Good Agricultural Practices for Ware Potato Production in Cameroon
1- Importance of the potato crop
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.

It produces more calories per unit area and unit of time than any other crop grown in cool climates.

It is also a good source of iron and zinc, 2 micro-nutrients important for human nutrition (especially infants and breastfeeding women).

Potato is one of the best food cash crops. This income enables smallholder farmers to upgrade their living conditions:
- better houses,
- better schools for children, and
- better healthcare

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

The income generated by growing potatoes is normally higher compared to the ones obtained from any other food crop.
2. Understanding the potato crop cycle
**Growth stage 1 – From planting to emergence (2-4 weeks)**
- Factors: soil type and moisture, seed physiological age, planting depth, soil temperature, etc.
- Very important to plant well sprouted tubers with multiple (minimum 3) and strong sprouts.
- This phase is very critical for better yields.

**Growth stage 2 – From emergence to tuber initiation (2-4 weeks)**
- Duration is strongly related with the type of varieties used.
- Fertilization process should be completed.
- Plants need more protection against diseases like late blight than later stages.

**Growth stage 3 – From tuber initiation to end of leaf growth**
- This is the flowering stage of the crop which marks the end of leaf growth.
- This means that all leaves are formed and fully grown.
- Ensure that plants have maximum soil around stems and all leaves are protected from any pests and diseases.

**Growth stage 4 – From tuber bulking to plant death**
- This is the maturity stage of the crop, leaves turn yellow and then die.
- Crop growth stops and tubers become bigger.
- It is important to wait until total death of the foliage for maximum yields.
- Control of pests and diseases, but chemical applications (fungicides and insecticides) must stop at 2 – 3 weeks before harvest.

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**Figure 2**

**Understanding the potato’s crop cycle**

1. What are the four stages of the potato crop cycle?
2. Why is it important to have maximum ground coverage by foliage until the end of the season?
3. When is it appropriate to harvest the potato field?

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**The more the ground is covered by potato foliage the more yield can be expected. It is important to preserve foliage throughout the cycle.**
3. Land selection and preparation
Potatoes like **cool environment**: 16 - 20°C, not beyond 28°C, nor below 10°C (normally grown in highlands and at mid-elevation).

- Soil should be deep, well drained and loose for proper development of roots, stolons and tubers.
- Site should be free of soil borne pests and diseases (bacterial wilt and nematodes), i.e. where potato has not been grown for more than 2 consecutive years.
- Plan for a 2-3 year **rotation** scheme as potatoes should not follow potatoes or other crops of the same family (eggplant, pepper, tomato, tobacco, etc).
- Essential to prepare soil early in the season when the soil is partially dry to prevent soil compaction.
- Prepare land until the ground becomes soft, free from clods and dug to a depth of over 30 cm.
- Ploughing soil using hoes is tiresome and labor intensive. Therefore, farmers are urged to modernize their agriculture and use **machinery** as being introduced by ProCISA:
  - Over 1 ha, use tractors, or
  - Less than 1 ha, use motocultivators.

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**Figure 3**

**Land selection and preparation**

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

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It is highly recommended to wait at least 2 to 3 years before you plant again potatoes or alike in the same field.
4. Application of manure and fertilisers
Application of manure and fertilisers

- Manure collected with 2 hands can be applied for 2-3 seed tubers (i.e., 15-20 t/ha). Not recommended for rich soils such as forest soils.
- Fertilisers: various compound NPK fertiliser packages but most commonly used fertilisers have a composition of NPK 12-11-18 (YaraMila) or NPK 11-11-22 to be mixed with a second N-rich fertiliser (15-0-0, like YaraLiva) at a ratio of 4/1.
- Avoid any NPK fertilisers like 20.10.10.
- For a planting density of 80 cm x 30 cm, 600 kg/ha of mixed fertilisers will be required, i.e., 480 kg/ha for the NPK-based fertiliser (e.g. YaraMila) and 120 kg/ha for the N-based fertiliser (e.g., YaraLiva).
- Apply 2 Fanta or beer bottle caps for each seed plant:
  - 1 cap of mixed fertilisers (e.g. Mila + Liva) at planting, and
  - Second cap of same fertilisers for top-dressing (1-2 weeks after emergence).
- For those who may not be able to fertilise after emergence, they can apply the 2 caps at planting.
- Also, you may apply the 2 caps after emergence.
- To fertilise the crop after emergence, dig one small hole at around 10-15 cm from the plant base using a stick. Put fertilisers and fill in using hands or a stick.

1. What is the quantity of organic manure required to fertilise potatoes on an area of 1 ha?
2. What are the mineral fertilisers that are recommended for potato crop in your area? At which dose?
3. When can you apply organic manure and mineral fertilisers if you wish to get better yields?

Unlike other crops, planting potatoes on a poor soil without manure and mineral fertilisers is a waste of time and resources.
5. Planting techniques
• Plant good **quality seed** of **market-preferred varieties** (most known are Cipira, Dosa, Panamera, Spunta, Mondial and Désirée).

• Use certified seed if available or quality seed from known seed producers or sources. Also, ensure the seed tubers are well sprouted and avoid too old tubers with long sprouts.

• Ensure that seed tubers of same size (category) are planted together in one area.

• Two ways of planting potatoes are possible whether using farmers’ tools or machinery: planting onto furrows or in holes. It is up to the farmer to choose the easiest method.

• Planting on ridges should be avoided because plants may not have enough soil for hilling-up.

• Prepare furrows or holes at a spacing of **75 - 80 cm**. But if your variety produces long stolons and/or the slope is steep, go up to 90 cm.

• Within rows, use a plant spacing of **25 - 40 cm** depending on seed size, 25 cm when tubers are small (around 30 mm of diameter) and 40 cm for largest size (like 55 mm of diameter).

• Note that on a sloping terrain, furrows or seed holes should run across the slope to reduce soil erosion and maintain runoff within plant rows.

• Tubers should be covered by enough soil (10 - 15 cm).

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**Figure 5**

**Planting techniques**

1. What are the names of the potato varieties that you grow in your areas? Are they local or improved varieties?

2. How would you arrange plant rows on a sloping terrain?

3. What is the optimal plant spacing for a maximum yield in ware potatoes?

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**Potato variety, seed tuber size, seed quality and soil quality are important factors to take into consideration when spacing seed at planting.**
6. Weeding and hilling-up
Potato crop should be weeded early to reduce competition (light, nutrients and water) from weeds and to prevent weeds from harboring pests and diseases.

Weeding occurs right after plant emergence.

Hilling-up potatoes for the first time is always done while weeding. The second and important hillling-up occurs 2 – 3 weeks later; it loosens the soil, allowing plants to produce many tubers of good size and shape.

A third and last hillling-up may occur 2 - 3 weeks later, especially when the slope and the rainfall are high.

Benefits of hillling-up potatoes include the following:

1. Facilitating nutrient assimilation while avoiding flooding conditions,
2. Maintaining soft ground for smooth root, stolon and tuber development,
3. Preventing that stolons become new but late above-ground stems when exposed to light,
4. Reducing tuber exposure to sunlight which turns the tubers green. Green tubers are NOT meant to be eaten because they are poisonous, and
5. Reducing exposure of tubers to pests and diseases such as potato tuber moth that can cause huge losses in field and storage.

Unlike other crops such as cereals, potato yield is underground. If you are unable to hill-up, please refrain yourself from planting potatoes.
7. Irrigation
Potato is considered to be one of the most drought sensitive food crops. Prior to planting, ensure that the crop will get enough water throughout the season. Potato water needs are critical at tuber initiation because drought causes longer duration of tuber formation and big yield reductions. Ensure that plants get enough water at least once a week, whether from rains or by irrigation. It remains difficult to determine the optimum irrigation frequency that cut across regions because water needs are dependent of many factors, including:
- type of variety (early or late maturing, drought sensitive or tolerant),
- soil type (clay, loam, sand),
- weather, and
- ground cover.
Since it is possible to grow potatoes during dry season, farmers are encouraged to invest in irrigation systems. Irrigation by gravity whenever possible is always the most reliable and cost-effective method. Otherwise do use the new solar irrigation innovation being introduced by GIZ-ProCISA. It includes a solar panel, an electric pump, pipe(s) and sprinkler(s).

1. At what stage of potato plant growth and development are water needs most critical?
2. What can you do if you wish to plant potatoes in a dry season?
3. What would you do if you have to use a pump to irrigate your field in an area where the 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.
8. Disease triangle

Host

Pathogen

Environment

Disease
It is important to protect potatoes against pests and diseases because they reduce tuber quality and yield (losses of 100% are possible).

For pests and diseases to occur either in field or storage, three conditions (DISEASE TRIANGLE) must simultaneously be met:
- The potato crop which is attacked by pests and diseases,
- The pathogen or pest (organism causing disease or damage), and
- The environment (conditions that favor the pathogen or pest).

For example, late blight can only be seen in the field if the relative humidity is very high (over 90%) and temperatures are low (less than 22°C).

Any initiatives or strategies to control pests and diseases should aim at breaking this harmful interaction.

Please note that the pathogen can stay in the plant or tuber for a long time without symptoms (latent infection – e.g., bacterial wilt).

1. Why is it important to control pests and diseases?
2. What are the three components of a disease triangle?
3. What 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.
9. Control of late blight
Late blight causes crop failure by damaging the leaves, stems and tubers. It can be controlled by spraying chemicals.

Severe infections occur at times of high relative humidity (over 90%) and cool temperatures (less than 22°C).

The disease spreads very quickly in the field and if it is not controlled, infected plants die within a week.

Late blight can be managed through:

- Timely sprays to prevent infection and even kill the pathogen after infection to avert spread.
  - Two major groups of chemicals are normally used to control this disease.
    - Group 1 comprises chemicals that kill by contact (contact fungicides). Examples: Mancozeb, Pencozeb, Balear (Tropic), Plantineb, Manesam, Mancobex and Mancozan.
    - Group 2 comprises systemic fungicides that enter the plant and move inside the plant and kill the pathogen. Examples: Ridomil (Gold and Plus), Fungi-Pro, Fungicur, Monchamp, Metalm 75 WP, Metrostar and Parastar.

- Planting clean seed of less susceptible varieties.

What and when to spray:

- Use first a contact fungicide just after plant emergence and then spray a systemic fungicide 2 weeks later, i.e., around 40 - 45 days after planting at a dose (commonly used) of about 3 g per liter (45-50 g/sprayer). The right dose is provided by the manufacturer.

- For subsequent sprays, use contact fungicides at 2-week intervals until the canopy turns yellow (maturity), except when disease symptoms are visible in the field, in which case you spray a systemic fungicide (max twice per season for less susceptible varieties).

Late blight is the most damaging foliage disease. Ensure that you have access to appropriate fungicides prior to planting.
10. Control of bacterial wilt
Bacterial wilt can infect the crop at all crop stages and can cause total failure of the crop. It is both a soil and seed borne disease.

It also affects plants such as chili, tomato, tobacco, black nightshade and eggplant, as well as several weed species.

It can be detected in the field by immersing a small piece of stem base in a glass of water (exclusive property of oozing from the stem and moving downward in the water). In fact, every wilt is not caused by bacterial wilt.

Bacterial wilt causes plant to wilt even if there is enough water in the soil.

When a tuber is cut in half, black or brown rings can be seen.

Sometimes fluid can come out of tuber eyes signified by soil sticking to tuber eyes when crops are harvested.

The disease can spread via infected seed, water, roots, soil, farming tools, livestock and people.

There is no commercial chemical for controlling bacterial wilt.

The only way of control is to manage the disease through cultural practices:
- Planting clean seed in fields free from bacterial wilt,
- Rotating potato crops with other crops not belonging to the potato family, such as cereals (maize as first rotation crop),
- Uprooting wilting plants together with soil around roots,
- Cleaning the tools before and after use, and
- In fields with serious infections, it is better to plant non-host plants for more than 5 years.

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1. What are the symptoms of bacterial wilt on the plant and tubers?
2. How can you detect bacterial wilt in the field?
3. 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.
11. Control of soft rot or blackleg
Soft rot also known as blackleg is caused by a bacterium which has the exclusive characteristic of altering tuber tissue into liquid (no other known disease which can produce the same effect).

Soft rot on infected tuber shows a decay from one spot which expand rapidly, resulting in rotting tissue that is mushy, slimy and water soaked.

Infected tubers rot either in field or in storage and produce a bad smell.

In line with the disease triangle, high soil moisture favors the pathogen to attack tubers and stems, causing significant crop losses.

Blackleg symptoms appear as black lesions at the base of the stem. Affected tissue becomes soft and water soaked under humid conditions and then the plant collapses.

Manage this disease by applying control measures recommended for bacterial wilt

1. What is potato soft rot (blackleg) and what are the symptoms?
2. How would you differentiate soft rot (blackleg) from bacterial wilt on tubers and plants?
3. 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.
12. Control of viral diseases
Viral diseases are difficult to recognize in the field since their symptoms are not seen immediately.
In mild infections, plants can show no signs of disease at all.
One of the potato viral diseases that can be easily detected is potato leafroll virus because infected plants show leaflets curling upward and turning pale yellow and when pressed they feel brittle and fragile.
There are many types of viruses and in most cases the field or the plant is infected by more than one virus. At least, farmers should be able to differentiate a normal plant (healthy looking) from a diseased one.
What these viruses have in common is that they all lead to smaller potato tubers which farmers unknowingly select for seed, leading to further reduced yields during subsequent seasons (seed degeneration).
Viruses are controlled by the combination of the following practices:
- Using clean/certified seed,
- Controlling insects that can spread viral diseases (insecticides, traps, predators, etc),
- Planting potato varieties that are less susceptible to viral diseases, and
- Uprooting and destroying any other non-potato plants which can attract and host the vectors of viral diseases
Note that you may need at least two types of insecticides as certain products may not be appropriate to control aphids.

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

1. Why does the negative impact of viral diseases go beyond the first season symptoms are observed in the field?
2. What are the most effective measures to control viral diseases?
3. Why is it important to use clean/certified seed?
13. Control of potato tuber moth
Potato tuber moths (also called potato tuberworms) infest the crop in the field and move with tubers to the store.

Moth larvae penetrate tubers through the eyes and create twisting tunnels in the tubers.

They reproduce continuously in stored potatoes causing huge losses. They display fewer characteristic tunnels in stores but they have clearly visible excreta, mainly at the eyes. Oftentimes, these tubers become drier than healthy ones.

Potato tuber moth can be controlled by:

- Spraying the field with appropriate insecticides at 2 – 3 week intervals. The first treatment starts right after plant emergence. Note that it is cost effective to mix fungicides and insecticides when spraying.
- Avoiding planting in too light and loose soil,
- Deep planting or high hilling up to protect the tubers,
- Decontaminating the storage rooms before putting potatoes,
- Inspecting the tubers carefully before and during storage and removing each tuber showing openings/galleries and/or excreta, and
- Using natural repellent plants such as Lantana.

Figure 13
Control of potato tuber moth

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

Planting a repellent plant around the diffused light store (DLS) such as Lantana can help to reduce the impact of potato tuber moth.
14. Control of nematodes
Two types of nematodes are known in potato production: potato cyst nematodes and root-knot nematodes (widely spread).

Root-knot nematodes are the most common across the globe and they attack tubers and cause blemishes making tubers unmarketable. Infested potatoes can become more susceptible to bacterial wilt.

Damage from cyst nematodes shows expanding patches of poor growth. The plants are stunted, yellow or yellow-white and wilting. Over time, yields are reduced and tubers become small.

Note that it is safe to eat potatoes containing nematodes. Do not keep them for seed but you can eat them.

Nematodes management should focus on reducing nematode population to levels below the damaging threshold.

Management practices should include:
- Selecting non-infested fields for production,
- Using healthy seed potatoes,
- Increasing crop rotation between potato crops to 5 years. Some forage species significantly reduce the quantity of nematodes found in the soil, and
- Cultivating potato varieties that are less susceptible.

Nematodes are hard to eradicate once introduced in the soil. Preventive measures are always the most effective approach.
15. Safe use of chemicals
Chemicals should be used carefully to ensure protection of the user and the environment because all chemicals are harmful and should be handled with much care.

The user should dress in recommended protective gear and follow instructions of safe spraying.

Many cases of pesticide poisoning occur in farming communities.

Chemicals should thus be the last resort once the farmer has exhausted other cultural or biological control mechanisms such as varieties with pest/disease resistance, healthy seed potatoes, rotation with other crops, organic pesticides (e.g., Neem) and integrated soil management.

When chemicals are mandatory (e.g., late blight), the farmer should not spray more than the dose required, nor exceed the treatment frequency recommended by the manufacturer.

The aim is to maintain pest populations and disease severity at acceptable levels while safe for human health and the environment.

There is a bad habit of spraying crops just before harvest. This is strictly forbidden. No fungicides or insecticides should be applied during the last 2-3 weeks of the crop.

Disposal of chemical containers is also another societal issue that needs to be addressed.

1. Why is it so important to be careful when using chemicals in general, and pesticides in particular?

2. Where can you get specific indications on how to use a pesticide?

3. When is the use of pesticides strictly forbidden in a potato field, and why?

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

- Harvest should be done when the crop is well mature, at complete death of the vegetation.
- Harvest should be done in dry weather and not when it is raining.
- Harvesting methods can affect tuber quality.
- Potatoes can be harvested either manually or using machinery.
- When harvesting manually, there are also two ways: directly by hand or by using a hoe.
- Harvesting by hand takes longer and is more labor intensive, but produces good quality and undamaged tubers.
- Using a hoe is less time-consuming and labor intensive, but some tubers are damaged in the process.
- Use of motocultivator or tractor is by far less labor intensive and faster method than harvesting manually especially when the field is relatively big (over 1 ha).
- Tubers should be left on the ground for a while to allow any soil caked on them to dry out and fall off.
- After harvest, you should sanitize the field, by gathering and destroying harvest remnants such as foliage residues, rotten tubers, etc (disease triangle).

1. When is it appropriate to harvest a potato field for maximum ware potato yield?
2. What are the different techniques used to harvest potatoes in the field?
3. Does the potato field require any care after harvest? Why?

Never harvest before complete death of shoots if you wish to have a maximum yield.
17. Sorting and grading tubers after harvest
• Tubers from diseased plants must be collected last.
• Healthy looking tubers should then be graded, separating big tubers from small ones (depending on what the market demands).
• All tubers are not appropriate for processing. Only large tubers (over 60 mm) are normally used for chip making.
• In principle, the farmer should take into account the different tuber classes when establishing prices.
• The cheating practice of displaying large tubers at the top of the bags while hiding small ones at bottom and/or stuffing bags should be discouraged.
• Also, the use of bucket as a metric for transactions hides malpractices. Use of scales is the method that instills trust between seller and buyer.

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

**All potato tubers harvested in the field do not have the same uses, and thus the same value. Please grade your tubers and price them differently, whenever possible.**
18. Storage of ware potatoes
Oftentimes farmers do not care much about storing ware potato like they do for seed. Tubers for consumption or the market provide long storability while maintaining good tuber quality when the following three major conditions are met:
- Cool temperatures (below 20°C),
- Darkness, and
- Ventilation.
Tubers exposed to direct sun light become green and poisonous.
Lack of aeration causes tubers to rot.
There is no harm to pour ware potatoes on the floor provided that there is a minimum of hygiene.

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

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