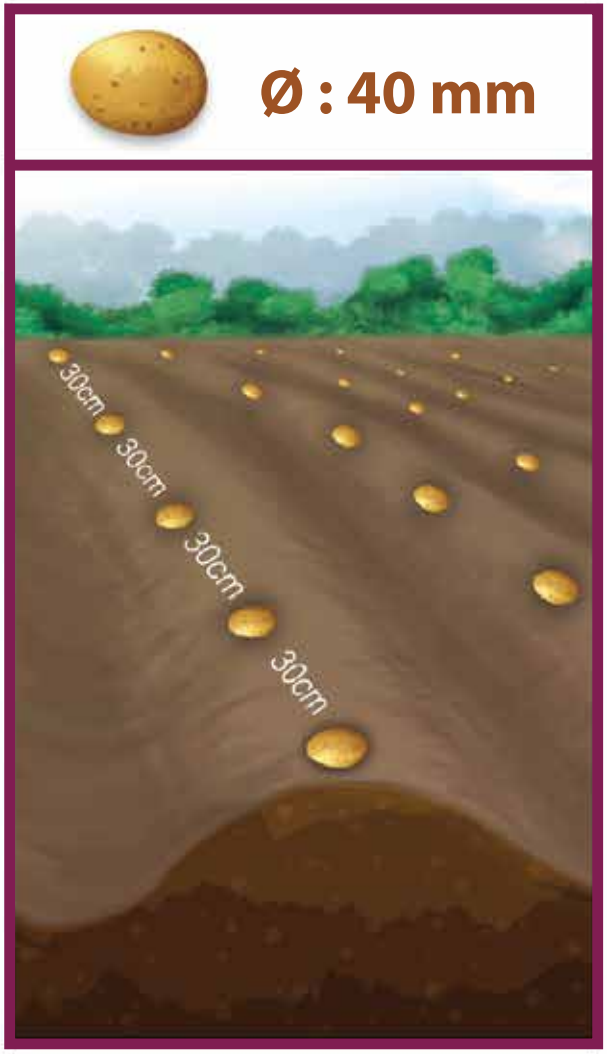
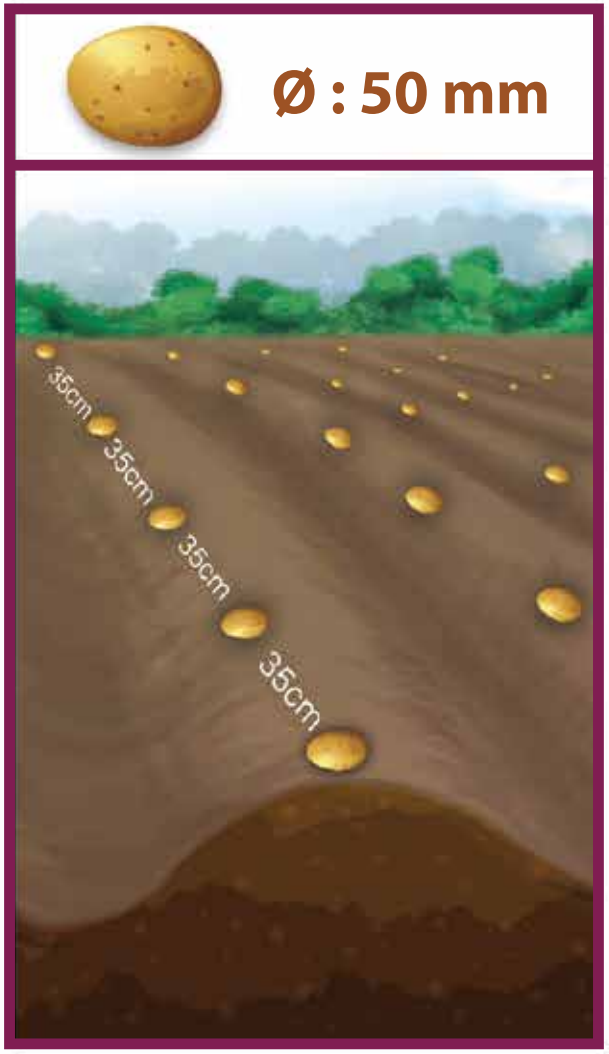
Planting potatoes on a poor soil without manure and mineral fertilizers is a waste of time and resources.

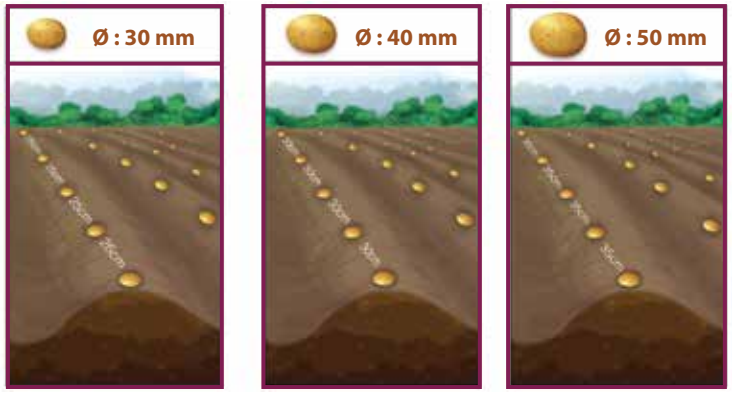
6 Planting techniques





6 Planting techniques

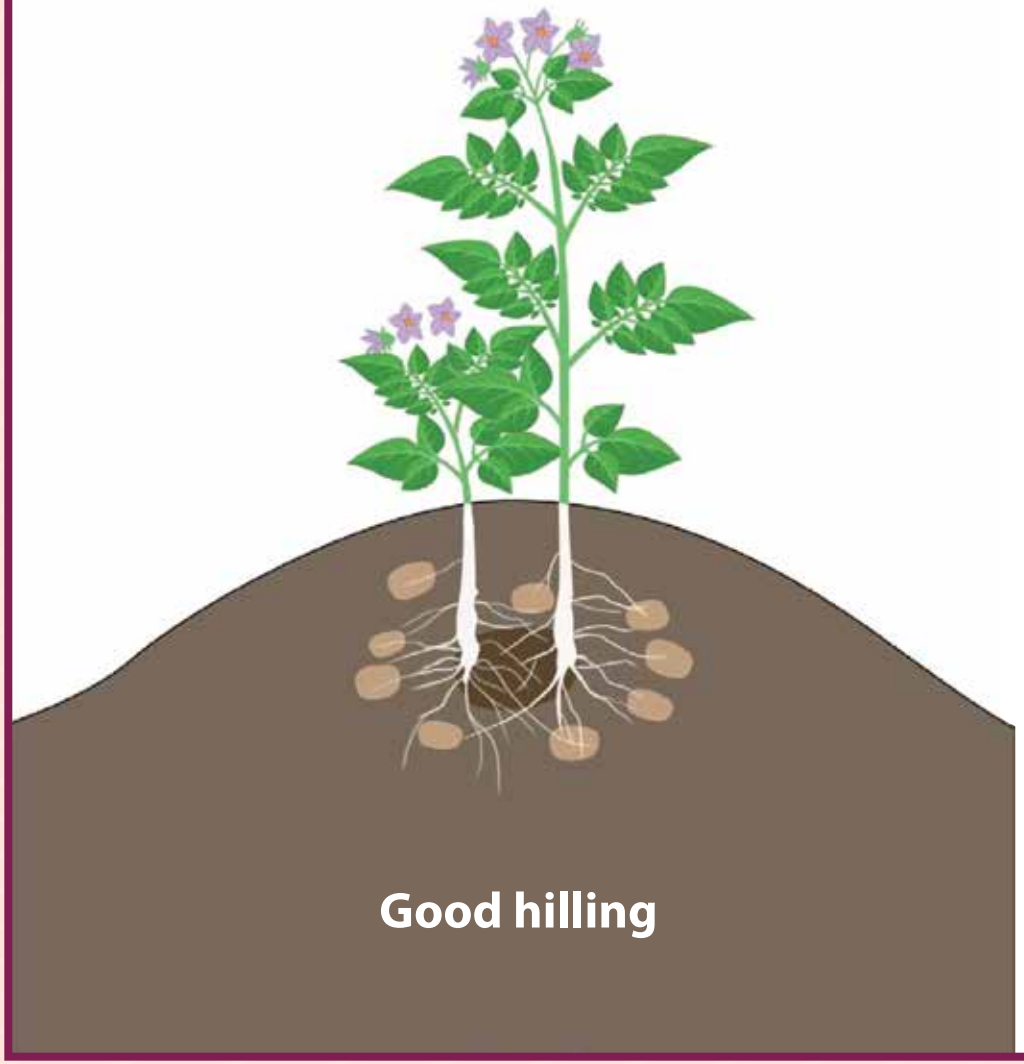
- Use **certified** or **good quality seed** from known seed producers. Do not use small seeds from the market, they are full of diseases.
- Ensure the seed tubers are **well sprouted** with strong, green and short (1-2 cm) sprouts and avoid old tubers with long sprouts.
- Plant seed tubers of the same size category in one area.
- Planting can be done in **furrows** or **holes.** Planting on ridges can be done in fields with steep slope, high rainfall, and/or poor drainage.
- Prepare furrows or rows of holes at a spacing of **70-80 cm.** But if your variety produces a lot of leaves and/or the slope is steep, go up to 90 cm.
- Within rows, use a plant spacing of **25 cm** when seed tubers are small, **30 cm** when seed tubers are medium sized, and **35 cm** when they are large.
- On a sloping terrain, furrows or seed holes should run across the slope.
- After planting, tubers should be **covered** by enough soil (10-15 cm). Uncovered holes or furrows should always be avoided.



- What are the names of the potato varieties that are grown in your areas?
- How would you arrange plant rows on a sloping terrain?
- What is the optimal plant spacing for a maximum yield in ware potatoes?

Potato variety, seed tuber size, and slope are important factors to take into consideration when arranging seed at planting.

7 Weeding and hilling

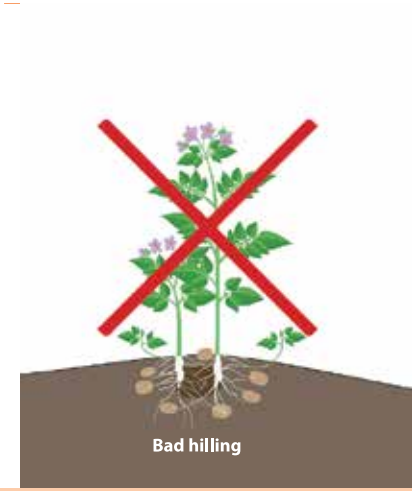


Good hilling

Bad hilling

7 Weeding and hilling

- **Weeding** reduces competition for light, nutrients and water, and prevents weeds from harboring pests and diseases.
- First weeding should be done right after plant emergence.
- **Hilling** is mounding earth around the stems of potato plants.
- Good hilling leads to a higher number of well-shaped tubers of good size, and protects the tubers from pests and diseases.
- **2-3 hilling** are required for potatoes planted on flat land, and at least 1 hilling for potatoes planted on ridges.
- Do the **first hilling** at first weeding after plant emergence, and the **second hilling-up** 2-3 weeks later. A third and last hilling may be done after another 2-3 weeks, especially when slope and rainfall are high.
- The height of the ridge after the first hilling should be about **15 cm**, and about 30 cm after the second hilling.



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- Why must a potato field remain clean, without weeds, until the harvest?
- Why is it important to hill potatoes?
- When should potatoes be hilled?

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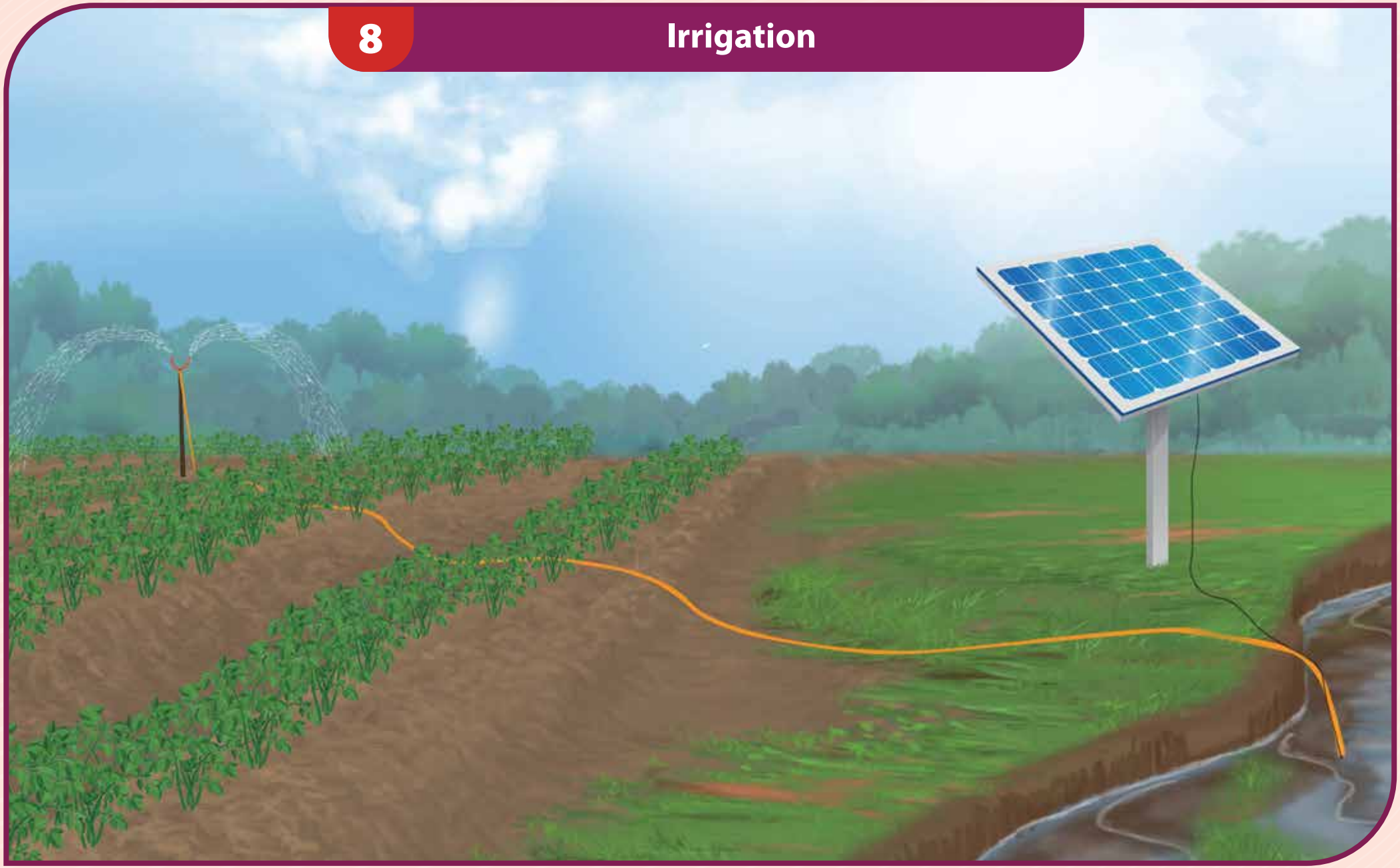
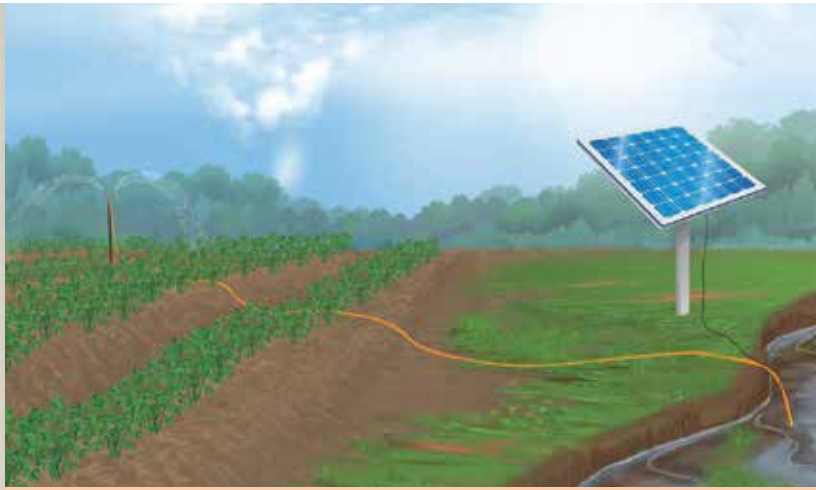
Unlike other crops such as cereals, potato yield is underground. You should not cultivate potatoes without hilling.

8 Irrigation



8 Irrigation

- Irrigation is one of the best adaptation strategies to climate change.
- Potato needs between **500 and 800 mm** of water per season to grow optimally.
- Potato water needs are most critical at **tuber initiation.**
- It is possible to grow potatoes during the dry season in Rwanda (May to August) if farmers invest in **irrigation systems.**
- Irrigation by **gravity** whenever possible is a reliable and cost-effective method.
- Water flowing through the field should be avoided when bacterial wilt is present to avoid spread.



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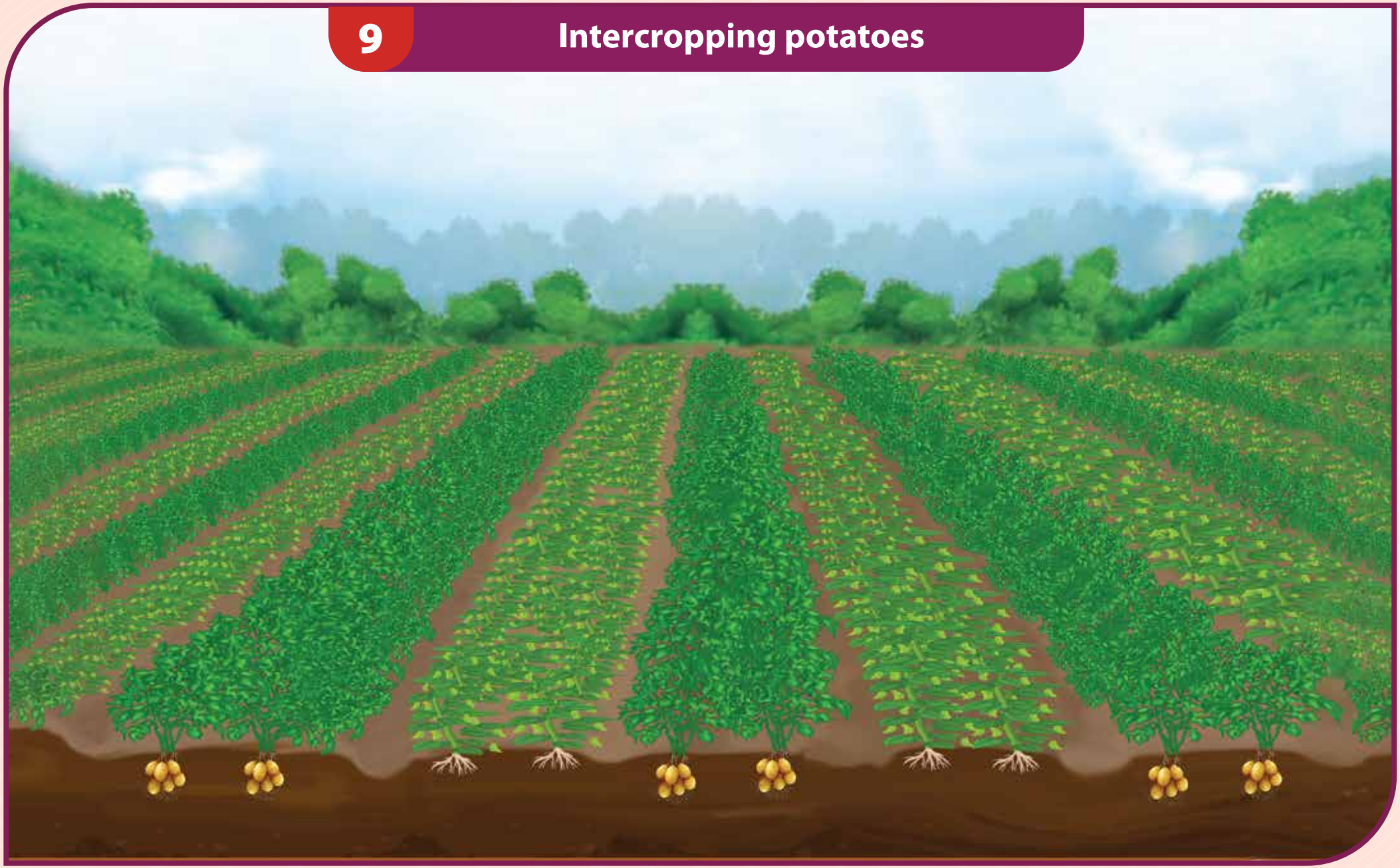
- At which plant growth stage of potato are water needs most critical?
- What can you do if you wish to plant potatoes in a dry season?
- What would you do if you have to use a pump to irrigate your field in an area where fuel is not available?

!

Please ensure that there will be enough rain or irrigation water until the end of the season prior to planting potatoes.

9 Intercropping potatoes



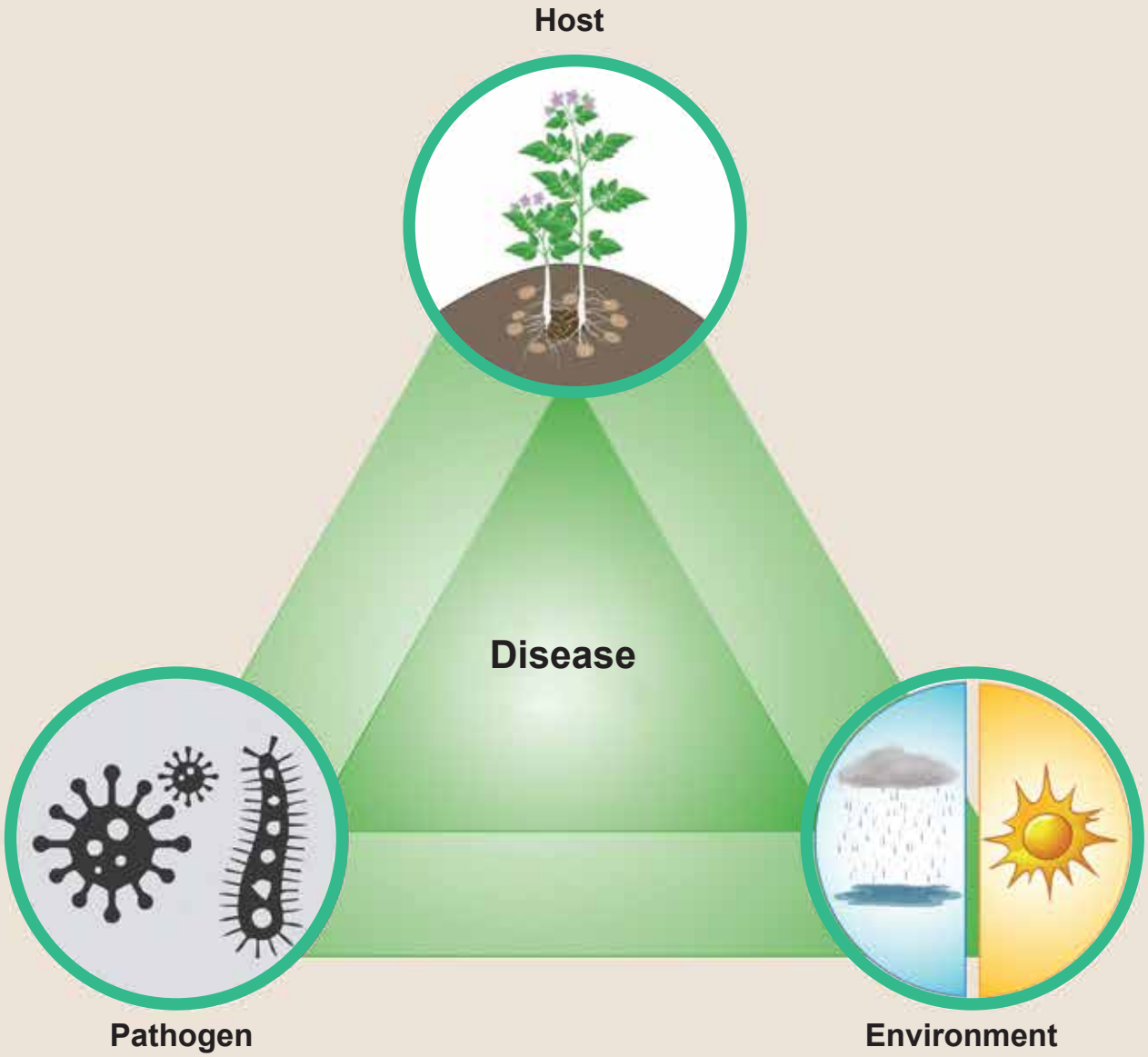
9 Intercropping potatoes

- In areas with steep slope and high rainfall, planting an intercrop in a potato field can r**educe soil erosion** through increasing soil cover.
- In hot areas, intercropping **prevents the soil from drying** and keeps the soil **at a lower temperature** which is good for tuber development.
- Intercrops can also help to **reduce pests and diseases** by providing a barrier between potato plants or trapping insects.
- Intercropping with high nitrogen-fixing legumes such as cowpea **improves soil fertility** and is recommended on soils with low soil fertility and when low rates of nitrogen fertilizer are used.

- What is the benefit of intercropping potatoes in areas with steep slope and high rainfall?
- Which intercrops can be good-choices on soils with poor soil fertility?
- What are the benefits of inter-cropping potatoes in hot areas?

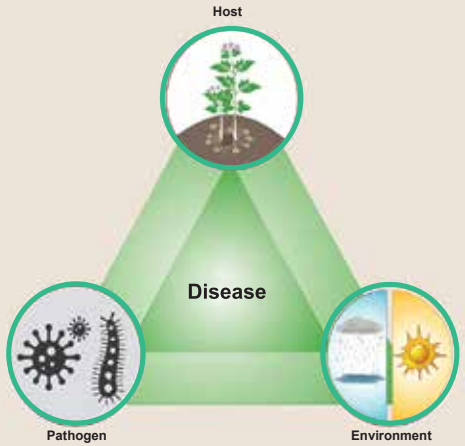
When intercropping potato with other crops, the type of intercrops, planting dates and crop arrangement should be carefully chosen to avoid competition for resources between crops.

10 The disease triangle



10 The disease triangle

- It is important to protect potatoes against pests and diseases because they reduce tuber quality and yield (losses of 100% are possible).
- Diseases can break out when there is a favorable interaction between the disease causal agent (also called the pathogen), host plants and the environment (the **DISEASE TRIANGLE**).
- The development of a disease is stimulated when the **pathogen** is present, the **host plant** is vulnerable, and the **environmental conditions** favor the spread and development of the pathogen.
- Two factors are extremely important for fighting potato pests and diseases: use of **high quality seeds,** and **crop rotation.**



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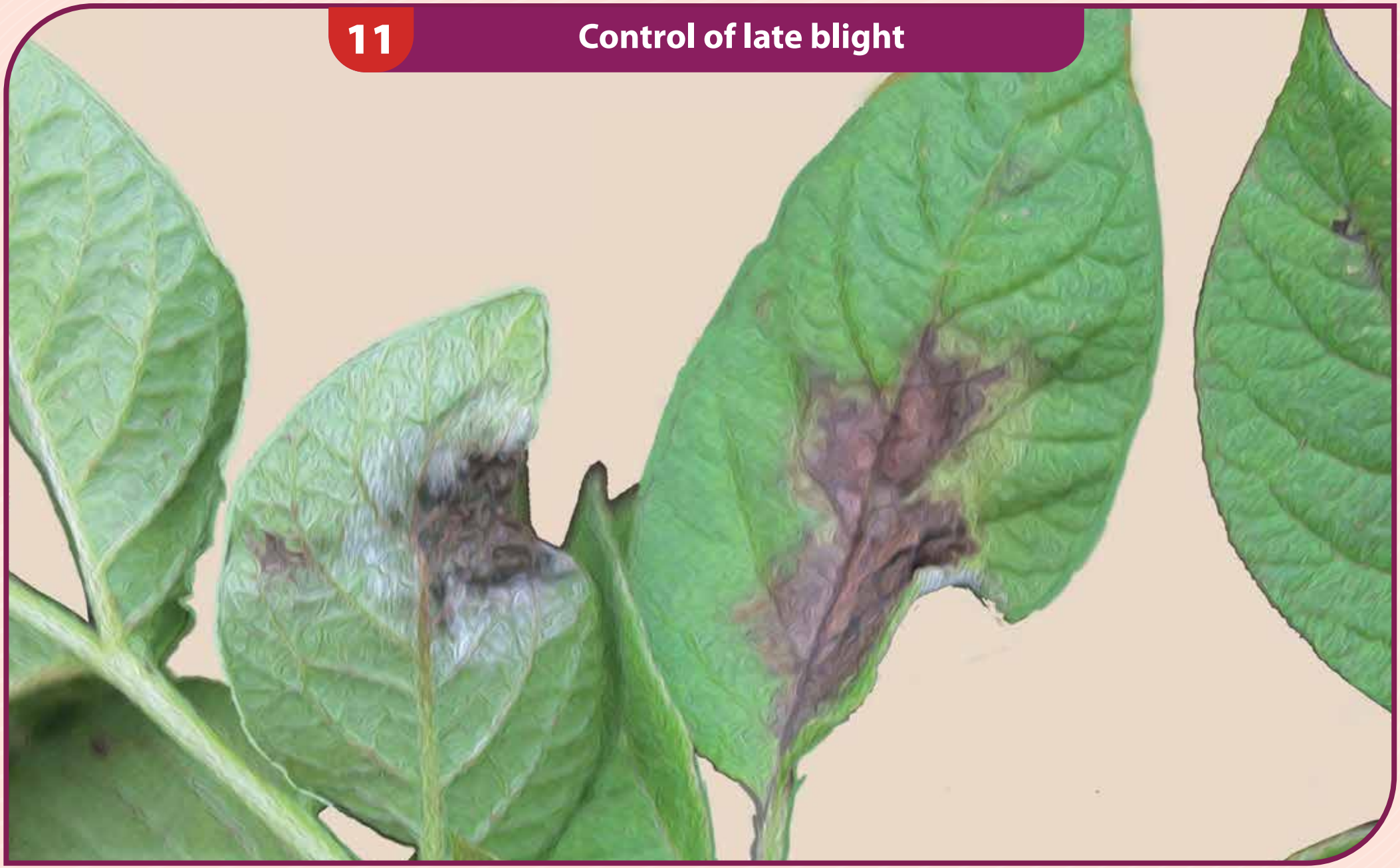
* Why is it important to control pests and diseases?
* What are the three components of a disease triangle?
* How do you call an infection of the potato plant or tubers that does not show symptoms?

!

Being able to differentiate diseased plants and tubers from healthy- looking ones (in field and storage) is an important step towards controlling pests and diseases.

11 Control of late blight



11 Control of late blight

- Late blight damages the leaves, stems and tubers. Infected leaves or stems have **grey/brown/black spots** as if they were burned. Symptoms also include white fluffy strands at the underside of the leaves.
- Late blight spreads through wind, water, soil and infected tubers and plant material. **Wet conditions** are favorable for late blight.
- Plant **clean seeds** of **less susceptible varieties** to avoid late blight in the field.
- **Collect** and **burn potato foliage** after harvest to sanitize the field.
- A wider plant spacing reduces humidity in the field which can help to reduce late blight.
- Use **contact fungicides** (e.g. Mancozeb) to prevent infection and **systemic fungicides** (e.g. Ridomil) to treat infection:
  - Spray a contact fungicide right after plant emergence when the plants are around 10 cm tall.
  - Spray a systemic fungicide 40-45 days after planting only if there is a lot of rain and a lot of late blight in the area.
  - For subsequent sprays, use contact fungicides at 2-weeks interval, except when disease symptoms are visible in the field. In that case, use a systemic fungicide. Once disease symptoms have disappeared, return to spraying with a contact fungicide.
- Systemic fungicides should not be used more than twice in a season because of high cost and harm to the environment.
- When using fungicides, always use the **dosage** that is recommended by the manufacturer.
- Contact fungicides (such as Mancozeb) should be applied at least **6 hours before it rains** to avoid the fungicides to be washed away. Systemic fungicides (such as Ridomil) should be applied at least **3 hours before it rains.** The leaves need to be dry before spraying (no dew on the leaves).

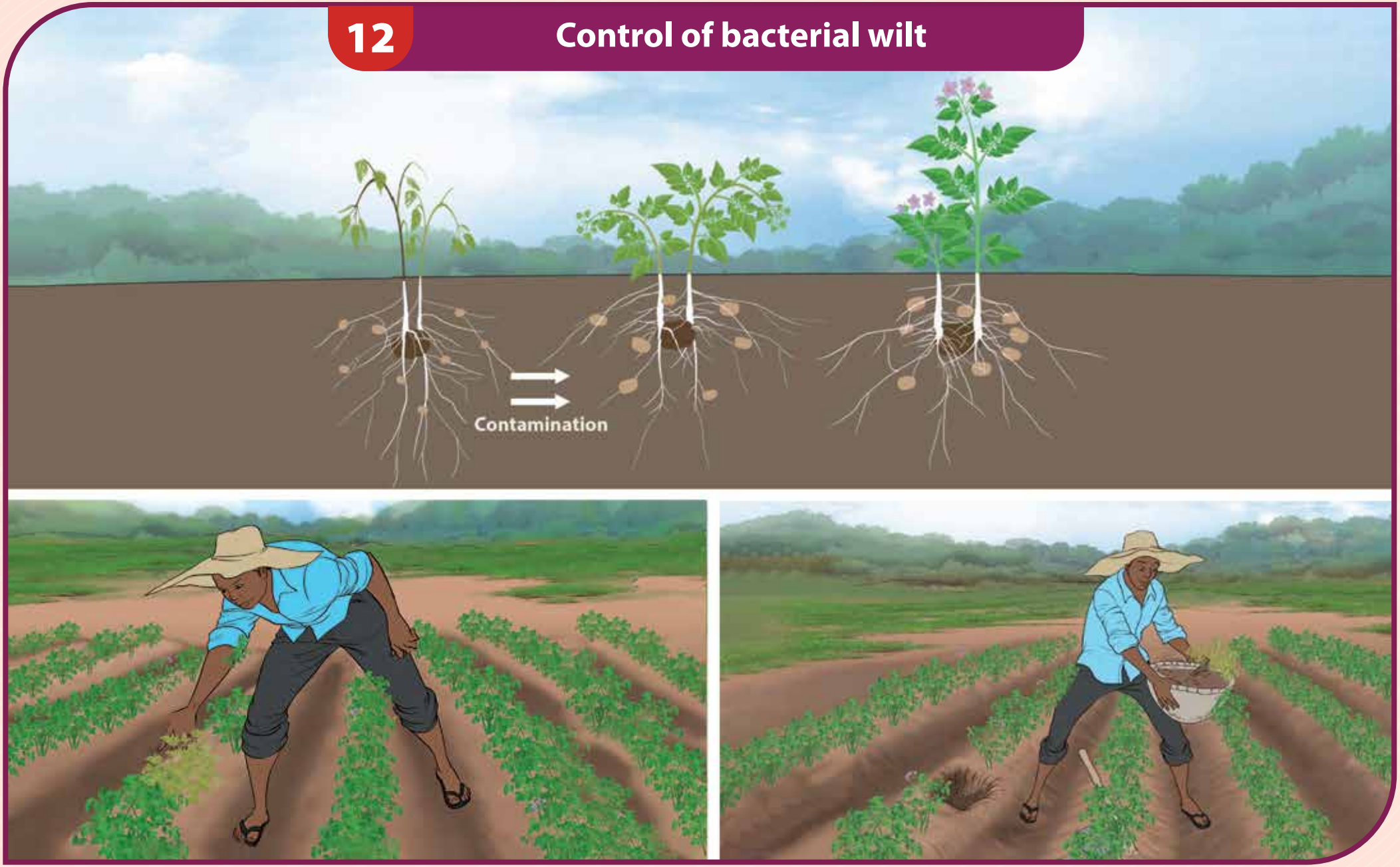
?

- What are the key symptoms of late blight in the field? And what are the key conditions for its outbreak?
- What are the most effective measures to control late blight in the field?
- What is the difference between a contact and a systemic fungicide?

!

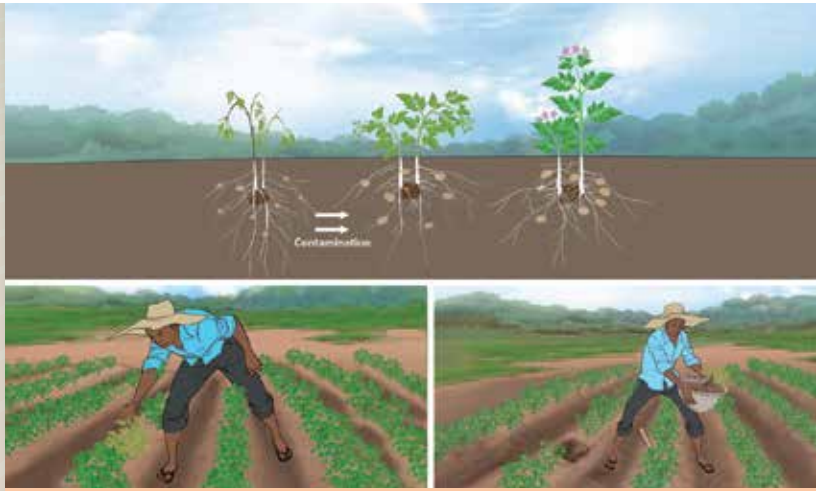
Late blight is the most damaging foliage potato disease. Ensure that you have access to clean seeds and know how to manage the disease before planting.

12 Control of bacterial wilt



12 Control of bacterial wilt

- Bacterial wilt causes **partial to complete wilting** of a plant even if there is enough water in the soil. When an infected tuber is cut in half, black or brown rings can be seen.
- The disease can spread via infected seed, water, roots, soil, farming tools, livestock and people.
- It also affects **other crops from the same family** such as chili, tomato, tobacco, and eggplant, as well as several weed species.
- There is no commercial chemical for controlling bacterial wilt.
- Plant **clean seeds** of **less susceptible varieties** in fields free from bacterial wilt.
- **Rotate** potato crops with other crops not belonging to the potato family, such as legumes and cereals.
- **Uproot** and **destroy** wilting plants together with soil around roots.
- Do not use compost with plant material from potato or crops from the same family.
- Clean and/or **disinfect farm tools** with fire or Jik before and after use.



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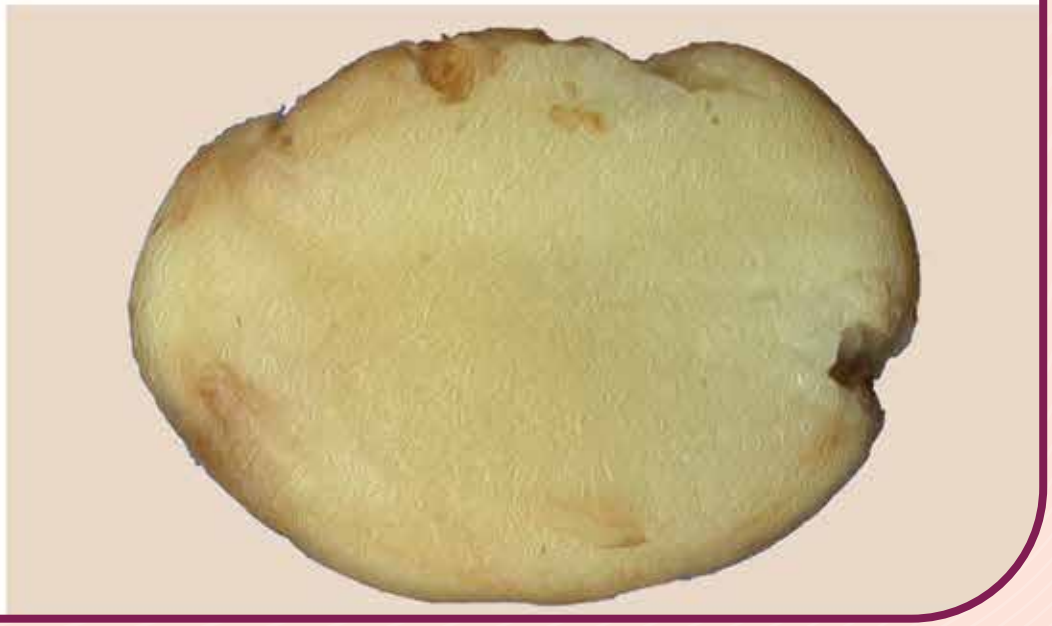
- What are the symptoms of bacterial wilt on the plant and the tubers?
- How can you detect bacterial wilt in the field?
- What are the most effective measures to control bacterial wilt?

!

There is no commercial chemical to control bacterial wilt. It is difficult to eradicate the disease once present in the soil.

13 Control of soft rot or blackleg



13 Control of soft rot or blackleg

- Soft rot, also known as blackleg, alters tuber tissue into **liquid or soft rot** and causes **black lesions** at the base of the stem.
- Infected tubers rot either in field or in storage and produce a **bad smell.**
- Manage this disease by applying the **same control measures** recommended for bacterial wilt (clean seeds, rotation, uprooting of diseased plants and disinfecting farm tools).

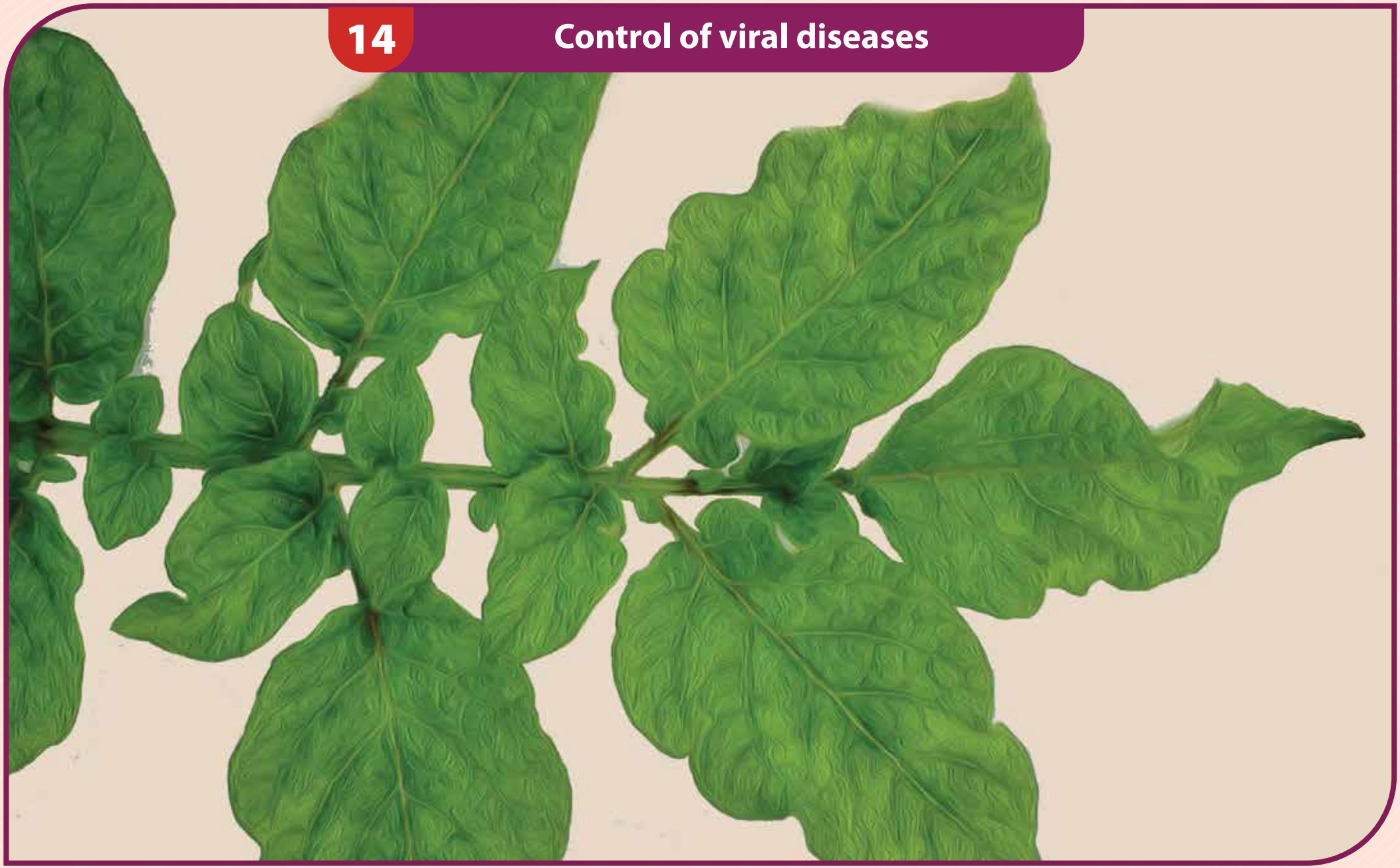
?

* What is potato soft rot (blackeg) and what are the symptoms?
* How would you differentiate soft rot (blackleg) from bacterial wilt on tubers and plants?
* What are the most effective measures to control soft rot (blackleg)?

!

There is no commercial chemical to control soft rot (blackleg). It is difficult to eradicate the disease once present in the soil.

14 Control of viral diseases



14 Control of viral diseases

- Viral diseases are difficult to recognize in the field. With mild infections, plants can show no signs of disease at all.
- Moderate to severe infections cause **changes in the shape of plants** (leaf curling, yellowing of the leaves, bubbling leaves, short and stunted plants).
- Viral infections lead to **smaller potato tubers.** Selecting small tubers as seeds for the next season can reduce yields in the next season as these tubers are likely infected!
- Control the disease by planting **clean seeds** of **less susceptible varieties.**
- **Uproot and destroy** infected plants.
- Insects such as aphids or whiteflies can spread viral diseases. Insecticides may be used to **control these insects**, but only as a last resort in case of severe infections.

?

* Why does the negative impact of viral diseases often go beyond the first season symptoms are observed in the field?
* What are the most effective measures to control viral diseases?
* Why is it important not to select seeds only based on size?

!

No need to know the names of viruses. What is important is to be able to differentiate a normal (healthy looking) plant from a diseased one.

15 Control of potato tuber moth

15 Control of potato tuber moth

- Potato tuber moths (also called potato tuber worms) infest the crop in the field and move with tubers to the store.
- Moth larvae create **tunnels** in the tubers and form **mines** in leaves and stems.
- Avoid planting in too light and loose soil as it facilitates exposure of the tubers.
- Perform **high hilling** to protect the tubers.
- **Inspect the tubers** carefully before and during storage and remove each tuber showing openings/galleries and/or excreta.
- Use **natural repellent plants** such as Lantana or Eucalyptus that cause moths to fly away.
- The field may be sprayed with appropriate **insecticides,** but only as a last resort in severe cases.

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* What is potato tuber moth (PTM)?
* What are the symptoms of PTM on tubers in storage?
* What are the most effective measures to control PTM in storage?

!

Planting a repellent plant around the potato store such as Lantana can help to reduce the impact of potato tuber moth.

16 Control of nematodes

16 Control of nematodes

- Two types of nematodes are known in potato production: **root-knot nematodes** (most widely spread) and **potato cyst nematodes.**
- Potato plants infested with nematodes may show stunting, yellowing of leaves and a tendency to wilt under moisture stress. Nematodes also cause **blemishes on tubers making** them unmarketable.
- Control of nematodes is primarily preventive because they are difficult to eradicate once they are present in the field.
- Plant **clean seeds of less susceptible varieties** in fields that are free from nematodes.
- Once nematodes are present in the field, **wait 5 years** before planting potato in the field again while avoiding crops from the same family (such as tomato, eggplant, chili).

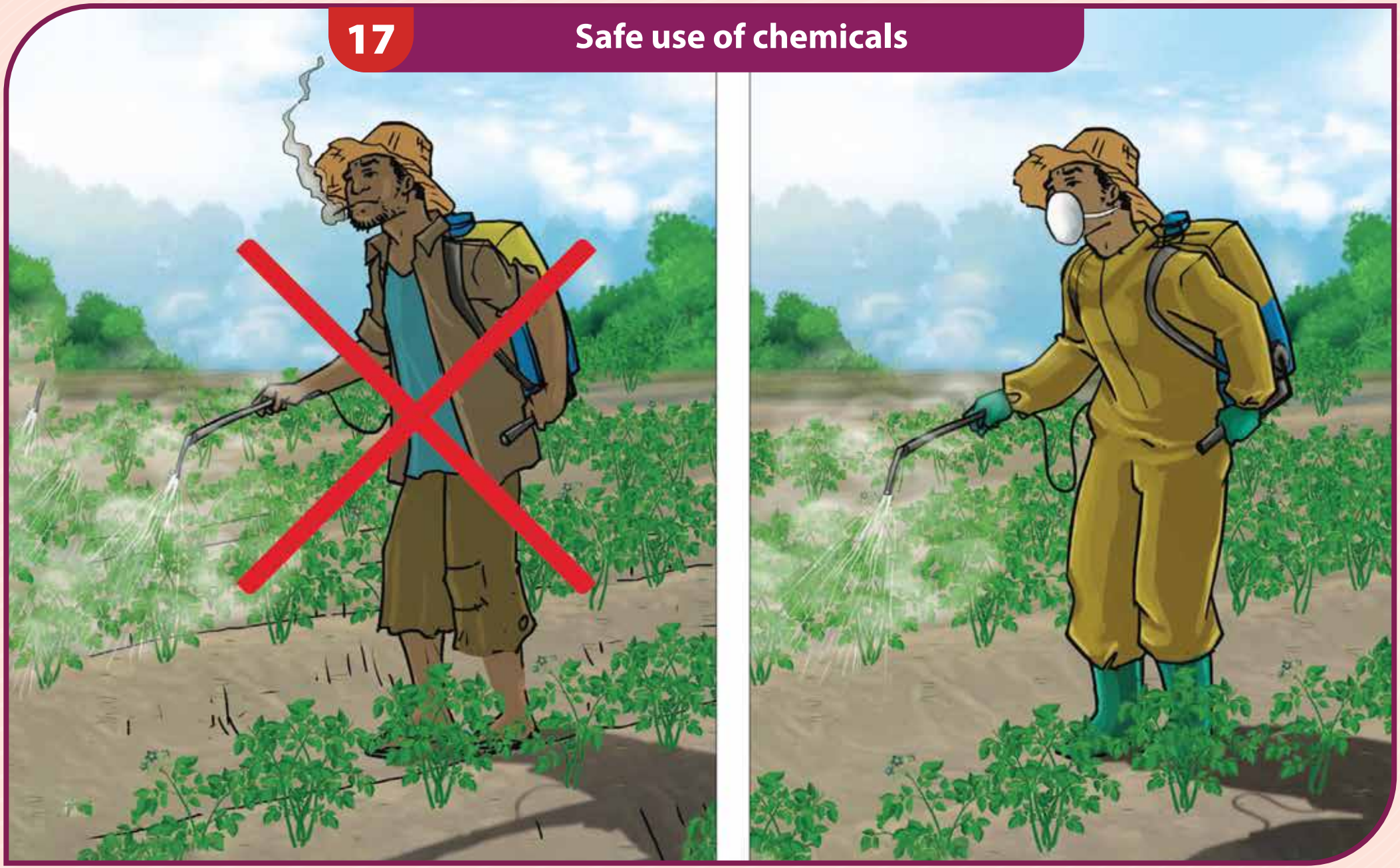
?

* What is potato nematode?
* What are the symptoms of nematodes on tubers?
* What are the most effective measures to control nematodes?

!

Nematodes are hard to eradicate once introduced in the soil. Preventive measures are always the most effective approach.

17 Safe use of chemicals



17 Safe use of chemicals

- Pesticides (fungicides, insecticides and herbicides) are **harmful** and should be used carefully to avoid harm to the user and neighbors' health and the environment.
- Pesticides should be the **last resort** after the farmer has exhausted other control mechanisms such as resistant varieties, healthy seeds and rotation.
- Always read the **instructions** given by the manufacturer on the label.
- Do not spray more than the **recommended dose** by the manufacturer.
- Wear **protective gear**: work suit covering arms and legs, a mask, boots and gloves.
- Avoid time of strong wind and do not spray against wind direction.
- Spraying of pesticides should **never be done by pregnant women or kids.** Also pregnant women and kids should not enter a field during or within a few days after spraying.
- Never spray crops just before harvest as it is harmful for the consumers.
- Keep pesticides in a **safe place** out of reach by children and far from food.
- **Do not dispose leftovers** of pesticide solutions in the environment.
- Do not re-use empty pesticide containers for other purposes.

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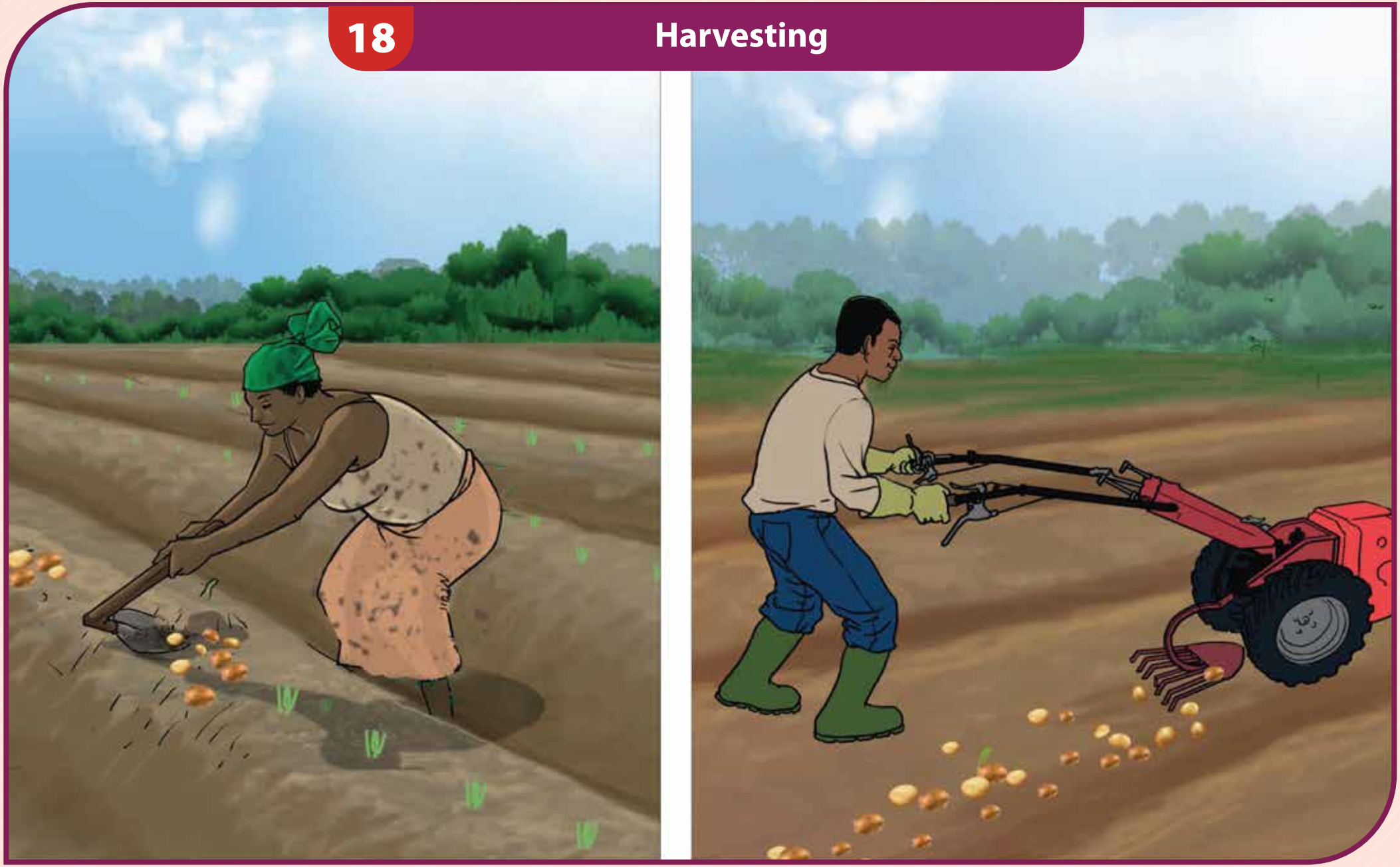
* Why is it so important to be careful when using pesticides?
* Where can you get specific indications on how to use a pesticide?
* How should you protect yourself and your family from the harmful effects of pesticides?

!

Please ONLY spray when necessary without exceeding the recommended dose and frequency.

18 Harvesting



18 Harvesting

- Harvest should be done when the crop is well mature, at complete death of the foliage and when the tuber skin is firm.
- It is recommended to **dehaulm plants 10-15 days before harvest** to allow the tuber skin to harden.
- Harvest should be done in **dry weather** and not when it is raining.
- Harvesting can be done by hand, hoe, motocultivator or tractor.
- Harvesting by hand takes longer but produces good quality and undamaged tubers.
- **Do not throw tubers** from a distance during harvesting.
- After digging up the tubers, leave them on the ground for a while max 2 hours but ideally less to allow soil to dry out and fall off.
- After harvest, **sanitize the field** by gathering and destroying residues and rotten tubers.

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* When is the right time to harvest a potato field for maximum tuber yield?
* What are the different techniques used to harvest potatoes in the field?
* Does the potato field require any care after harvest? Why?

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Never harvest before complete death of shoots if you wish to have a maximum yield.

19 Sorting and grading tubers for the market

19 Sorting and grading tubers for the market

- Tubers from diseased plants must **be harvested and collected last** and kept aside (this is called sorting).
- Healthy looking tubers should be **graded**, separating big tubers from medium-sized and small ones.
- The farmer should consider the different **tuber size classes** when establishing prices (depending on what the market demands).
- Only large tubers (over 60 mm) are normally used for processing (making chips or crisps).
- Use a **scale** to measure quantities during sale to instill trust between seller and buyer.

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- Why is it important to sort potatoes after harvest?
- Why is it important to grade tubers after harvest?
- What are the possible consequences of using buckets instead of a scale while selling potatoes?

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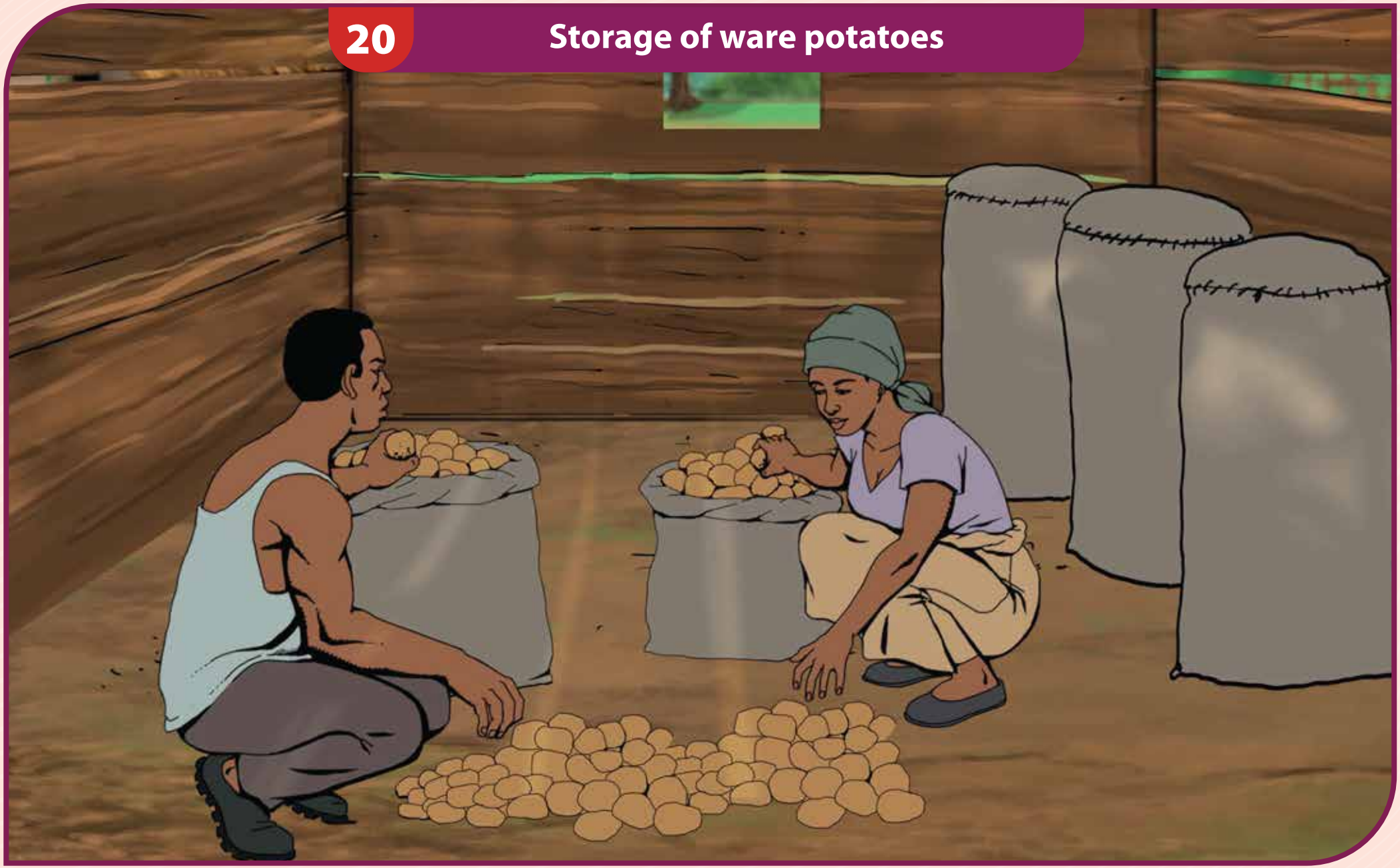
All potato tubers harvested in the field are not intended for the same uses, and thus do not all have the same value. Please grade your tubers and price them differently, whenever possible.

20 Storage of ware potatoes



20 Storage of ware potatoes

- Properly storing ware potatoes can help farmers to **preserve food** for home consumption or get a **higher price** after the harvest season.
- Only good quality potatoes should be stored to avoid spread of pests and rot during storage.
- Ware potatoes can be stored for a long time when there is a **cool temperature** (below 20°C), **darkness**, and **ventilation.**
- Use a material for the roofing of the store that helps to maintain cool temperatures inside the store.
- **Close doors during the day.** Doors may be opened during the night to allow ventilation.
- Tubers exposed to direct sunlight become **green and poisonous.**
- Store potatoes on **racks or in crates** to improve ventilation. Alternatively, potatoes can be stored in bulk on a clean floor. Potatoes can be be stored in bags for maximally 3 weeks.
- Frequently **inspect the store** for rotten tubers or tubers infected by potato moth. Remove and destroy infested tubers.
- Use **natural repellents** such as Lantana or Eucalyptus. Plant around the store or cover potatoes with leaves and branches. In the last case, make sure tubers get enough air to breath.

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* Does it make any sense to care about storage of ware potatoes? Why?
* What are the best conditions for a longer shelf-life of ware potatoes?
* Why is it recommended not to expose ware potatoes to sunlight for too long?

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Never eat or sell for consumption green tubers or tubers presenting green spots. They are poisonous.