REPORT OF THE STUDY TOUR IN KENYA FOR CAPACITY BUILDING ON EARLY GENERATION SEED POTATO PRODUCTION

From 7 to 14 March 2022

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SUMMARY

Within the framework of the South-South cooperation, the International Potato Center (CIP) and the Green Innovation Centres for the Agriculture and Food Sector Project (ProCISA) organized a study tour for twelve Cameroonian delegates. The delegates were drawn from the Ministry of Agriculture and Rural Development (MINADER), the Institute of Agricultural Research for Development (IRAD), seed producers from the three major potato-producing regions, CIP, and ProCISA. The objective was to learn from the Kenyan experience with the latest innovations in technology and policies and thus build their capacity in early generation seed production techniques, management, formal organizations, and policies. The aim is to boost the national seed system, which is still underdeveloped.

The tour took place on 7–14 March 2022 and brought the delegates to eight public and private seed potato actors across Kenya, where they acquired essential knowledge on the setting up and functioning of laboratories and systems for producing clean seed potato, appropriate storage facilities, mechanization, as well as policies governing the sector.

At the end of the tour, the public sector representatives resolved to replicate the Kenyan model in Cameroon by first bringing all the actors together on a national platform to build a strong potato sector. For the private sector actors, this was long overdue. Their visits to local and large-scale apical cutting producers inspired them to action. They resolved to share the knowledge gained upon return with their peers so they can work together to improve the seed sector.

I. INTRODUCTION

Within the framework of a GIZ-funded project titled "Potato Value Chain Development in Cameroon (PVCD-Cameroon)," the International Potato Center (CIP) plans to re-establish and strengthen the national seed system by integrating the entire multiplication chain from *in vitro* to certified seed production. To this end, CIP collaborated with the Green Innovation Centres for Agriculture and Food Sector Project (ProCISA) to re-establish the Institute of Agricultural Research for Development (IRAD) tissue culture laboratory and strengthen the Structure TOWA tissue culture laboratory. This ProCISA-CIP partnership has also constructed two screenhouses in the west of Cameroon to produce minitubers and rooted apical cuttings (RACs). This will improve farmers' and cooperatives' access to quality seed in Cameroon. However, to ensure sustainability, the project needs to build in-country capacity to produce early generation seeds focusing on partner institutions and the private sector.

In this light, CIP, again in collaboration with ProCISA, organized a study tour around Kenya for partner institutions to build their capacity in early generation seed potato production from tissue culture to field multiplication. Once acquainted with modern technologies, these partners share the knowledge with their peers in the country and eventually boost the production of pre-basic seed potatoes. The choice of Kenya was motived by the recent developments in using modern technologies to produce millions of minitubers and RACs with solid technical backstopping from CIP.

This activity falls within the third component of the CIP-Cameroon project to establish a sustainable national seed system for improved access of farmers and cooperatives to quality seeds of disease-resistant and market-demanded varieties for increased productivity and resilience.

2. PARTICIPANTS

These were delegates from:

- The Ministry of Agriculture and Rural Development (MINADER);
- The Institute of Agricultural Research for Development (IRAD);
- The private sector (seed growers);
- GIZ - ProCISA (the donor); and
- CIP.

See Annex 1 for a complete list of participants.

3. OBJECTIVES

3.1. Overall objective of the study tour

Build the capacity of strategic partners (seed growers, MINADER, and IRAD) on early generation seed (EGS) production techniques such as micropropagation, minituber, RAC production, and the technical and management aspects.

3.2. Specific objectives

- Introduce stakeholders to all steps of a formal potato seed system, including rapid multiplication techniques (RMTs);
- Train stakeholders on various techniques for producing and handling apical rooted cuttings, including practical training;
- Expose stakeholders to the business aspects of producing EGS in laboratories and fields;
- Acquire knowledge of business plans for the production of EGS; and
- Pass on the acquired knowledge and skills to other stakeholders upon return; and

4. STRUCTURES VISITED

The tour took place on 7–14 March 2022 and brought the delegates to eight public and private seed potato actors across Kenya. The structures visited included seed firms, laboratories, research centers, and organizations involved in policies. See the tour program in Annex 2, and places visited in Annex 3.

4.1. STOKMAN ROZEN KENYA LTD (SRK)

4.1.1. History of SRK

This is a private company situated in Naivasha at 1900 m.a.s.l. Their primary activity is the propagation of flowers for sale in the local market and export. However, they identified the gap in the potato seed sector in Kenya and decided to step in to produce clean potato planting material for farmers. They have a tissue culture laboratory and screenhouses to produce pre-basic and basic material and make it available to farmers nationwide and beyond. They are backed by over twenty years of experience, experienced staff, and have the capacity to multiply many crops via micropropagation while adhering to strict hygiene and production protocols as advised by KEPHIS. Their plantlets are certified clean and free from bacteria and viruses; this has earned them a strong reputation nationally and beyond. The tissue culture (TC) lab was not visited during this tour because it is situated 15 km from the screenhouse where rooted apical cuttings (RACs) are produced.

4.1.2. Production of plantlets in the TC lab

They source the starter material from KEPHIS, which is cleaned of bacteria and viruses using a combination of thermotherapy and meristem culture. Before multiplication, this material is screened again in their lab for bacteria and viruses using PCR and ELISA techniques. To check contamination, they include yeast in the multiplication medium to favor the growth of fungi. Large stocks of clean TC material are then taken to the screenhouse for further multiplication to produce RACs for sale to partners. The TC starter material is renewed every two to three years with fresh TC plantlets from KEPHIS.

4.1.3. Varieties produced

The varieties produced are open access and free varieties that are registered by KALRO and licensed by KEPHIS. The choice of varieties is market-driven, and the priority variety is *Shangi* which is the most preferred by Kenyan farmers. Other varieties include Konjo, Unica, Chulu, Dutch Robyn, Wanjiku, Tigoni, and Nyota, amongst others. In addition to the open varieties, they also maintain breeder material in the lab and only produce them under license from the breeder and for a specific client.

4.1.4. Procedures to produce RACs in the screenhouse

The substrate used in the screenhouse to produce RACs is called cocopeat and is sourced from the local market. Before using, the cocopeat is first soaked overnight in a calcium nitrate solution (25 kg calcium nitrate/10 000 L of water). Calcium nitrate is drained, and the substrate is flushed with clean water to remove all the salt. This is checked by measuring the pH of the drainage water. The washed cocopeat is dried and then loaded into plugs produced by the company. The screenhouse is divided into three units:

1. The mother plant unit where the *in vitro* plantlets are acclimatized under a polythene shade for five days;
2. The propagation room where apical cuttings are multiplied. This unit has a black shade to reduce temperatures; and
3. The rooting unit where the apical cuttings are rooted for sale to farmers. The plants are exposed to conditions like field conditions and this section has no black shade.

4.1.5. Management of RACs in the screenhouse

The cocopeat is disinfected in an NPK solution (9:0:6) before the planting of *in vitro* plantlets and apical cuttings. *In vitro* plantlets that constitute the mother plants are planted in crates at a 5 x 5 cm spacing, while the apical cuttings are planted in plugs in trays. Fertilization is done using liquid fertilizer, which is applied before weaning the plants and then about two weeks after. The plants are checked every morning and watered as required. On hot days, the floor is also watered to maintain humidity.

4.1.6. Minituber storage

After harvesting the minitubers from the screenhouse, they are graded according to size and packed in crates.

4.1.7. Production challenges

1. Difficulty in timing production and volumes as Kenyan farmers rely on heavy rain-fed agriculture. Any delays in standard rain patterns pose a problem for the farmers and the company.
2. Unreliable delivery systems for small quantities using both couriers and public transport to far-off destinations.
3. Lack of or isolated centralized distribution centers for small-scale farmers.
4. Drop in potato prices. Thus, seeds produced are not bought.

4.1.8. Opportunities

1. Fast, assured, and scalable way of mass-producing clean minitubers.
2. Potential to provide employees with access to even small plots of land and water.
3. Possibility of cleaning existing local varieties that are virus-infected but are in high demand in a short time.

Figure 1. Group photo at SRK. Photos courtesy of Nathan Ronoh (CIP) and Ruth Ngo Oum (GIZ).

Figure 2. SRK screenhouses for production of RACs.

Figure 3. Julius Muchiri, presenting tissue culture techniques to the delegates.

Figure 4. Washed cocopeat dried in pits (left) and sieved (right) before filling in plugs and trays.

Figure 5. Cocopeat filled in plugs (left)and the plugs fitted into trays (right).

Figure 6. Mother plants planted in cocopeat ready to harvest cuttings (left) and SRK staff demonstrating the process in the screenhouse (right).

Figure 7. Mother plants in the screenhouse and harvesting of apical cuttings.

Figure 8. SRK cold storage for potato seeds and flowers.

4.2. KENYA PLANT HEALTH INSPECTORATE SERVICE – PLANT QUARANTINE AND BIOSECURITY SAFETY STATION (KEPHIS – PQBS)

The delegation was received by Kevin Sambai, sitting in for the Director, who later joined virtually. Kevin gave a brief presentation on KEPHIS as a state-funded agency with the primary aim to ensure the import and export of crop produce and seed certification. This is assured by phytosanitary and seed inspectors trained by KEPHIS. Before the presentation of the Director, the delegates expressed what they expected to know about and learn from KEPHIS. The expectations were as follows:

- The organizational setup of KEPHIS, the policies, and how often the latter is revised to meet the realities.
- The role of KEPHIS in the potato value chain.
- Diagnostic laboratories run by KEPHIS and their procedures.
- Inspection procedures for seed import and export.
- Seed certification procedures.
- Plant propagation methods used in general.
- Conditions for field inspections and the number of inspections done during the crop season.
- The possibility of having exchange visits between KEPHIS and the DRCQ.
- Management of viruses in seed plots.
- Seed regulations, procedures for registering varieties in the catalog.
- The interaction with farmers and challenges faced.
- Outreach model to reach farmers and other partners.

4.2.1. Presentation by George Ngundo

KEPHIS is the national regulating body whose mandate is to ensure quality importation of plant material and carry out seed certification. It is a state-funded entity governed by policies and acts adopted by the

government. Plant health and seed certification procedures are governed by two laws. Potato is the second most important food crop in Kenya after maize. The potato seed sector is well regulated, though the total seed production is still far below demand. **Only high-standard, clean plant material (basic seed) is imported into the country,** and the recommended early generation seed production technologies are tissue culture, aeroponics, and RAC techniques. Farmers and firms pay a registration fee of 750 USD for the first year of production to KEPHIS, and a yearly fee to renew their registration (the entire full presentation is available upon request). Kenya has a zero tolerance for bacteria and viruses in seed potato production. Thus, a mandatory soil test is done prior to seed production.

4.2.2. Tour of laboratories

Laurent Kinusa took the delegation around the plant and soil diagnostics labs run by KEPHIS, notably the bacteriology, mycology, nematology, molecular biology, entomology, and virology labs. These labs perform various diagnostics tests to ensure quality seed is imported and multiplied in the country. **Josephine Muriuki** led the delegation to the CIP TC genebank, where she presented the main units of the lab, phytosanitary procedures observed, culture media components, preparation and storage of stock solutions, and sterilization of media. A practical session was carried out on nodal and meristem culture with the participation of Victorine Fornkwa and Rauwitta Omabit. Josephine also presented the thermotherapy incubators for bacteria and virus elimination from plant material before multiplication. In addition to the CIP TC lab, the national lab is where germplasm is multiplied and maintained for the national system. At the end of the KEPHIS visit all the delegates signed the visitors' book.

Figure 9. Group photo with KEPHIS – PQBS staff.

Figure 10. Presenting gifts to KEPHIS – PQBS (left) and CIP TC lab officials (right), Kevin and Josephine, respectively.

Figure 11. Delegation following a presentation by the KEPHIS Director.

Figure 12. Visit to the CIP TC lab and hands-on practical on nodal culture and meristem excision.

Figure 13. CIP gene bank.

Figure 14. Thermotherapy incubator in the CIP lab for heat treatment of explants before meristem excision.

4.3. GRACE ROCK FARMS LTD

4.3.1. Brief history

This is a private firm situated in the Limuru area at 2400 m.a.s.l. They produce seedlings of various crops and sell them to farmers. They also produce vegetables like tomatoes and sell them in the local market.

4.3.2. Production of RACs and minitubers

They source *in vitro* potato plantlets from KEPHIS, which they acclimatize in a mini screenhouse placed in one corner of the main screenhouse. These are transplanted to cocopeat and maintained under high temperature and humidity for three days, after which the polythene covering is removed, and only the insect-proof net is left. These would constitute mother plants from which apical cuttings are harvested after seven to ten days. The sub mothers are planted in pots filled with the same substrate mixture as above and further harvested to produce RACs or planted in troughs to produce minitubers for field multiplication. Fertilization in the troughs consists of DAP (5 g/plant) applied at planting, calcium at the end of flowering, and potassium nitrate at the beginning of tuberization. The substrate in troughs consists of a mixture of cocopeat and sand at a ratio of 2:1. The plants produce about 8–12 minitubers per plant. The minitubers are planted in the field to produce G1 seeds sold to farmers at 60 KES/kg. The seeds are certified by KEPHIS after screenhouse and field inspections.

Figure 15. Group photo at Grace Rock Farms.

Figure 16. Grace Rock screenhouses to produce RACs and other vegetables like tomatoes.

Figure 17. Pots with six months old mother plants (left) and trays with RACs ready for sale to seed multipliers (right).

Figure 18. Production of minitubers from RACs.

Figure 19. Drip irrigation system to produce minitubers.

Figure 20. Shangi seeds and minitubers for sale.

4.4. FRESHCROP LTD

4.4.1. Brief history presented by the CEO, Christopher:

FreshCrop is a private firm located in the Mau Narok area at about 3000 m.a.s.l. After their studies, Chris and his wife were motivated to start ware potato production for the Kenyan market. They started seed production four years ago on 2 ha of land after identifying the need for quality seed as a major constraint in potato production. They contacted CIP's Monica Parker, who introduced them to the RAC technique, which they adopted with much conviction and moved production from 1.6 ha to 18 ha of certified seed. The firm operates on **200 ha** of land leased to them by the Masai community. FreshCrop has three hub sites located in Nakuru, Narok, and Nyandura. The hub sites aim to ensure the continuous education of farmers through field demonstrations, ensure easy access to certified seeds, and provide other agro services like agrochemicals to them.

4.4.2. Mission and vision

The mission of FreshCrop is to revolutionize the potato value chain from tissue culture to consumption through the empowerment and education of farmers, the implementation of smart agricultural practices, and the utilization of the appropriate agro-technologies. They aim to become Kenya's number one certified seed potato producer and provide the best quality varieties. FreshCrop Ltd is a member of the NPCK, which helps them to market their products and equally channels their complaints to the competent state authorities.

4.4.3. Varieties

They are certified by KEPHIS and the varieties produced are **Shangi, Dutch Robijn, Wanjiku, Chulu, and Unica.** They highly appreciate Chulu because it produces well at all altitudes and even at high temperatures in the screenhouse. They recently imported true potato seeds (TPS) of four new varieties

that are good for chips and table potatoes. They will plant the TPS in the screenhouse to obtain plantlets for field multiplication.

4.4.4. Seed multiplication and outreach model

They receive TC material from SRK, which they acclimatize in their solar-powered screenhouse to produce RACs for field multiplication. They multiply RACs in the screenhouse mostly during periods of heavy rainfall and move to the field when the rains subside. Field multiplication is done entirely by FreshCrop up to G5 before commercializing to ware potato farmers. FreshCrop partners with farmers in the community to multiply certified seeds. They have 35 farms distributed in the communities run by contract farmers (out-growers) who had previously undergone a one-week training program with them. These farmers, in turn, train 120 farmers each in their various communities, and they form a network that produces ware potatoes and sells them back to the firm for their processing unit. The contract farmers produce certified seed under FreshCrop's license; FreshCrop provides the agrochemicals, does the planting with their machinery, does monitoring during the entire crop cycle, and helps them sell their seed. They follow-up with the contract farmers from planting to harvesting and train them to do large-scale production. Before admitting farmers into the network, they must fulfill some basic criteria like the availability of farmable land for rotation (at least 5 ha), and the land must be free of bacterial wilt and nematodes.

4.4.5. Mechanization

Agriculture at FreshCrop is 99 % mechanized, and this has cut the cost of production by 50 % and increased the yield by 30–35 %, that is, 25–35 tons/ha for ware potato and 15–20 tons/ha for seed. During the peak harvest periods (July, August, and January), they send 24–36 tons of ware potato to the market daily. They have various machinery including plows, planters, harrows, harvesters, and graders. These are imported from Turkey and re-adapted with locally made parts for easy maintenance. The machines are used in all their hubs, starting from the central hub and then to the communities. Due to the cut in the cost of production, they sell seed at 55 KES/kg (about 250 FCFA/kg), which is an affordable price for farmers.

4.4.6. Sorting, grading, and storage

After harvesting, the seeds are sorted by women, then put in the grader, which grades the seed to various sizes. These are conditioned in 50 kg bags and stored in diffused light stores in all the hubs. They mainly keep the 25–35 mm and 45–55 mm sizes, the above 55 mm is sold as ware, and the below 25 mm is used as animal feed (they also rear sheep).

4.4.7. Rotation

They rotate potatoes with other food crops like barley, wheat, and carrots for at least four years before bringing potatoes back to the land.

4.4.8. Challenges

These include, amongst others:

- The management of cash flow is a major challenge since they work with many contract farmers in the communities;
- Cases of bacterial wilt were discovered in one of the contract framer's seed farm, which was then transferred to ware much to the dislike of the farmer; and
- The use of specific NPK fertilizers per region according to the results of the soil tests.

Figure 21. Briefing upon arrival at FreshCrop by Dr. Monica Parker.

Figure 22. Presentation of various machinery at FreshCrops by Chris Gasperi.

Figure 23. FreshCrops vast farmland of over 300 ha.

Figure 24. Planting in FreshCrops Farm.

Figure 25. Sorting and grading of seeds are done mainly by women.

Figure 26. Diffused light store for seed storage.

4.5. KENYA AGRICULTURAL AND LIVESTOCK RESEARCH ORGANIZATION (KALRO) – TIGONI

The delegation was accompanied to KALRO–Tigoni by the CIP Regional Director, Dr. Paul Demo. They were received by Mr. Patrick Pwaipwai, who coordinated the registration and introduction of participants. In his word of welcome, the Director, Dr. Moses Nyongesa, acknowledged the excellent collaboration between CIP and KALRO and thanked the Regional Director for choosing KALRO as one of the places to visit by the delegation. He said it was the first time they were receiving such a delegation from Cameroon and that they were open to future collaboration in any aspect of potato research with the team.

4.5.1. Brief history presented by the Director, Dr. Moses Nyongesa

KALRO is a state organization of sixteen institutes grouped into livestock, crop, and cross-cutting research centers. KALRO has 52 centers, each specialized in a particular crop, with the Tigoni center being focused on potato research.

4.5.2. Seed sector overview presented by Dr. Nyongesa

KALRO Tigoni specializes in potato research and is the center of excellence for releasing new varieties developed by their researchers or other research institutes such as CIP. KALRO SEED is an autonomous unit that coordinates all aspects related to seed. They release new varieties and obtain a license from KEPHIS to produce certified seed. The farmers who multiply their varieties pay royalties to KALRO. To increase the productivity and income of farmers, they provide capacity building in GAPs for seed production and facilitate subsidies for inputs to farmers. KALRO has a licensing agreement that it shares with farmers and companies who pay royalties to them.

Figure 27. The Director of KALRO Dr. Moses Nyongessa presenting.

4.5.3. Tour of seed production facilities

4.5.3.1. Tissue culture Lab

The delegation was led to the TC lab by the lab technicians Patrick Pwaipwai and Ann Namusonge. Ann took us through the procedures used in the lab to produce pre-basic seed (meristem and nodal culture), stock solutions, preparation and storage of stock solutions and culture media, and general phytosanitary procedures in the TC lab. The lab is divided into four compartments: the changing area, the media preparation room, the transfer room, and the growth room. The basic equipment includes an automatic autoclave, water distiller, laminar-flow hood, precision balance, and stereo microscope, amongst others. The main varieties they multiply are Tigoni and Shangi, but they also maintain some breeder varieties for research.

Figure 28. The growth room of the KALRO tissue culture lab.

4.5.3.2. Hardening unit

The delegation was received here by Martha Odongo, who explained the processes involved in hardening *in vitro* plantlets to produce RACs for the aeroponic and hydroponic units, as well as minitubers for field multiplication. She said plantlets from the lab are acclimatized for about one week, after which apical cuttings are harvested, rooted in peat moss, and sent to the aeroponics and hydroponics units for minituber production.

4.5.3.3. Aeroponics and hydroponics units

Bethwel Kawili and Patrick Pwaipwai led the tour of the two units. Bethwel controls the pumping system in the two units, monitors the nutrient tank, and ensures the medium is drained and replaced every fortnight. The nutrient tanks are buried such that the nutrient can be pumped under gravity to and from the screenhouse. Patrick explained how the aeroponic system functions: the RACs are planted in plugs on styrofoam in the screenhouse, and the roots grow into a dark box where they are misted by the nutrient solution. When the plants are still young, the roots are misted for 15 mins on and 5 mins off, and as they grow older, it is timed at 15 mins on and 15 mins off. The top foliage is treated regularly with fungicides to prevent late blight. The plants are constantly pushed down as they grow taller to keep the root area in the dark box where tubers develop. The tubers are monitored and harvested; they start harvesting after two months and stop harvesting after six months. The plants are discarded, and the screenhouse is disinfected before beginning another cycle.

The RACs are planted in troughs filled with treated cocopeat as a growth medium in the hydroponic unit. Other media that can be used include sand and peat moss, but sand is avoided because it would clog the fertigation pipes. They are fertigated by drip irrigation with the same nutrient mix as in the aeroponic unit. The fertigation solution is also recycled like in aeroponics and flushed out every fortnight. The plants are sprayed to control late blight and insects.

Figure 29. KALRO aeroponics (left) and hydroponics units (right).

4.6. THE NATIONAL POTATO COUNCIL OF KENYA (NPCK)

The delegation was received at the NPCK by the CEO, Mr. **Wachira Kaguongo,** and his staff. In his presentation, the CEO highlighted the following points about the NPCK:

- The NPCK is a public-private partnership forum that brings together stakeholders in the potato value chain to exchange information on challenges and opportunities in the sector. Thus, its members are drawn from state institutions, research institutes, international organizations, and the private sector.
- It is governed by a Board of Directors (BOD) of 40:60 public to the private sector. The BOD appoints the CEO, who in turn appoints the secretariate members. The mandate of the BOD members is three years renewable once.
- The NPCK has a central structure with representatives in the various counties
- Its primary mandate is to help organize, plan, and coordinate the potato value chain activities.
- The aim is to link research, farmers, NGOs, and the market.
- They act as a referee between farmers and KEPHIS in case of problems with seed.
- The main challenge faced by the NPCK is funding to run its activities. They, therefore, get their funds from members' registration, grants, and affiliation fees paid yearly by stakeholders.
- The CEO equally presented the NPCK digital platform known as VIAZI SOKO. The platform provides end-to-end value chain information from production to marketing of potatoes, as well as weather advisory service for all stakeholders. Farmers place seed orders in advance through this platform, and NPCK organizes scheduled deliveries.

After the CEO's presentation, delegates asked questions to better understand the functioning of the council and draw inspiration from it to build a solid national potato platform in Cameroon. To that effect, the NPCK offered documentation that could be of help to Cameroon.

Figure 30. Group photo at NPCK.

Figure 31. Reception of documents offered by NPCK to the team.

Figure 32. Delegates visiting the exhibition stands set up for the purpose of the visit.

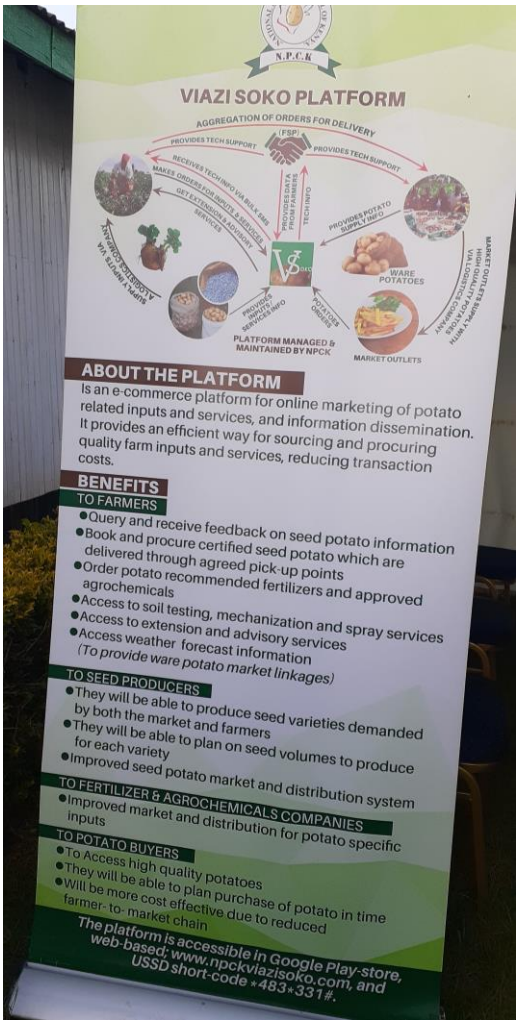

Figure 33. Summary of the NPCK VIAZI SOKO platform.

4.7. KISIMA FARM LIMITED

4.7.1. Brief history

Kisima Farm is a Kenyan mixed farming company incorporated in 1943 and is situated in Timau, Meru County, at above 2000 m.a.s.l. The foundation of Kisima farm is based on education and agriculture extension in the community. It is wholly Kenyan-owned and operated. Kisima is an extensive agribusiness that spans 4500 ha, has an annual turnover of 14 million USD, and 650 employees. Its primary focus is on red-fed arable crops, which are cultivated at 1500 ha per season and two seasons per year. The cereals cultivated are wheat and barley, and rotation crops include peas, canola, sunflower, and other pulses. The secondary focus is on floriculture, with 20 ha of roses cultivated in greenhouses and 4 ha of outdoor crops (primarily Delphinium, Matthiola, Craspedia, and Alstroemeria). In addition to the floriculture and arable

crops, they also run a forestry program constituted of 650 ha of radiata pine for construction timber and eucalyptus for poles. They can mill 120,000 cubic meters of timber per year.

4.7.2. Management

Kisima farm is run by a Board of Directors supported by Jonathan Moss, Managing Director, Buzz Robertson, General Manager, Oliver Francombe, Potato Production Manager, and Nteere Gitonga, Executive Officer, Kisima Foundation.

4.7.3. Community development

They run an agricultural extension program, and support education (nine primary schools and one secondary school), health care (health center), and water management by providing boreholes in the community.

4.7.4. Minituber production through aeroponics and storage

They obtain RACs from SRK for the aeroponics and hydroponics units. Kisima produces more than 200 000 minitubers per year through aeroponics in the screenhouse. Kisima has adopted a 3G strategy where the seed is produced in aeroponics, scaled up through three field multiplications, and made available to farmers in 18 months instead of three years. After harvest, the minitubers are air-dried for one week before taking to the store. They have cold storage with a capacity of 2000 tons. Seed is stored at less than 2^{o}C and ware potato at 8^{o}C at least. The storage room is fumigated before and during storage to control pests. Before planting, the seeds are taken out of the cold room for some weeks to break dormancy. **Minitubers are sold at half a dollar per piece (about 250 FCFA/minituber).**

4.7.5. Link with KEPHIS and KALRO

Kisima pays royalties to the tune of 2.5% of their annual income to KALRO to multiply and disseminate their varieties. KEPHIS inspects their seed farms four times during the growth cycle, after which the seeds are certified. KEPHIS equally inspects all their imported genetic material before multiplication and dissemination.

4.7.6. *Production of certified seed potato and crop rotation*

They are the leading producer of certified seed in the country and supply over 2500 smallholder farmers annually. They multiply varieties from CIP, KALRO, and a Dutch Company, HZPC (they have the right to multiply their varieties), among which are Unica and Shangi, the farmers' preferred varieties. Field multiplication is done on 200 ha per year with an average production of 2–4,000 tons of certified seed per year. Certified 3G seed typically increases smallholder yields by 3–5 times (8 t/ha to 40 t/ha). They have complete control of their seed from pre-basic to G3 when they start selling to seed growers. They do not practice the out-grower model as observed at FreshCrop. They do a **rotation for seven years** with the crops mentioned previously. The cost of seeds depends on the size; the 25–35mm and the 35–60mm seed

are sold at **55 KES/kg (about 290 FCFA/kg),** those more than 60mm are sold as ware at 25 KES/kg and those less than 25mm used as animal feed. Close to 14,000 smallholders benefit from the resale of Kisima seed potatoes every two years (four seasons).

4.7.7. Mechanization

Agriculture at Kisima is 99% mechanized. They have field preparation, planting, harvesting, sorting, and grading machinery.

4.7.8. Farmers' outreach model

Kisima's dedicated agricultural extension program assists smallholders in developing optimal technologies through field days, farmer training, and seed provision. The Kisima Agri Information Center is part of the Kisima Farm Foundation funded by Syngenta and 0.5 % of the Kisima Farm Ltd annual turnover. The center is located on 1 ha and benefits smallholder farmers. They offer one-week training sessions to individuals and farmers' groups. The Foundation organizes two major field day events annually, during which agro companies showcase their products to farmers and distribute inputs freely to smallholders. Companies set up demonstration plots in the center with their products (seeds, fertilizers, pesticides), and the foundation takes care of field maintenance. The center is open daily to inform farmers and interested visitors. Potato is their flagship crop. They also use digital platforms like WhatsApp to share information with Kisima farmers and officials of the ministry in charge of agriculture. KEPHIS also visits them occasionally to inspect the demonstration plots set up by agro companies.

4.7.9. Challenges

The main challenge of Kisima Farm Ltd is the difficulty in distributing seeds to smallholders. This is due to long distances coupled with poor roads. The Agri Information Center, on its part, faces the challenge of adopting new technologies from some farmers who prefer to stick to old beliefs. They also have difficulties keeping farmers' cooperatives together due to the non-development of a proper business development plan for farmers.

Figure 34. Group photo on the Kisima potato farm.

Figure 35. Kisima aeroponics unit.

Figure 36. Seed grader in Kisima Farm.

Figure 37. Kisima Seed storage at 4^0C.

Figure 38. Harvester in Kisima farm.

Figure 39. Group photo at Kisima Foundation.

Figure 40. Demonstration plots set up by various companies of phytosanitary products at Kisima Foundation.

4.8. VISIT TO A DECENTRALIZED RACs MULTIPLIER

The last day of the tour was held at a satellite nursery in Meru County run by a small-scale RAC multiplier **Paul MUNENE.** Paul is an extension officer and village potato adviser who benefitted from the Farm Inputs Promotion Africa (FIPS-Africa) approach in collaboration with CIP. FIPS-Africa adopted the RAC technique from CIP to train village-based farmers, who in turn train other farmers in the communities. FIPS-Africa develops farmers to be entrepreneurs in specific value chains; they supervise and work with 10,000 producer farmers in Meru County like Paul Munene. FIPS-Africa equally supports producers with business registration.

4.8.1. Production of RACs

Munene gets hardened *in vitro* plantlets from SRK to constitute the stock of mother plants to produce RACs. He harvests three times to constitute sub-mothers from which he multiplies RACs in plugs using cocopeat and peat moss as substrate. The mother and sub-mother plants are maintained in his new screenhouse at temperatures of 15–20°C, and the cuttings hardened in his old screenhouse are held at 20–25°C. Munene's screenhouse is 40 m^2 and can produce 5,000 plants in crates and about 25,000 in plugs.

4.8.2. RACs as a successful agri-business

Munene does not face competition in his locality because he is the sole successful RACs producer. The cost of production is 5 KES/RAC, and the market price is 10 KES/RAC, making a 100 % benefit, and a 50 % benefit on investment per month. This has made his life relatively better than before, and he is grateful to CIP and FIPS-Africa for the benefit he has received from this great opportunity.

4.8.3. FIPS-Africa outreach program

FIPS-Africa shares the cost of the construction of screenhouses with the farmers and the local government. They support the farmers with 50 plantlets as starter material.

4.8.4. Challenges

Despite Munene's success story, he still faces some challenges, such as:

- Lack of skilled laborers to work in the screenhouse;
- Dishonesty of some farmers who do not pay for RACs collected;
- Lack of a market during peak production periods leading to the loss of RACs; he thus envisages multiplying in his own field;
- Unavailability of a quality substrate;
- The low rate of adoption of the new technology by some farmers;
- The activity is time demanding, and he needs to always be there for proper follow-up;
- Need to continuously monitor the weather to maintain conducive temperatures in the screenhouse.

Figure 41. Private satellite nursery in Meru County with a capacity of over 25,000 RACs.

Figure 42. Hands-on practice by Kenfack, Bassirou, and Wara.

Figure 43. Paul Munene enjoys the fruits of his labor.

Figure 44. RAC ready for sale.

5. CONCLUSION AND RECOMMENDATIONS

The study tour lasted five days and was a huge success. The delegates left with a resolve to replicate lessons learned back in the country. They drew lessons on the seed sector's policies, the production techniques for early generation seeds, storage, mechanization, and seed production as an agri-business. Upon return to the country, the delegates gave their impressions about the tour during a restitution session held with Dr. Dieudonné Harahagazwe, CIP Cameroon Country Manager and Project Coordinator, and made the following recommendations:

- Putting in place a national platform like the NPCK that would bring together all actors in the potato value chain;
- Emphasis should be placed on the tissue culture technology as the entry point for quality seed, and the private investors should be encouraged to establish tissue culture labs;
- Seed growers should be encouraged to invest in screenhouses to produce clean planting material;

- The various actors must master their roles in the potato value chain to build a viable potato seed sector in Cameroon;
- It is essential for seed multipliers and the regulatory bodies to work together to build a strong seed sector;
- Research institutes should bring in competitive varieties which farmers can multiply and pay royalties to them for sustainability; and
- The Cameroon delegates to the tour pledged to partner with their peers in the various sectors to build their capacities to boost potato production in Cameroon by making a strong and viable seed sector.

CIP and the delegates would like to thank Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) for their generous support of potato research in Cameroon.

6. ANNEXES

Annex 1. List of the delegates

N°	Name and surname	Structure	Function
1	Ruth NGO OUM	GIZ-ProCISA	Technical Advisor for the Potato value chain
2	Julie THE	MINADER	Deputy Director of Agricultural Seed Systems
3	Joel NJOME ETAME	MINADER	PAPMAV-Q.
4	Belinda EYONG ECHAW Épse TABENYANG	MINADER	DRCQ
5	Serge MELI	MINADER	Agronomist, Bansoa screenhouse
6	Rauwitta OMABIT AFOH	IRAD	Tissue Culture Specialist
7	Étienne-Fanong MASSECHI NGAKAM	IRAD	Researcher in the IRAD Bayangam screenhouse
8	Honoré MAFOUO	MINADER	ProCISA-MINADER Focal Point – West Region
9	Victorine FORNKWA (head of the delegation)	CIP	Seeds and Varieties Specialist and Regional Coordinator for the Northwest and West regions.
10	Norbert KENFACK	Private	Seed multiplier
11	Bassirou MOUHAMADOU	Private	Seed multiplier
12	Clement WARA	Private	Seed multiplier

Annex 2. Kenya tour schedule

DAY	ACTIVITY	DETAILS
7 March 2022	The arrival of the Delegation from Cameroon	Night in Nairobi
8 March 2022	Visit the large-scale apical cuttings production unit at **Stokman Rozen Kenya Ltd**, Naivasha: hands-on training with technicians. **Drive back to Nairobi for the night.**	Brief history of the firm and activities **Production and management in tissue culture lab**, media, and phytosanitary procedures: observation of basic processes Practical session on apical cutting production procedures Transfer of tissue culture plantlets to the screenhouse **(post-flask management)** Production of mother plant stocks and maintenance Substrate preparation; types, cleaning, and storage Varieties produced and reasons for the choices Minituber production and storage Production challenges and opportunities Business plan
9 March 2022	**<u>Morning</u>** **PQS - KEPHIS**	Training in potato tissue culture **Production and management in tissue culture lab** Media preparation Phytosanitary procedures Multiplication process
	<u>Afternoon</u> Visit to the medium-scale apical cutting production unit at **Gracerock Farm Ltd, Limuru** **Overnight stay in Nairobi**	Brief history of the firm and activities Apical cuttings production at medium scale Mother plant stocks Rooting media types Varieties produced and reasons for the choice Production challenges and opportunities Business plan
10 March 2022	Visit of the **FreshCrop** seed potato merchant in Narok, a large-scale certified producer of cuttings **Drive back to Nairobi for the night**	Brief history of the firm and activities Mechanization in seed potato production Seed sorting/grading Seed storage Varieties produced Crop rotation/acreage of land allocated Production challenges and opportunities

		Business plan
11 March 2022	**<u>Morning</u>** Visit EGS potato production facilities at **Tigoni (KALRO)** (Seed growers, GIZ, IRAD, CIP, MINADER screenhouse manager)	Visit the tissue culture lab Visit the aeroponics facility – briefing on aeroponics procedures Storage of germplasm **Production and supply of basic seed** Business plan (especially for IRAD)
	<u>Afternoon</u> Meet with the CIP Regional Director (All) Meeting with the National Potato Council of Kenya **(NPCK)** and other value chain actors: strategic partners (DDA, DRCQ, PAPMAVQ) **Overnight stay in Nairobi**	Discuss policies, public-private partnerships, decentralization, challenges, etc.
12 March 2022	**<u>All day</u>** Visit **Kisima Farm** **Overnight stay in Nanyuki** (Delegation from Cameroon plus CIP Nairobi staff)	Brief history of the farm Varieties produced Production of certified seed Minituber production through aeroponics and storage **Farmers outreach model – Agri-Information Center** Business plan Role of partners (CIP, Syngenta Foundation, etc.)
13 March 2022	**<u>Morning</u>** Visit decentralized RAC multipliers in Meru **<u>Afternoon</u>** Drive back to Nairobi	Production and supply of RACs in rural area settings Challenges RAC as a successful agri-business
14 March 2022	Departure of delegation back to Cameroon	

Annex 3. People interacted with during the tour

Nº	Name	Structure	Function
1.	Julius Muchiri	SRK	
2.	Kevin Sambai	KEPHIS - PQBS	KEPHIS staff
	Laurent Kinusa		KEPHIS staff
	Josephine Muriuku		In charge of the Tissue Culture lab
3.	Stephen Njega	Grace Rock	Farm Manager
4.	Christopher Gasperi	FreshCrop Limited	CEO
5.	Moses Nyongesa	KALRO - TIGONI	Director
	Patrick Pwaipwai		In charge of the Tissue Culture lab
	Ann Namusonge		Tissue culture Lab
	Martha Odongo		Screenhouse technician
	Bethwel Kawili		Aeroponics and Hydroponics unit technician
6.	Wachira Kaguongo	NPCK	CEO
7.	Jonathan Moss	Kisima Farm Limited	Managing Director
	Buzz Robertson		General Manager
	Oliver Francombe		Potato Production Manager
	Nteere Gitonga	Kisima Foundation	Executive officer
8.	Mercy Chepkoech	FIP	Key informer on RAC production.
	James Ngugi		Key informer on RAC production/ Licensed seed potato merchant
	Paul Munene		Satellite Nursery owner