Good Agricultural Practices for Ware Potato Production in Cameroon

Producer Manual

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Registered offices
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Rue 1.820
P.O Box 7.814, Yaoundé / Cameroon
T +237 222 212 387
T +237 222 209 440

E info@giz.de
I www.giz.de

Name of project/ program:
Green Innovation Centres for the agricultural and food sector (ProCISA) Cameroon

With contributions from:
Dieudonné Harahagazwe – Elly Ouma Atieno – Elmar Schulte-Geldermann – Peter Kromann (CIP Kenya)
Honrère Mafouo – Richard Anagho (MINADER Cameroon)
Arne Schuffenhauer – Laetitia Sossou – Arnaud Breitenstein – Kongyu Ali Festus (GIZ/ProCISA Cameroon)

Illustrations and Formatting:
Hervé Momo

On behalf of the
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“The International Potato Center, known by its Spanish acronym CIP, is a research-for-development institution with a focus on potato, sweetpotato, and Andean roots and tubers. CIP is dedicated to delivering sustainable solutions to the pressing world problems of hunger, poverty, and the degradation of natural resources.”
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Module 1

Introduction to the potato crop

1.1. Importance of the potato crop

The potato crop comes from South America from where it was spread all over the world, including Africa. The crop is currently the third food crop in the world, after wheat and rice. In the human diet, potato is the most consumed non-cereal food in the world. It produces more calories per unit area and unit of time than any other crop grown in cool climates. It is reported that tubers contain a higher protein concentration (more than 2% of fresh matter) than any other root or tuber crop. With regard to vitamins, a medium-sized potato tuber may contain half of the daily needs of an adult in vitamin C. Potatoes contain a lot of potassium, a nutrient which is good for health, including blood pressure, bones and muscles.

Besides these nutritional values, potato is one of the best food cash crops in many countries, including Cameroon. Therefore, this income enables smallholder farmers to upgrade their living conditions, e.g., better houses, better schools for children, and better healthcare.

Before venturing into potato agri-business, the following conditions must be fulfilled:
1) Have the minimum access to the knowledge or technical backstopping on integrated potato crop management.
2) Land free of potato diseases is available.
3) Resources to purchase inputs and pay labor before planting (e.g., seed, fertilizers and pesticides) are available.
4) Good quality seed of desired varieties is available and accessible.
5) Production plan for the next three or more seasons (indicating hectarage to be grown each season and the sources of seed) is prepared.
6) Target market for the produce is identified before planting.
7) Have a storage facility or post-harvest handling plan of the produce.

1.2. Understanding the potato crop cycle

Understanding different growth and development stages of potato crop will help potato growers to know the right time to perform targeted agronomic practices in the field to minimize yield losses. The national average tuber yield in Cameroon is around 3 t/ha whereas yields of over 30 t/ha are easily obtained in experiments. Closing this yield gap requires understanding and sorting out challenges encountered by the crop throughout its growth cycle.

Growth cycle of potato crop can be divided into four stages (phases) which require timely and specific farming operations.
Growth stage 1 – Planting to plant emergence
This stage begins when sprouted tubers are planted and ends when plants emerge from the soil (emergence). In normal conditions, this stage lasts 2 to 4 weeks, but it can also be longer depending on planting conditions such as soil type and moisture, seed physiological age, planting depth, ambient temperature, etc. It is highly recommended to plant well sprouted tubers with multiple (minimum 3) and strong sprouts to ensure uniform germination of multi-stem plants in the field. This phase is very critical in the crop growth cycle as it drives the crop success or failure, because the harvest is strongly related to the seed quality used.

Growth stage 2 – Emergence to tuber initiation
This stage starts from plant emergence to tuber initiation. It also lasts 2 to 4 weeks after germination but this period is strongly related with the type of varieties used. Some varieties start forming tubers much earlier than others. During this phase, the fertilization process should be completed. Also plants are still young and fragile. Therefore, they need more protection against diseases like late blight than later stages. In this regard, one treatment with a systemic fungicide should be conducted before or at tuber initiation.

Growth stage 3 – 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. The crop reaches its maximum coverage of the soil. During this stage, farmers should ensure that plants have maximum soil around stems and all leaves are protected against pests and diseases.

Growth stage 4 – End of leaf growth to plant death
This is the maturity stage of the crop. At this stage, crop growth stops and tubers become bigger. The leaves turn yellow and die. It is important to wait until total death of the foliage because yield increases significantly at this stage. This means that foliage remains protected against pests and diseases till natural death occurs. However, chemical applications (fungicides and insecticides) must stop at 2 – 3 weeks before harvest.
Potatoes like cool environment (16 - 20°C). Therefore, plant potatoes in an area that is not too hot (i.e., beyond 28°C), nor too cold (i.e., below 10°C) and select a site open, without shades. In Cameroon, potatoes are grown in highlands (above 1,800 masl) and at mid-elevation (800 – 1,800 masl). The soil should be deep, well drained and loose for proper development of roots, stolons and tubers. The site should be free of soil borne pests and diseases, such as nematodes and bacterial wilt. To reduce the risk of pests and diseases, select a site where potato has not been grown for more than two consecutive years. Also plan for a 2-3 year rotation scheme (i.e., 5 cycles or seasons) as potatoes should not follow potatoes or other crops of the same family (e.g., eggplant, pepper, tomato or tobacco) on the same field. During rotation, ensure that all volunteer potato plants are removed. Soil testing is ideally recommended to find out soil needs in nutrients before planting. But the common practice is to follow advices from local extension services. It is 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 encouraged to modernize their agriculture and take advantage of machinery introduced by ProCISA Project. For those planning to plant on less than 1 ha, motocultivators are indicated whereas those preparing bigger land (over 1 ha) could use tractors.

2.2. Application of manure and fertilizers

Like any other crop, potato requires adequate nutrients from manure and chemical fertilizers to grow well. The manure collected with the two hands of an adult can be applied to feed 2-3 seed tubers. This is equivalent to 15-20 t of well decomposed manure per ha. This manure is very useful on poor soils. It is not recommended for rich soils such as forest soils. For fertilizers, various compound NPK fertilizer packages are available on market in Cameroon. The most commonly used fertilizers have a composition of NPK 12-11-18 or NPK 11-11-22 and they are mixed with a second N-rich fertilizer (15-0-0) at a ratio of 4/1, respectively. Avoid any NPK fertilizers that have proportions between major nutrients (N, P and K) very different from the ones proposed here (e.g., 20-10-10). If the plant spacing is for example 80 cm x 30 cm, 600 kg/ha of mixed fertilizers will be required, i.e., 480 kg/ha for the NPK-based fertilizer and
120 kg/ha for the N-based fertilizer. In practical terms, apply the content of two Fanta or beer bottle caps for each seed tuber or plant. Apply one cap of mixed fertilizers at planting and reserve the second one of same fertilizers for top-dressing, 1-2 weeks after plant emergence. But for those who may not be able to fertilize after emergence, they can apply the two caps at planting. Also, if you fail to apply fertilizers at planting, you may apply the two caps after emergence. To fertilize the crop after emergence, dig one small hole at around 10-15 cm from the plant base using a stick. Put fertilizers and fill in using hands or the stick.

2.3. **Planting techniques**

Plant good quality seed of market-preferred varieties. The most grown varieties are Cipira (also called Tigoni in Kenya), Dosa, Panamera, Mondial, Spunta and Désirée. New varieties are being evaluated with the facilitation of ProCISA and may be released soon. Those varieties are currently six, namely, Bavapom, Sevim, Juwel, Krone, Marabel and Jelly.

Use certified seed if available or quality seed from known seed producers or sources. Ensure the seed tubers are well sprouted and avoid too old tubers with long sprouts which can get off or damaged easily and result into poor crop vigor and irregular germination. Short and strong sprouts will ensure that once planted growth will be faster, uniform and crop will be more vigorous. Ensure that seed tubers of same size (category) are
planted together in one area. This results in uniform crop vegetation which will facilitate better management.

Two ways of planting potatoes are possible whether using farmers’ tools or machinery: planting onto furrows or on flat (holes). The two methods produce the same results. Therefore, 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 at later stages of development. Prepare furrows or holes at a spacing of 75 - 80 cm. But if your variety produces long stolons than normal varieties 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 large size (like 55 mm of diameter). Note that on a sloping terrain, furrows or 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). Do not waste your time in arranging tubers in a way sprouts are placed in upright position. They naturally get their way out without any noticeable delay regardless of their position.

2.4. Weeding and hilling up

Potato crop should be weeded early to reduce competition for light,
nutrients and water from weeds, and to prevent weeds from harboring pests and diseases. First weeding normally occurs right after plant emergence. The field should remain free of weed till the end of the cycle. Avoid planting potatoes in a field where there is a weed which is difficult to control or eradicate.

Hilling up potatoes for the first time is always done with the first weeding, especially when plants grow fast. It loosens the soil, allowing plants to produce many tubers of good size and shape. The second and important hilling up occurs 2 – 3 weeks later, depending on the growth speed of the vegetation. A third and last hilling up may occur 2 - 3 weeks later, especially when the slope and the rainfall are high. Ensure that formed tubers are not uncovered at any time. Also, use a smaller (thinner) hoe than the one used for other field activities.

Benefits of hilling up potatoes include the following:

i. Facilitating nutrient assimilation while reducing risks of flooding conditions.

ii. Maintaining soft ground for smooth root, stolon and tuber development.

iii. Preventing that stolons become new but late above-ground stems when exposed to light.

iv. Reducing tuber exposure to sunlight which turns the tubers green. Green tubers are NOT meant to be eaten because they are poisonous.

v. Reducing exposure of tubers to pests and diseases such as potato tuber moth that can cause huge losses in field and storage.
2.5. Irrigation

On one hand, potatoes produce more food per unit area and unit of time than any other food crop. But on the other hand, it is considered to be one of the most drought sensitive food crops. Therefore, please ensure that the crop will get enough water throughout the growth season. Potato water needs are critical at tuber initiation. When drought occurs at that stage, the duration of tuber formation increases which results in big yield reductions. Half of expected yield can be lost. Therefore, it is important for the plants to 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, peat, etc), weather and ground cover. Once tubers are formed, avoid dry spells to enable regular tuber growth. Otherwise, tubers may present abnormal shapes (secondary growth).

Since it is possible to grow potatoes in Cameroon during dry season (from October to February), farmers who can access water are encouraged to invest in irrigation systems. Irrigation by gravity whenever possible is always the most reliable and cost-effective method. Otherwise, do take advantage of the new solar irrigation innovation being introduced by ProCISA Project. It includes a solar panel, an electric pump, pipe(s) and sprinkler(s).
Like any other crop, it is important to protect potatoes against pests and diseases because they reduce tuber quality and yield. The loss can be total (100%). For pests and diseases to occur either in field or storage, three conditions that form a triangle known as DISEASE TRIANGLE must simultaneously be met. Those conditions are the following:

a) The potato crop, which is attacked (by pests and diseases);

b) The pathogen or pest (organism causing disease or damage, also known as causal agent);

c) The environment (conditions that favor the pathogen or pest).
This triangle constitutes the base for the control of pests and diseases. Therefore, 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 as long as the environmental conditions are not conducive to the disease outbreak. This phenomenon is known as latent infection which is very frequent for a disease called bacterial wilt.

In the following paragraphs, the manual provides insights on some of the most common and harmful pests and diseases found in sub-Saharan Africa in general, and Cameroon in particular.

### 3.2. Control of late blight

Late blight causes crop failure by damaging the leaves, stems and tubers. Infected leaves or stems present brown spots as if they were burned. Fortunately, 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:

i. Timely sprays to prevent infection and even kill the pathogen after infection to avert spread. Several chemicals are well known to control late blight when used as prescribed. Two major groups of
chemicals are normally used to control this disease. The first group contains chemicals that kill by contact at the plant surface (contact fungicides). The most used by potato growers are the following: Mancozeb, Pencozeb, Balear (Tropic), Plantineb, Manesam, Mancobex and Mancozan. The second group comprises chemicals known as systemic fungicides because they enter the plant and move inside the plant and kill the pathogen. The most known potato fungicides in the country are the following: Ridomil (Gold and Plus), Fungi-Pro, Fungicur, Monchamp, Metalm 75 WP, Metrostar and Parastar. These are lists of fungicides available on the market. It does not mean that they are all effective against late blight. Also, systemic fungicides containing metalaxyl may be banned from next year.

ii. Planting clean seed of less susceptible varieties;

iii. Collect and burn potato foliage after harvest.

Even though late blight is controlled by spraying, it is important to know what and when to spray because chemicals do have side effects on the environment, in addition that they are costly. Therefore, use first a contact fungicide just after plant emergence and then spray a systemic fungicide two weeks later, i.e., around 40 - 45 days after planting at a dose of about 3 g per liter (45-50 g/sprayer). Please note that exceeding this dose does not provide any additional benefit but rather side effects. For subsequent sprays, do use contact fungicides at 2-week intervals until the canopy turns yellow due to maturity, except when disease symptoms are visible in the field. In that case, spray a systemic fungicide. In principle, less susceptible varieties do not require spraying more than twice in a season with systemic chemicals because of their cost and potential to induce pathogen resistance and cause harm to the environment.
3.3. Control of 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, a milk like fluid may come out of tuber eyes signified by soil sticking to tuber eyes at harvest.

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. Bacterial wilt has the exclusive property of oozing from the stem and moving downward in the water.

The disease can spread from field to field or from plant to plant within a field via infected seed, water, roots, soil, farming tools, livestock and people.

There is no commercial chemical for controlling bacterial wilt. Therefore, the only way is to manage the disease through cultural practices which include the following:

i. Planting clean seed in fields free from bacterial wilt;
ii. Rotating potato crops with other crops not belonging to the potato family, such as cereals. Maize is the most recommended crop after potato;

iii. Uprooting wilting plants together with soil around roots;

iv. Cleaning the tools before and after use.
3.4. 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. There is no other known disease which can produce the same effect on tubers. Therefore, soft rot on tubers 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.
3.5. Control of viral diseases

Viral diseases are difficult to recognize in the field since their symptoms are not seen immediately, but after several seasons when yield reduction becomes a point of concern. In mild infections, the plants can show no signs of disease at all. One of the potato viral diseases that can be easily detected is potato leafroll virus. Plants infected by this virus 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 causing compound effects. Since there are no specific control strategies for each virus, do not blame yourself for not knowing the different viruses. What is important is to 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. This stage is called seed degeneration which should not be confounded with variety degeneration happening when a given variety loses its intrinsic resistance to a pest or disease.

Viruses are controlled by the combination of the following practices:
i. Using clean/certified seed. It is very risky to select seed potatoes based on tuber size alone, as plants infected with viral diseases generally produce smaller tubers.

ii. Controlling insects that can spread viral diseases. Sucking insects such as aphids, thrips, mites, leafminers and whiteflies are carriers of viruses. Therefore, management of these insects by spraying chemicals, trapping them and/or using predators reduces the spread of viral diseases. Note that you may need at least two types of insecticides as certain products may not be appropriate to control aphids.

iii. Planting potato varieties that are less susceptible to viral diseases.

iv. Uprooting and destroying any other non-potato plants which can attract and host the vectors of viral diseases and prevent mechanical spread.

3.6. 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. They form mines in leaves and stems. Moth larvae penetrate tubers through the eyes and create twisting tunnels in the tubers. They reproduce continuously in stored potatoes causing huge losses. When tubers are attacked while in storage, they
display fewer characteristic tunnels, 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:

i. Spraying the field with appropriate insecticides at 2 – 3 week interval. The first treatment starts right after plant emergence. Note that it is cost effective to mix fungicides and insecticides when spraying. The following are the most commonly used insecticides on potato in the country: Cypercal, Cygogne, Decis, Kumfu, Timol and Pyrifos.

ii. Avoiding planting in too light and loose soil, as this facilitates exposure of tubers on which the female moths can deposit their eggs.

iii. Deep planting or high hilling up to protect the tubers.

iv. Decontaminate the storage rooms before putting potatoes.

v. Inspecting the tubers carefully before and during storage and removing each tuber showing openings/galleries and/or excreta.

vi. Using natural repellent plants such as Lantana that cause moths to fly away from storage place.
3.7. Control of nematodes

Two types of nematodes are known in potato production: the potato cyst nematodes and the root-knot nematodes. Infested potato plants may show varying degrees of stunting, yellowing of leaves and a tendency to wilt under moisture stress.

Root-knot nematodes are the most widely spread across the globe. 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. Twenty years may elapse from the nematode introduction until field symptoms become obvious.

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

Management of nematodes should focus on reducing the population to levels below the damaging threshold. Control of nematodes is primarily preventive because they are difficult to eradicate when they are present in the field. Management practices should include:

i. Selecting non-infested fields for production.

ii. Using healthy seed potatoes.

iii. Increasing crop rotation between potato crops to 5 years while avoiding any other crops belonging to the potato family, e.g., tomato, eggplant. Some forage species significantly reduce the quantity of nematodes found in the soil; and

iv. Cultivating potato varieties that are less susceptible to nematodes.
3.8. Safe use of chemicals

Chemicals should be used carefully to ensure protection of the user, neighbors and the environment. All chemicals are harmful and should be handled with much care. The user should dress in recommended protective gears 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 natural pest predators, 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 like in case of late blight, the farmer should not spray more than the dose required, nor exceed the treatment frequency recommended by the manufacturer. When spraying, avoid time of strong wind and do not spray against wind direction.

The aim is to maintain pest populations and disease severity at acceptable levels while keeping pesticides and related interventions to levels that are economically justified and safe for human health and the environment.

Some farmers have 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 at scale.
Module 4

Post-maturity practices

4.1. Harvesting

Harvest should be done when the crop is well mature, at complete death of the vegetation. Harvesting should be done in dry weather and not when it is raining. Harvest 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 can be 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.
4.2. Sorting and grading

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.
4.3. **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. As mentioned earlier, 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.