REPORT

Nigeria Potato Seed Security Partnership (NPSSP): Building back resilience post COVID-19

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Nigeria Potato Seed Security Partnership (NPSSP): Building back resilience post COVID-19

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2nd Technical Report

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Acronyms

BW	Bacterial Wilt
CIP	International Potato Center
DLS	Diffused Light Store
EAC	East African Countries
ECOWAS	Economic Community of West African States
EGS	Early Generation Seed
FMARD	Federal Ministry of Agriculture and Rural Development
GAP	Good Agricultural Practices
GIAE	Green Innovation for Agriculture and Food Sector
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GPVCWG	Global Potato Value Chain Working Group
IITA	International Institute of Tropical Agriculture
IS	Innovation Sites
LAMP	Loop-mediated Isothermal Amplification
LB	Late Blight
LGA	Local Government Area
MOU	Memorandum of Understanding
NACGRAB	National Centre for Genetic Resources and Biotechnology
NASC	National Agricultural Seed Council
NCRP	Nationally Coordinated Research Project
NCVLBRRC	National Crop Varieties and Livestock Breeds Registration and Release Committee
NPSSP	Nigeria Potato Seed Security Project: Building back resilience post COVID-19
NRCRI	National Root Crops Research Institute
NVRC	National Crop Varieties and Livestock Breeds Registration and Release Committee
PADP	Plateau Agriculture Development Program
PVS	Participatory Varietal Selection
RACs	Rooted Apical Cuttings
SAH	Semi Autotrophic Hydroponics
SEWOH	One World–No Hunger
SSA	Sub-Saharan Africa
TC	Tissue Culture
ToT	Training of Trainers

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Summary

Nigeria Potato Seed Security Partnership (NPSSP): Building back resilience post COVID-19, funded by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) aims to support potato seed security in Nigeria by building local capacity within the public and private sector to supply adequate amounts of quality seed of varieties that are in-demand and locally adapted to meet the main market segment. The project helps smallholder farmers to maximize their investments in seed by building capacity in on-farm seed quality management, good agricultural practices (GAP), and best practices for improving soil health and fertility. In addition, NPSSP plans to introduce climate-smart varieties with desired traits, including resistance to late blight disease and higher heat tolerance, as a specific and short-term response to the ongoing COVID-19 crisis. This is the second technical report (April 01–September 30, 2021) of NPSSP. During this period, the International Potato Center (CIP) focused on **objective 1** (Enhanced capacity for potato early generation seed (EGS) production by both the public and private sector), **2** (Demonstration and training of potato on-farm seed management, soil fertility and other key agronomic practices and innovations through innovation farm learning sites), and **3** (Testing and registration of new CIP late-blight resistant varieties through public-private partnerships).

A baseline survey was conducted at the beginning of the project targeting the six main potato producing local government areas (LGAs), namely Barkin Ladi, Bassa, Bokkos, Jos South, Mangu and Pankshin, to understand the potato production system, major constraints and challenges in potato production. A total of 201 households were surveyed, of which 75% were male led, while 25% were female led. Over 95% of the household heads were below 60 years of age, with majority falling between 30 and 60 years. Farming was the main occupation for most of the households. Land ownership was very limited among the households with the majority having between 1 and 5 acres. A total of 19 potato varieties had been grown in past three years. Marabel was the most popular potato variety among farmers, followed by Nicola, Connect, Caruso and Jelly, respectively. Farmers received training on seed production from various agencies, including National Root Crops Research Institute (NRCRI), Plateau Agriculture Development Program (PADP), and NGOs. However, most farmers still use seed saved from their previous harvest. Seed and ware storage was a challenge for the majority of farmers, most of whom store their seed potato in dark rooms in their homes. There was very little awareness of improved seed storage technologies, such as Diffused Light Store (DLS). Seed production was mainly done during rainy season with very few farmers producing seed during the dry season. Crop rotation was commonly practiced with most farmers adopting two-season or three-season rotation plans due to the scarcity of land. Most farmers practiced hilling during the season with the majority hilling their crop only once. Dehaulming of the crop before harvesting is not a common practice among the farmers.

Under **objective one**, the screenhouse of a private sector partner, Fruits and Veggies Global Limited (hereafter, Fruits and Veggies), has been upgraded and fully equipped with operations for EGS production. Rooted apical cuttings (RAC) and sand hydroponic units have been established on the facility. At the National Root Crops Research Institute (NRCRI), upgrading of the screenhouse is almost complete, while small-scale production of RAC has commenced. A total of 24,647 RAC have cumulatively been produced from the two facilities. Capacity development for tissue culture (TC) production awaits the delayed signing of a cooperation agreement between Wise Synergy and the Federal Ministry of Agriculture and Rural

Development (FMARD) on the use of the TC laboratory at NRCRI Vom. In-field multiplication of basic seed is underway at both Fruits and Veggies and NRCRI. Over 3,000 RAC have already been transplanted in the field.
Under **objective two**, the trained PADP staff and the lead farmers have successfully established 31 innovation sites (IS) across the six LGAs. Seven potato production technologies were demonstrated in each of the IS. Farmer training and field days were conducted in 26 of the 31 IS. Training programs could not proceed in six sites due to current security issues, which prevented travel and gathering, and heavy flooding, which affected the plots. About 3,506 farmers were trained during the field days organized at the IS, and of the attendee farmers, 56% were male and 44% were female. Results from the demonstrated technologies indicate improved yields compared to traditional practices and yields up to 28 t/ha were recorded in the Barkin Ladi LGA. Three e-communication materials have been completed and are currently available for sharing in different forums for farmer education and training.

For **objective three**, the varieties imported to Nigeria are currently being multiplied to produce enough seed for on-station, multi-location and on-farm trials, which are prerequisites for the evaluation of varieties before recommendations can be made for their release and registration in Nigeria. The project is working with NRCRI Vom on this objective as they are the institute with the mandate for potato research in the country.
In collaboration with Green Innovation Centre for the Agriculture and Food Sector (GIAE) and Global Potato Value Chain Working Group (GPVCWG), the project has managed to train 38 staff from different agencies within the potato value chain, including universities, regulatory bodies, producers, and extension services. A total of 15 were trained on the use of the loop-mediated isothermal amplification (LAMP) assay for the detection of *Ralstonia solanacearum*, which causes bacterial wilt disease in potato, and 23 people were trained in seed potato inspection and the identification of potato pests and diseases. About 37 seed producers, representing different cooperatives, were also trained in quality seed production through the same collaboration.

Seed availability, high disease pressure, the lack of open-access varieties for multiplication, limited land, the lack of better storage facilities and constant conflicts and insecurity were the main risks and challenges identified during the long rain season. To minimize these, the project adopted a holistic approach in tackling these challenges, including a systematic view of the seed value chain and the fostering of strategic partnerships and collaborations with relevant stakeholders within the potato value chain.

1. Project background

Nigeria is one of the major potato-producing countries in Africa. It boasts extensive acreage under potatoes in the higher-elevation Local Government Areas (LGAs) in Plateau and other states where potato is grown. However, a huge deficit exists between supply and demand, and the current yields of 3–4 tons per hectare fail to satisfy demand. These low yields also prevent farmers from benefitting from the full economic potential of what is an important cash crop in the country. Various constraints that limit production, processing and marketing have been identified in the past. These include the inadequate supply of good-quality seeds, inadequate storage facilities, diseases, and pest management, which affect the yield and value addition to the potato crop.

Various interventions have been implemented in the past. Notably, the work of the GIAE in Nigeria aimed at raising both the productivity and income of potato growers within Plateau State through targeted interventions. To build on the gains of the GIAE project, the NPSSP project was commissioned. This project is implemented by the CIP through the support of GIZ-GIAE and in collaboration with the GIZ-assisted interventions in capacity building and South-South learning through the One World—No Hunger (SEWOH) initiative mediated through the GPVCWG.

NPSSP aims to support potato seed security in Nigeria by building local capacity within the public and private sector to supply adequate amounts of quality seed for in-demand and locally adapted varieties that meet the main market segment, while supporting smallholder farmers (SHFs) in maximizing their investments in seed through building capacity in on-farm seed quality management, GAP, and best practices for improving soil health and fertility. Further, the project is working towards the introduction of climate-smart varieties with desired traits including tolerance to heat and late blight disease.

To achieve these targets, three objectives have been set out:

1. Enhance capacity for potato EGS production by both the public and private sector.
2. Demonstrate and train SHFs in potato on-farm seed management, soil fertility and other key agronomic practices and technologies through innovation farm-learning sites.
3. Testing and registration of new CIP late-blight resistant varieties through public-private partnerships.

This report highlights the progress made between April 2021 and September 2021 towards achievement of the objectives and outcomes of the project.

2. Activities Implementation

2.1 Summary of baseline survey

2.1.1 Characteristics of respondent in the baseline survey

Total of 201 farmers from six LGAs, namely Barkin Ladi, Bassa, Bokkos, Jos South, Mangu and Pankshin, were interviewed during the baseline survey. Among them 75% were male while 25% were female (**Annex 1**). The majority of the respondents had formal education: only 5.6% reported not having attended any formal schooling. The highest number of respondents had attained secondary school education followed by college, university and primary education, respectively. Over 95% of the respondents were below 60 years of age, with the majority falling between 30 and 60 years. The main occupation for most respondents was farming-related activities, while 13.9% reported to have other main occupations apart from agriculture, which included formal employment, businesses, and other hands-on jobs such as masonry, mining, and blacksmithing.

The majority of the respondents were experienced in potato farming: over 97% reported to have grown potato for more than three years. Land ownership was found to be very limited among the farmers, with 66.7% having between 1 and 5 acres of land that is used for the homestead, livestock and crops. Very few farmers have more than 10 acres of land.

These demographics show farming is the most important economic activity for most Plateau State residents. The main reported challenge is the scarcity of land, which makes it difficult to practice proper crop rotation or effectively engage in seed production.

2.1.2 Seed potato value chain

Varieties and their characteristics

Farmers in Plateau State identified 19 potato varieties that they have been growing in the three years before the project (**Figure 1**). Marabel was the most frequently grown variety followed by Nicola, Connect, Caruso and Jelly, respectively. Of the varieties identified by farmers, only three, Marabel, Jelly and Rhumba, have been officially released and registered in Nigeria. Nicola is the oldest variety that has been grown in the country with its origin still unclear. Farmers rated the varieties they grow on different attributes that they deemed important to them (**Figure 2**). The five top varieties that were rated by farmers include, Marabel, Nicola, Connect, Jelly and Yellow.

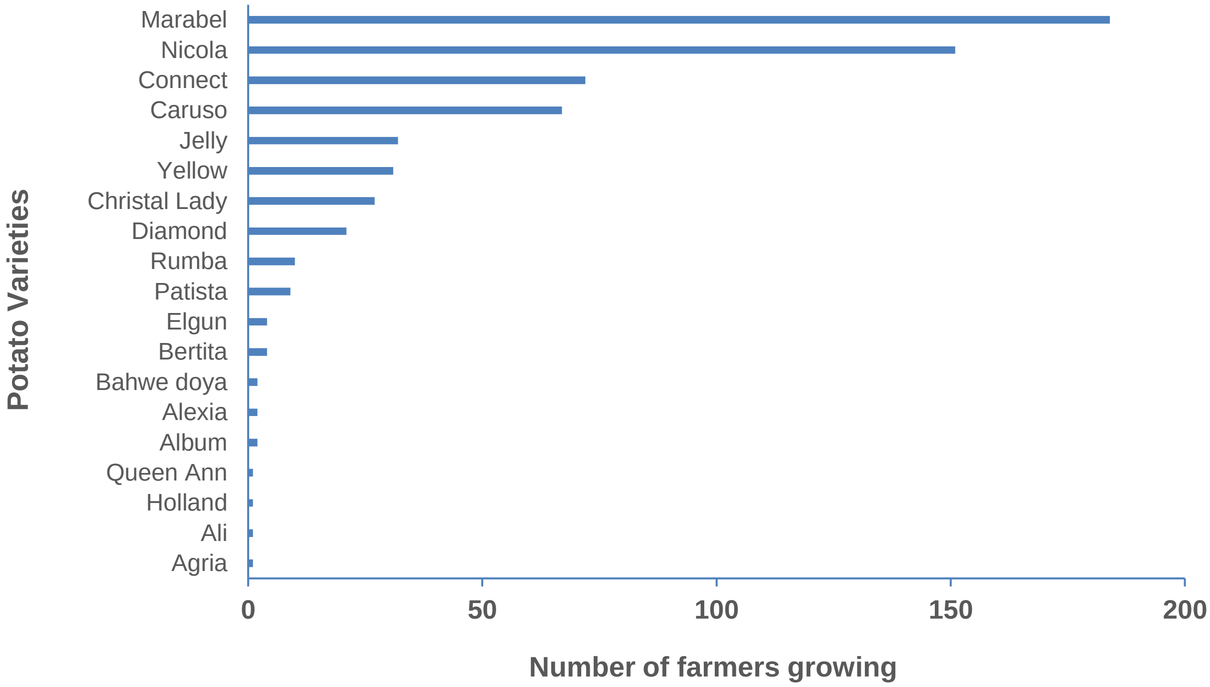

Figure 1. Potato varieties grown by farmers in the past three years in six LGAs: Barkin Ladi, Bassa, Bokkos, Jos South, Mangu and Pankshin. Results obtained from 2021 base line survey

For tuber yields, Connect was the most preferred as a high-yielding variety, followed by Marabel. Connect was also considered to have the best resistance towards late blight, while Marabel was rated the worst among the five varieties. On early maturity, Connect was rated as a good variety, followed by Marabel and Nicola, respectively. Jelly was rated as a bad variety in terms of early maturity indicating that it takes the longest time in the field compared to others. All five varieties were rated as good in terms of market demand. Seed availability differed greatly and the older varieties, such as Nicola and Yellow, were rated as good in terms of their seed availability compared to the recently released varieties, such as Marabel, Connect and Jelly.

Most of the varieties grown in Nigeria are privately owned and farmers require permission or special arrangements with the owners of the varieties before they produce and sell the seed. In most cases, this involves importation of the basic seed to be multiplied locally before being sold to farmers. This makes it difficult to effectively and sustainably produce enough seed to meet the demands of farmers. Introducing more open-access varieties that can be produced and multiplied freely is a viable and more sustainable approach to develop and improve the seed potato system. Farmer's preferences for high-yield, disease-tolerance and early-maturity characteristics should also be considered when introducing the new varieties to provide options that meet the challenges they are currently facing with available varieties.

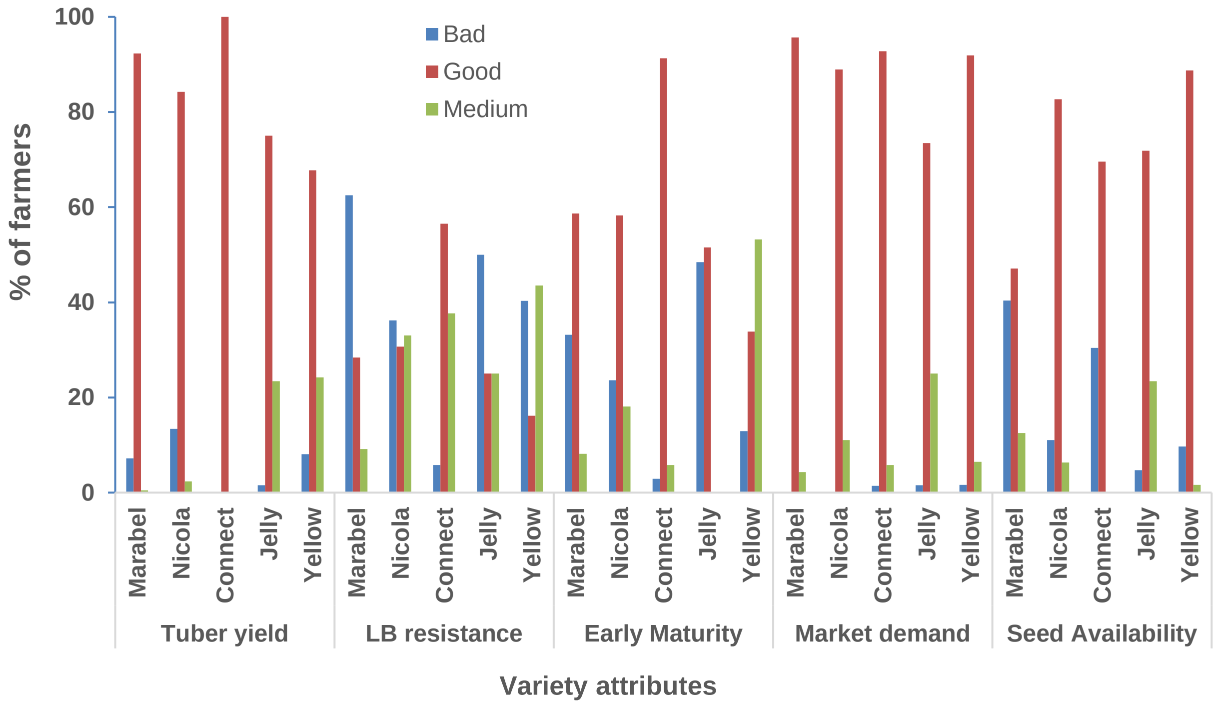

Figure 2. Percentage (%) of farmers' ratings of the top five varieties based on preferred attributes from the 2021 baseline survey

Seed sourcing, handling, and training

Almost half of the respondents reported having received training on seed production, with the majority receiving the training from NGO and PADP extension staff. The majority of the farmers (80%) rely on farm-saved seed with 10% getting seed from imported sources. Very few respondents (1.5%) get their seed from the local market (**Annex 2**). In terms of storage, the majority of farmers store their seed in dark rooms within their homes. Over 80% of the farmers are not aware of the DLS store. Very few farmers replace their seed regularly, which relates to their tendency to use their own saved seed. Most farmers are engaged in seed production during the rainy season with the few who could afford irrigation producing seed in dry seasons.

2.1.3 Potato production practices

Crop rotation

The majority of farmers (66.5%) reported practicing crop rotation in their fields, however responses were different in Jos South and Pankshin (**Figure 3**). Another important factor in the crop rotation practice is the number of seasons and the rotation pattern employed by the farmers. Most of the farmers have a rotation plan of between two and three seasons with the majority having a three-season rotation plan, which means they will grow potato again in the same plot after three seasons. However, the recommended minimum rotation plan in a potato-based farming system for better disease control and soil fertility management is four seasons.

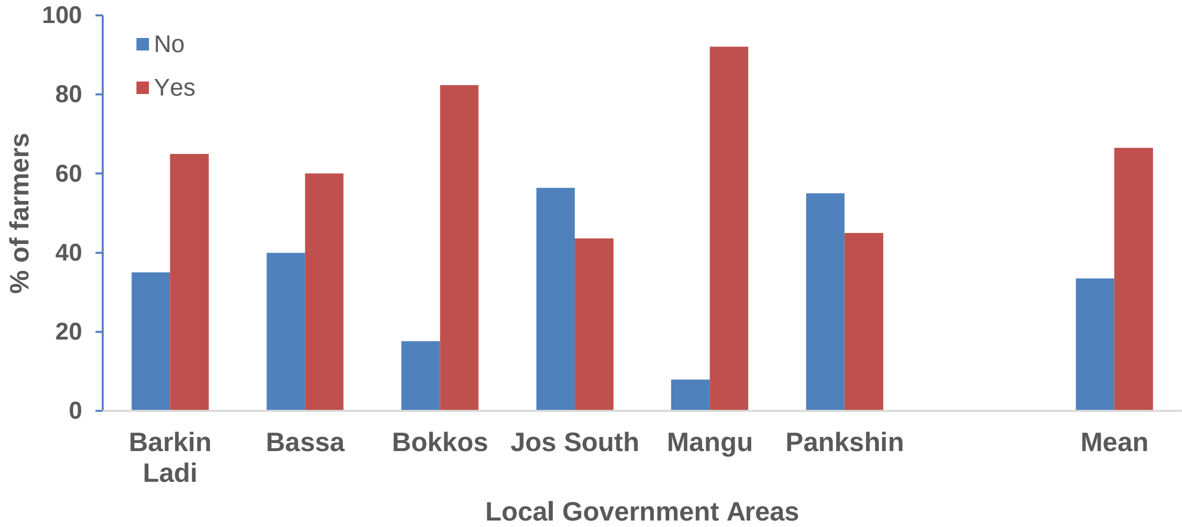

Figure 3. Percentage (%) of farmers conducting crop rotation in their fields from the six LGAs from the baseline survey

Some farmers, for instance in Bokkos and Bassa, rotate their crops after four seasons (**Figure 4**). Farmers gave land scarcity as the main reason why they are not rotating their crops every season and the lack of alternative crops of economic importance to include in the rotation. These are important considerations that need to be investigated when advising farmers on crop rotation patterns to ensure food and income diversity for the household while improving integrated soil health and fertility management. Farmer education and behavioral change in this regard will be necessary to ensure that farmers adopt alternative crops and technologies for sustainable food and income provision to the households.

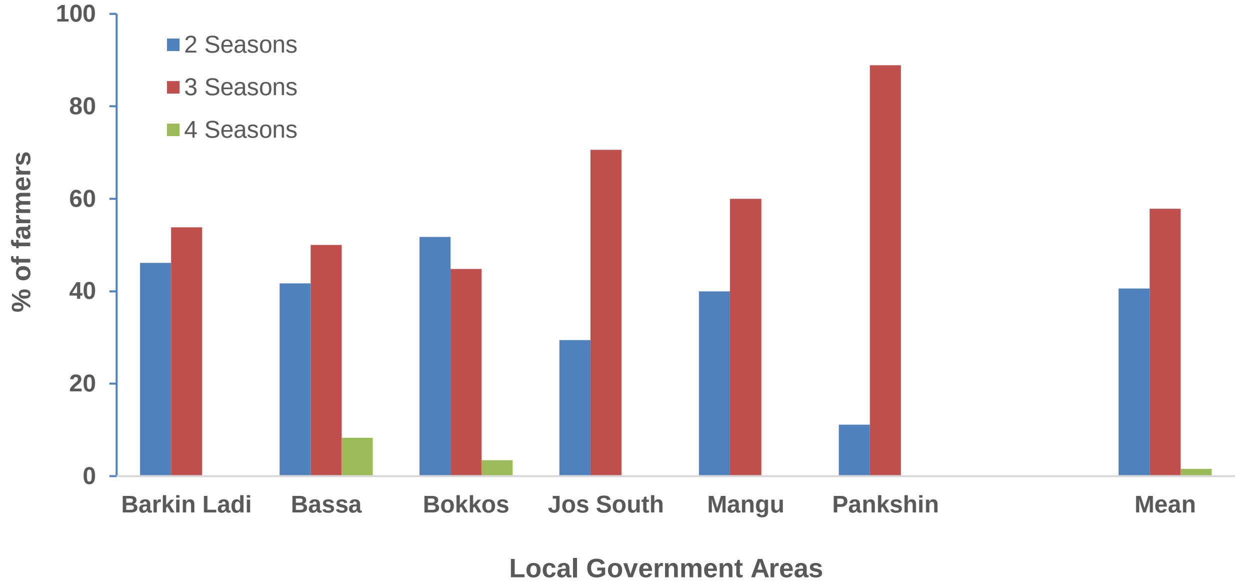

Figure 4. Percentage (%) of farmers adopting different crop rotation patterns in the six LGAs

Hilling practices

Over 80% of the farmers hill their potatoes. All respondents in Mangu LGA reported this practice (**Figure 5**). Barkin Ladi and Bassa had the highest number of farmers at 29% and 30%, respectively, who do not hill their potatoes. Hilling is an important activity in potato production as it improves both the tuber shape, size, number, and quality. The number of hillings and the timing are important considerations.

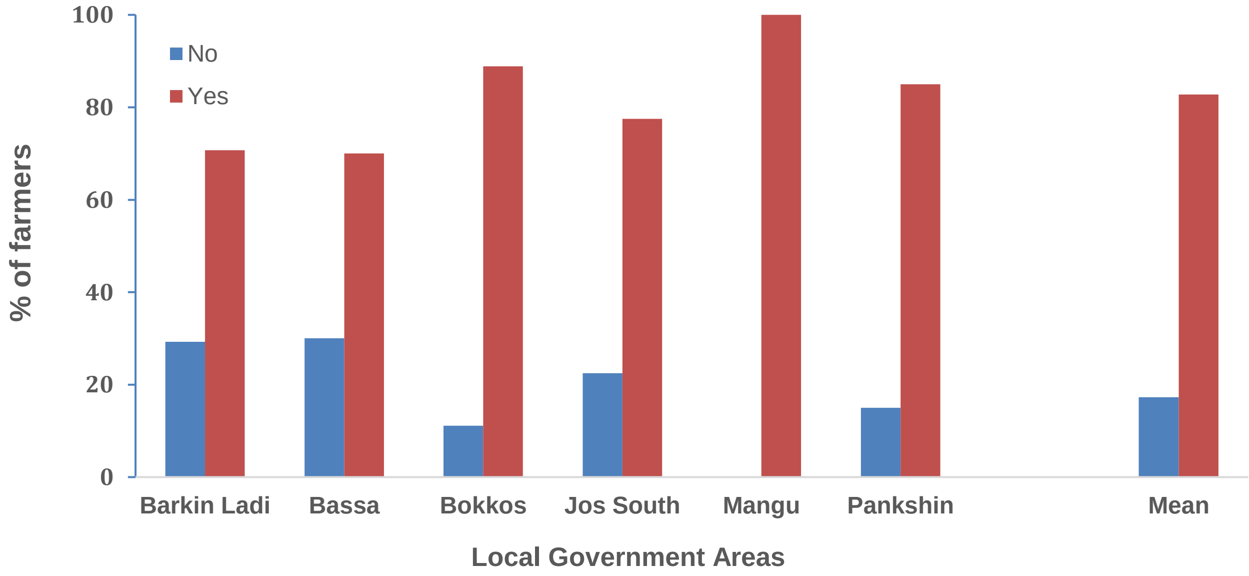

Figure 5. Percentage (%) of farmers practicing hilling on their potato crop during the season in the six LGAs

The majority of the farmers (over 60%) practice one hilling during the season (**Figure 6**). All the respondents in Bassa LGA reported doing hilling once. It is only in Mangu LGA that the majority of the farmers were practicing hilling twice a season as recommended. A few farmers in Bokkos also reported doing hilling three times when heavy rain is experienced during the rainy season to minimize the waterlogging risks.

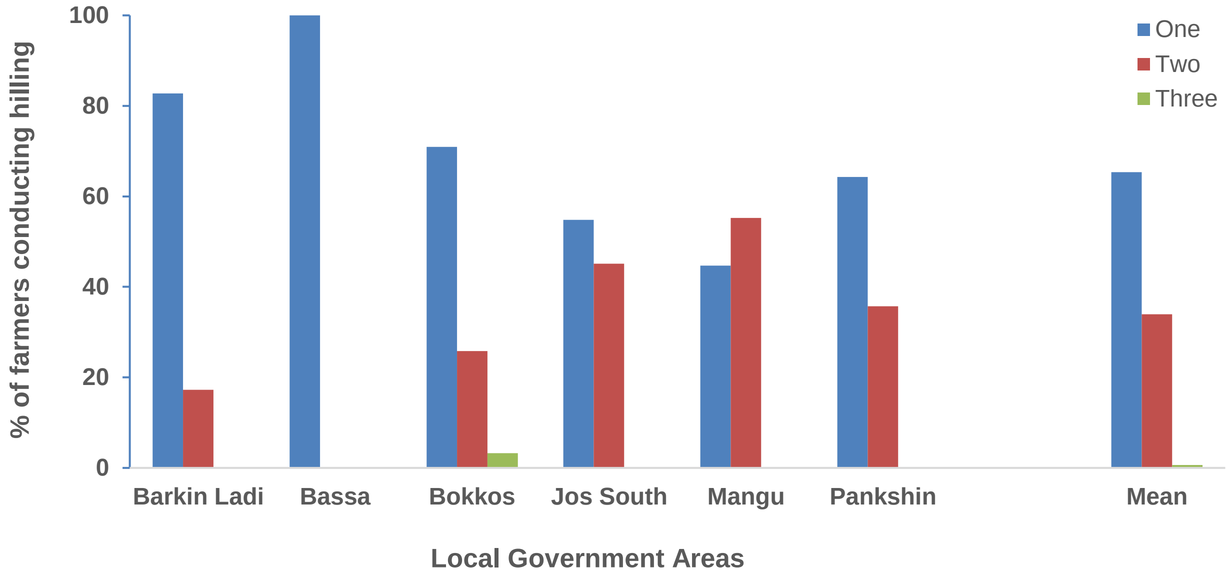

Figure 6. Percentage (%) of farmers and the number of hillings they conduct on their potato crop during the season

Dehaulming

Potato dehaulming is another important agronomic practice recommended prior to harvesting to ensure proper curing of the skin and to avoid bruises during harvesting. It also helps in preventing disease spread from the foliage to the tubers before harvesting. However, the majority of the farmers did not dehaulm their crops, and it was only in Pankshin LGA where most of the farmers reported dehaulming practices (**Figure 7**).

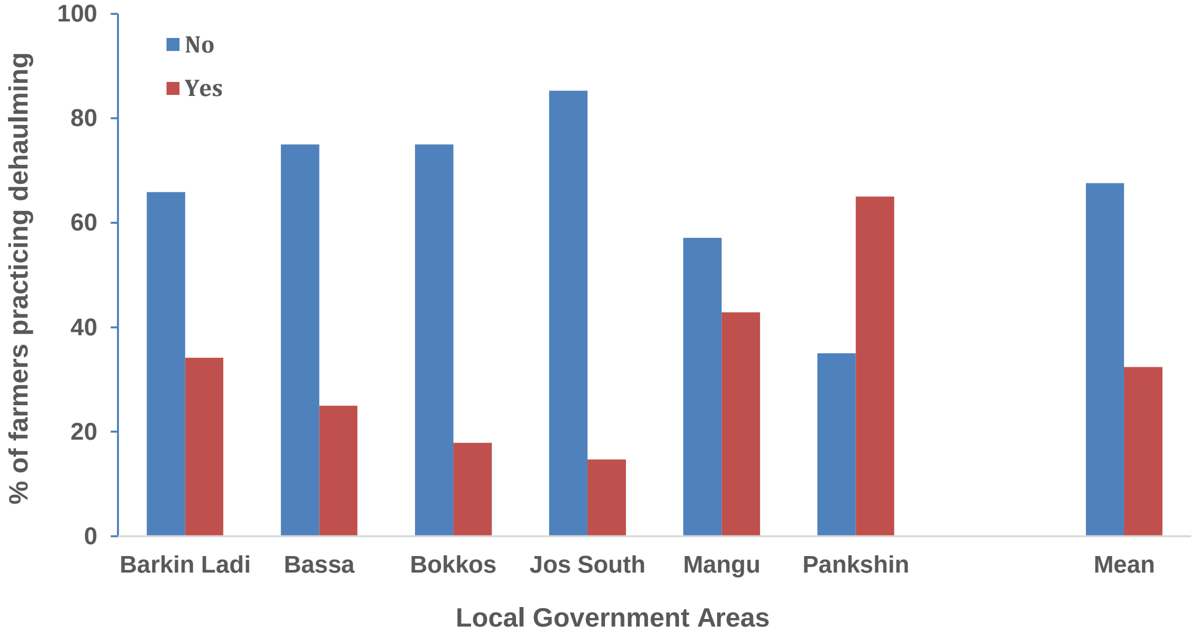

Figure 7. Percentage (%) of farmers dehaulming their potato crops before harvesting in different LGAs

2.2 Objective 1: Enhanced capacity for potato EGS production by both the public and private sector

Limited access to quality seed is largely responsible for the low yields plaguing potato production in Nigeria. Productivity can be increased by availing quality seed to farmers at affordable prices. Seed potato goes through three physiologically different forms in the first three generations in the production system. Seed along these generations is known as EGS. The first generation (G0) is the production of TC plantlets in the laboratory. This is the foundation and conservation material for varieties. TC plantlets are transferred to a screenhouse to produce mini-tubers (G1) under protected production units (screenhouse) using sand hydroponics, rooted apical cuttings (RAC) or aeroponic rapid multiplication technologies. Mini-tubers or RAC are planted in the field to produce G2 seed; thereafter, seed production is about bulking tubers from G2 over a few more generations from G3 to G5. Availability of these EGS from G0 to G2 continues to limit the availability of seed upstream. The production of EGS is more capital intensive and not usually attractive to private sector players, especially for public varieties. The commercial seed producers that make up the private sector often do not see a profit incentive for moving upstream into EGS production, which is more capital intensive than later-stages of seed multiplication. Ultimately, the public sector plays an important role for delivering the essential services for an EGS system to exist, while the health and success of an EGS system can be greatly influenced by the level of private sector involvement. The project has supported this objective through capacity enhancement of EGS production by both public and private sector partners through various interventions.

2.2.1 Output 1: Screenhouse upgraded and equipped at NRCRI and private sector partner

2.2.1. Milestone accomplished and Activities

2.2.1.1 Upgrading and equipping screenhouse at Fruits and Veggies

Upgrading and equipping of screenhouse at Fruits and Veggies in Dorowa Babuje was completed and reported in the previous reporting period. The facility received materials to set up EGS production units for RAC and sand hydroponics production.

Sand hydroponics improve upon the conventional EGS multiplication technology used to produce clean pre-basic seed potato. It uses sterilized sand as the substrate material and nutrient solution to feed the plants. Sand was sterilized with sodium hypochlorite solution followed by clean water. Starter planting materials for sand hydroponics were tissue culture plantlets and semi-autotrophic hydroponic (SAH) plantlets obtained from IITA Ibadan.

Currently, ten plants of each of the eight CIP imported varieties are undergoing multiplication in the sand hydroponics system for the production of mini-tubers (**Photo 1**).

Photo 1. Sand hydroponics unit established at the Fruits and Veggies facility in Dorowa Babuje

RAC is a novel technology currently being used in several developing countries. It has the potential to revolutionize the seed system through the rapid multiplication of the early generation seed. Rooted transplants are produced in a screenhouse from TC plantlets (**Photo 2**). Rather than allowing TC plantlets to mature and produce mini-tubers, cuttings are produced from the TC plantlets by maintaining the juvenility of TC plantlets (mother plants) throughout the production cycle in a substrate media (**Photo 3**). Cuttings are produced by taking three-node cuts from lateral shoots (**Photo 4**). The first round of cuttings is from the apical part of the plant, and in the subsequent rounds, the shoot number produced per plant increases in an arithmetic progression over time, depending on the variety and environmental conditions. This process continues as long as mother plants are juvenile and produce juvenile shoots. The cuttings are then planted into plugs for rooting, and these rooted cuttings will be ready for transplanting in one and a half months (**Photo 5**). Once rooted, the cuttings are transplanted into the field to produce seed tubers (**Photo 6**).

Photo 2. TC plantlets of one of the CIP imported varieties received from IITA for use in sand hydroponics and RAC production

Photo 3. Established mother plants from TC plantlets used for production of RAC at the Fruits and Veggies facility

Photo 4. Cutting of the established mother plants three weeks after transplanting

Photo 5. Cuttings transplanted to trays at the Fruits and Veggies facility

Photo 6. RACs ready for transplanting in the field to produce tubers

2.2.1.2 Upgrading and equipping the screenhouse at NRCRI Vom

The project had planned to use screenhouses constructed at the NRCRI Vom facility by a private entrepreneur, Wise Synergy. CIP signed a collaboration agreement to use the facility for sand hydroponics and RAC units. However, there have been delays since Wise Synergy and FMARD have not signed the agreement allowing Wise Synergy to use the facility. To overcome these delays, the project is currently renovating a screenhouse at the facility (**Photo 7**).

Photo 7. Current renovation of screenhouse at NRCRI facility in Vom

Small-scale production of RAC has also been initiated at NRCRI in another screenhouse for the training and establishment of mother plants while the renovations of the main production screenhouse are ongoing (**Photo 8**).


Photo 8. RACs produced at the NRCRI facility

A total of 24,647 RAC have been produced so far between August and October 2021. Production at the Fruits and Veggies facility began in early August, while at NRCRI, production only began in early October.

Table 1. Total number of RAC produced at the Fruits and Veggies and NRCRI facilities

Site	Number of RAC
Fruits and Veggies	21,716
NRCRI	2,931
Total	**24,647**

2.2.2 Output 2: Capacity building and procurement of materials for tissue culture production

2.2.2.1 Milestone accomplished and Activities

Availability of sufficient quantities of EGS is the corner stone for the development of a sustainable seed system. The TC laboratory is an important component in the seed potato value chain for the purposes of cleaning, conservation, and rapid multiplication of planting materials. The project relies on this service from IITA Ibadan, which is about 800 km from Jos. Given the distance and the fragility of the TC material, this arrangement has proven to be expensive and unsustainable. The project had envisaged to support NRCRI to improve their TC multiplication and production facility. However, delays in the signing of cooperation agreement between FMARD and Wise Synergy is preventing the progress.

The project team is still engaging additional partners, both private (Contec Global LTD) and public (including universities), who might be interested in investing in the upstream stage of the seed potato value chain. The project team held a meeting with Wise Synergy, and were informed that the process is now at an advanced stage and is awaiting presentation and signing by the new minister.

2.2.3 Output 3: Establishment of in-field multiplication (G2) of basic seed

2.2.3.1 Milestone accomplished and Activities

In-field multiplication of RAC is currently ongoing at Fruits and Veggies in Dorowa Babuje, and in NRCRI preparations are underway for the first planting of RAC in the field for multiplication. Over 3,000 RAC have already been transplanted at Fruits and Veggies (**Photo 9**).

Photo 9. Planting of the first batch of RAC in the field at Dorowa Babuje

 

Photo 10. RAC under field multiplication at Dorowa Babuje

2.3 Objective 2: Demonstration and training in on-farm seed management, soil fertility and other key agronomic innovations through innovation sites

Capacity building for farmers plays a central role in the adoption of new technology for improved productivity. The project implemented its capacity building through the innovation sites (IS) approach, which provides an opportunity for beneficiaries to see the technologies together with their benefits, as well as to interact with the scientists, extension staff and other development and research personnel. The beneficiaries can have their key questions answered and doubts cleared, thereby reinforcing their decisions to adopt the demonstration technologies.

The approach involved identification of the broad challenges faced by most farmers. This participatory approach enabled us to select a set of relevant technologies and innovations to mitigate these challenges and to subsequently demonstrate and evaluate them at different locations to target farmers. The IS concept bridges the information-flow gap by bringing together research, extension, and farmers through practical demonstration and evaluation of the technologies and innovations from research, while providing an avenue for feedback loops for further improvements.

2.3.1 Output 1: Development/adaptation of CIP training material from East Africa

2.3.1.1 Milestone accomplished and Activities

Training materials have been developed for the training of extension staff (training of trainers; ToT) and to help lead farmers establish IS for further farmer training. Farmers were provided with brochures summarizing the different innovations that were demonstrated at the IS.

2.3.2 Output 2: CIP training of PADP extension staff (ToT)

2.3.2.1 Milestone accomplished and Activities

Ten PADP extension staff trained at the beginning of the project, together with the CIP team, selected 30 lead farmers for further training and establishment of IS. The IS were used as avenues for training smallholder farmers on innovative technologies in potato production. PADP extension staff supported the lead farmers with the establishment of IS, provided technical backstopping and assisted in the organization of the farmer training and field days.

Two review/refresher training sessions were conducted for the PADP staff to further familiarize them with new technologies and to review the activities in the IS. Feedback was provided to the project team, which helped improve the coordination of project activities among the partners.

Refresher training and identification of lead farmers to establish IS in the dry season is planned for November.

2.3.3 Output 3: Establishment of innovation sites through lead-farmers and training of smallholder farmers

2.3.3.1 Milestone accomplished and Activities

A total of 31 IS were established in six LGAs of Plateau State during the rainy season (**Table 2**). Planting was done in June and crops were harvested in September. Training and field days were conducted at 26 sites, while five sites were not able to conduct training or field days due to either security crises (three sites in Bassa LGA) or flooding in the field.

Table 2. Number of IS established in each LGA during rainy season

LGA	Male-led IS	Female-led IS	Total
Barkin Ladi	6	0	6
Bassa	2	1	3
Bokkos	5	2	7
Jos South	4	1	5
Mangu	4	2	6
Pankshin	2	1	2
NRCRI Vom			1
Total	**23**	**7**	**31**

Seven innovative technologies were demonstrated in each of the IS targeting important production themes as follows:

1. Integrated soil fertility management (ISFM)
   a. Crop rotation patterns
   b. Fertilizer options
2. Integrated seed health management (ISHM)
   a. Small seed plot technology
   b. Positive selection
3. Integrated pest management (IPM)
   a. Late blight management strategies (spray regimes, tolerant varieties, and different products)
4. Good agronomic practices (GAP)
   a. Hilling strategies
   b. Potato-legume intercropping

Field and training days conducted at the IS were attended by 3,506 farmers from 26 of the 31 IS established during the rainy season (**Table 3; Photo 11**). Among the farmers who attended the field days, 56% were male and 44% were female. Field days were not organized in three sites due to security issues in the area, while one site was affected by floods.

Table 3. Number and gender of farmers attending field days at the IS in different LGAs

LGA	Sites	Male	Percentage	Female	Percentage	Total
Barkin Ladi	6	453	57	338	43	791
Bokkos	7	448	54	386	46	834
Jos South	5	278	49	295	51	573
Mangu	6	622	60	415	40	1037
Pankshin	3	156	58	115	42	271
Bassa	3	-[1]	-[1]	-[1]	-[1]	-[1]
Total	**30**	**1,957**	**56**	**1,549**	**44**	**3,506**

[1]Field days could not take place due to insecurity in the area


Photo 11. Farmers attending field day at the IS of lead farmer, Rufus Bature, in Gangere, Barkin Ladi

Crop rotation patterns

Three crop rotation patterns were demonstrated to showcase the importance of crop rotation in reducing diseases and pest build-up in the soils, e.g., bacterial wilt; improving and managing soil fertility and health through diversification of food production; and the safe use of chemicals. Potato yields in crop rotation plots were higher than the national average of 4 t/ha (**Table 4**). On average, a higher yield was observed in Barkin Ladi while the lowest yield was observed in Pankshin LGA.

Table 4. Potato yield (t/ha) in different crop rotation patterns during rainy season

	Crop rotation pattern[1]			
LGA	**Bacterial wilt**	**Farmer practice**	**Organic**	**Soil fertility**
Pankshin	13.3 ±2	14.5 ±5	7.6 ±2	15.3 ±1
Mangu	16.0 ±6	15.6 ±4	14.3 ±6	14.5 ±6
Jos South	17.8 ±4	13.7 ±3	15.0 ±6	20.3 ±4
Bokkos	14.1 ±8	14.7 ±8	11.9 ±7	17.7 ±9
Barkin Ladi	22.3 ±10	21.9 ±10	15.5 ±8	22.7 ±8

[1]This interpretation is from one season thus should not be interpreted as the effect of the rotation pattern which can only be observed after a complete rotation cycle of four seasons.

Fertilizer use

Depleted nutrients can be restored to soils by adding inorganic fertilizers and organic manures. High fertilizer prices limit their use. The purpose of the fertilizer-use demonstration was to showcase soil fertility management options so that farmers can explore possibility of mixing the two or more fertilizers for better crop production, cost reduction and soil fertility management.

The highest yield improvements in all the sites were observed when organic fertilizers were mixed with inorganic. The second highest yield improvements were from inorganic fertilizer application, while the lowest yield increase was observed in plots where no fertilizer was used (**Table 5**). Organic fertilizer increased the yield slightly.

Table 5. Comparison of potato yield under different fertilizer combinations[1] demonstrated at IS during rainy season

LGA	Manure	Manure + NPK	No fertilizer	NPK
Barkin Ladi	17.3 ±5	23.1 ±9	14.2 ±5	21.7 ±9
Bokkos	13.2 ±6	17.2 ±8	7.4 ±4	13.9 ±6
Jos South	10.9 ±5	13.6 ±5	9.0 ±3	14.3 ±3
Mangu	9.3 ±2	11.3 ±5	7.6 ±3	10.9 ±6
Pankshin	6.5 ±2	8.1 ±3	3.7 ±2	8.1 ±5
Mean	11.9 ±6	15.3 ±8	8.6 ±5	14.0 ±7

[1]Where manure and NPK were mixed, the rate of NPK and manure were both reduced to half of the recommended.

Potato-legume intercropping

Intercropping potato with deep-rooted legumes can optimize the soil N balance in smallholder farms. This strategy was demonstrated to present farmers with options to increase the productivity of existing agricultural resources while providing more stable yields. On average, intercropping potato with local beans or soya beans gave higher yields compared to intercropping with green beans (**Table 6**).

Table 6. Potato yield under different potato-legume intercropping combinations

LGA	Potato + Green beans	Potato + Local beans	Potato + Soya beans
Barkin Ladi	16.3 ±6	21.0 ±4	19.8 ±5
Pankshin	14.8 ±5	16.8 ±6	15.4 ±6
Mangu	14.7 ±4	15.2 ±5	16.4 ±9
Bokkos	13.5 ±3	10.8 ±5	10.8 ±4
Jos South	12.5 ±0	16.0 ±1	17.6 ±3
Mean	14.3 ±5	15.6 ±6	15.8 ±7

Late blight management strategies

Late blight occurs at times of high rainfall, high humidity, and low temperatures. These are the typical conditions during the rainy season in Plateau State. The disease is mainly managed through resistant varieties and fungicide sprays. The results in **Table 7** show that the choice of fungicide and variety can determine the level of late blight control. Better understanding of the active ingredient of the chemical being used, in combination with exploiting varietal resistance, can help to reduce the frequency of spray which, in turn, lowers the production cost and minimizes the health risks from sprays.

Table 7. Yield (t/ha) data from three varieties under different late blight management strategies

		LGA					
Treatment	**Variety**	**Barkin Ladi**	**Bokkos**	**Jos South**	**Mangu**	**Pankshin**	**Mean**
BI-WS[1] PRD1	Jelly	28.5 ±5	16.4 ±12	13.7 ±7	12.0 ±3	16.0 ±4	16.1 ±9
	Marabel	21.0 ±7	12.7 ±9	13.6 ±5	14.6 ±6	30.2 ±13	16.6 ±9
	Nicola	16.9 ±7	11.5 ±7	10.4 ±4	9.9 ±4	12.1 ±4	11.8 ±6
BI-WS[2] PRD2	Jelly	20.5 ±7	16.8 ±11	11.4 ±3	11.1 ±3	9.3 ±2	14.8 ±8
	Marabel	16.0 ±4	12.5 ±3	13.9 ±5	14.4 ±5	19.2 ±4	14.5 ±5
	Nicola	14.4 ±2	11.1 ±5	10.7 ±4	9.8 ±4	7.1 ±2	10.8 ±4
WS[3] PRD1	Jelly	27.9 ±4	14.3 ±9	17.1 ±7	15.6 ±6	9.1 ±2	16.0 ±8
	Marabel	21.2 ±7	15.8 ±9	17.9 ±5	15.7 ±7	19.8 ±8	17.9 ±7
	Nicola	15.6 ±3	11.0 ±6	10.8 ±3	11.2 ±5	7.8 ±2	11.4 ±5
WS[4] PRD2	Jelly	24.1 ±7	19.3 ±14	17.1 ±9	11.3 ±3	11.1 ±3	16.4 ±10
	Marabel	19.0 ±7	14.9 ±9	16.0 ±5	13.8 ±6	19.3 ±3	16.2 ±7
	Nicola	13.8 ±3	10.7 ±4	10.3 ±3	10.5 ±3	11.3 ±6	11.1 ±4
No Spray	Jelly	17.6 ±7	6.9 ±3	12.0 ±1	8.8 ±4	11.5 ±3	10.0 ±5
	Marabel	14.1 ±6	5.9 ±3	12.4 ±5	10.8 ±3	13.2 ±3	10.8 ±5
	Nicola	13.4 ±6	5.1 ±3	9.8 ±3	7.7 ±3	6.3 ±3	7.7 ±5

[1] Biweekly spray alternating Glory and Ridomil Gold
[2] Biweekly spray with Ridomil Gold alone
[3] Weekly spray alternating Glory and Ridomil Gold
[4] Weekly spray with Ridomil Gold alone

Hilling strategies

Hilling helps to loosen the soil, which leads to the production of many tubers of good size and shape. It also reduces the exposure of tubers to both sunlight, which turns the tubers green, and pests such as potato tuber moth. Three hilling strategies were compared through demonstration. These included:

1. One hilling, where soil is added to the plant only once: two weeks after emergence

2. Two hilling, where soil is added two times: two weeks and four weeks after emergence
3. Pre-hilling, where the potato is planted on a pre-formed ridge

Planting on pre-hilled ridges produced higher yield on average, followed by one and two hilling, which were both higher than the non-hilled plots (**Figure 8**).

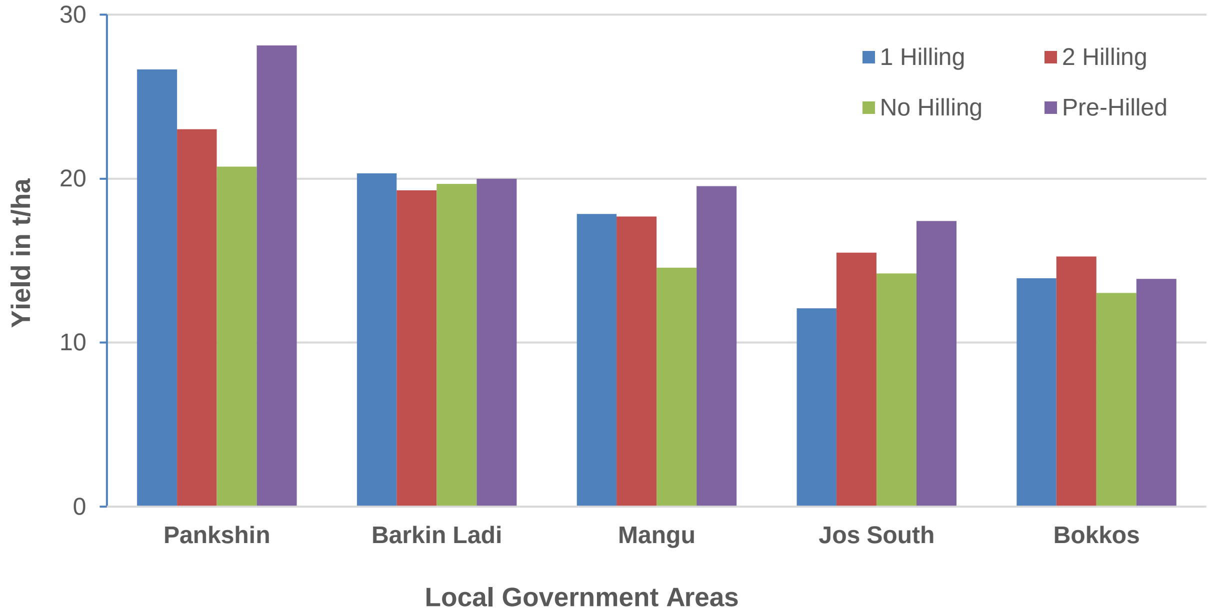

Figure 8. Yield comparison of three different hilling strategies demonstrated at IS during rainy season

2.3.4 Output 4: Development of e-extension materials

2.3.4.1 Milestone accomplished and Activities

Three animated videos for e-communications are completed and available for viewing and use on YouTube. Two additional animated videos are at an advanced review stage of production (**Table 8**). The project is currently working on different avenues and strategies that will be used to disseminate these e-communication materials to a wider community of SHFs.

Table 8. Status of animated videos for e-communication under development

Topic	Link
Rooted Apical Cuttings: Best practices for field multiplication	https://youtu.be/2kbIhT4Xs8s
How to hill potatoes	https://youtu.be/M3XNKouSlmE
Positive Selection	https://youtu.be/Y2GDfPX4MW8
Bacterial wilt management	Advance stage of production
Certified seed production	Advance stage of production

2.4 Objective 3: Testing, registration, and licensing of new CIP late-blight resistant varieties through public-private partnerships

2.4.1 Output 1: Multiplication of introduced CIP new material

2.4.1.1 Milestone accomplished and Activities

Multiplication of introduced CIP materials is continuing at different levels. IITA, as the current custodian of the materials, is conserving and multiplying the material through tissue culture and SAH technology. To date, IITA has supplied the project with 320 TC plantlets for the establishment of mother plants for the production of RAC. The project has also received 10,950 SAH plantlets for multiplication through RAC and sand hydroponics (**Table 9**). From these materials, over 24,000 RAC had been produced by October, with 3,010 RAC currently planted in the field for tuber production.

Table 9. List of SAH plantlets received from IITA between August and October 2021

CIP Number	August	September	Total
CIP 392797.22	200	2,000	2,200
CIP 398190.200	200	1,100	1,300
CIP 381381.13	200	1,100	1,300
CIP 398098.65	200	500	700
CIP 394611.112	200	500	700
CIP 398208.29	200	1,200	1,400
CIP 393371.157	200	1,100	1,300
CIP 393371.58	200	1,850	2,050
Total	**1,600**	**9,350**	**10,950**

2.4.2 Output 2: Field testing and assessment of introduced varieties under supervision of NRCRI at selected sites in replicated trials

2.4.2.1 Milestone accomplished and Activities

The project is working with the NRCRI as the crop mandate institute for the evaluation, data collection and presentation of data for the release and registration of suitable varieties. On-station trials are planned at the NRCRI Vom field station and the Fruits and Veggies facility in Dorowa Babuje. Multi-location and on-farm trials are planned during the rainy season as seed multiplication is underway to produce enough seed for 10 multi-location trials and 10 on-farm trials. The project is putting together a team that will conduct the trials and release of successful varieties.

2.4.3 Output 3: PVS assessment of introduced material

2.4.3.1 Milestone accomplished and Activities

Participatory varietal selection (PVS) of the new materials will be organized during the on-farm trials to get feedback from farmers regarding the new varieties under trial. This feedback will be important to give early indications of farmer and stakeholder preferences for different varieties. Selected growers will participate in PVS, along with public and private stakeholders, and will have the opportunity to become familiarized with the best performing candidate varieties.

2.4.4 Output 4: Introduction, multiplication, and demonstration by private sector partners

2.4.4.1 Milestone accomplished and Activities

Due to limited availability of seed, only one private-sector partner is currently doing multiplication of the new varieties from CIP. Again, given that these varieties are not officially released, the project prefers that the multiplications are controlled until successful varieties are identified, released, and registered for public use.

2.4.5 Output 5: Identification of candidate varieties for registration and addition to West African catalogue

2.4.5.1 Milestone accomplished and Activities

Once the on-station, multi-location and on-farm evaluations are completed, the 3–5 best performing CIP germplasm lines will be identified. These potential candidate varieties will be submitted to the National Crop Varieties and Livestock Breeds Registration and Release Committee (NCVLBRC) and coordinated by National Centre for Genetic Resources and Biotechnology (NACGRAB) for the registration and release process.

3. Overall outputs targeted vs achieved and variances

Table 10. Progress on the achievement of the project's targeted outcomes

Outputs	Target	Achieved	Variance	Comments
Objective 1: Enhanced capacity for potato EGS production by both public and private sector				
At least 5,000 in-vitro TC plantlets produced at NRCRI during the life of the project	5,000	0	-5,000	Agreement signing between FMARD and Wise Synergy
Two centers of excellence (one private and one public partner) for EGS production established	2	1	-1	Renovation of screenhouse ongoing at NRCRI
EGS production using RAC and aeroponics established at private and public sector	2	2	0	Completed and production is ongoing
Objective 2: Demonstration and training of on-farm seed management, soil fertility and other key agronomic innovations through innovation sites				
SHFs trained in seed quality management, fertilizer use, disease management and improved crop rotation practices	4,000	3506	-494	Target to be reached during the dry season
At least 30 IS established by March 2022	30	31	+1	
SHF capacity built to produce at least 25% of their seed using on-farm seed quality management practice through positive selection	25%			TBD by end line survey
Evidence collected on the efficacy of training SHFs in on-farm seed management training on the yield-gap in the Nigerian context				TBD by end line survey
Four videos (e-communication) developed to promote GAP and positive selection for TV and various online channels, including social media	4	3	-1	Two videos are at advanced review stage
Objective 3: Testing, registration, and licensing of new CIP late-blight resistant varieties through public-private partnerships				
Two–three candidate varieties identified for registration and addition to West African catalog (ECOWAS)	3	0	-3	Seed bulking trials ongoing

4. Cooperation/collaboration with stakeholders and other actors

Through collaboration between GIAE, the GPVCWG and the project, three training programs were conducted for strategic stakeholders within the project to build and strengthen the linkages within the seed value chain. GPVCWG supported an expert who trained seed producers, seed inspectors and lab technicians on disease diagnostic technologies. GIAE identified and mobilized the stakeholders for the training. These stakeholders play a very important role in the development of the sustainable seed system envisaged by the NPSSP project.

Table 11. Stakeholders trained through collaboration of different projects

Stakeholder	Role	Members trained			Total
		Seed multiplication	Seed inspection	LAMP assay diagnostics	
Plateau State University	Research			2	2
University of Jos	Research		2	1	3
Cooperatives	Production	31			31
NAQS	Regulatory		2	1	3
NASC	Regulatory	1	6	4	11
ASTC&M LTD	CapDev		1	1	2
Fruits & Veggies	Production	5	2	2	9
NRCRI	Research		3	3	6
PADP	CapDev		5		5
Potato platform	Oversight		2		2
Total		**37**	**23**	**15**	**75**

5. Challenges/Risks

1. Reliance on rain-fed agriculture

Most of the farming activities are rain-fed. The two distinct seasons limit farming opportunities to the rainy season, which is restricted to only four to five months in a year. During the dry season, the rains are insufficient, uncertain, and irregular, thus causing uncertainty in production. Very few farmers have invested in irrigation infrastructure for use during this period. This means that there is always less production during this period, leading to shortages of food and seed, which in turn causes increases in prices.

2. High disease pressure during rainy season

High rainfall during the rainy season offers favorable climatic conditions for the multiplication and spread of late blight disease. Many farmers have found it difficult to manage the disease due to the high cost of chemicals and the use of sub-standard fungicide in the market. Some farmers harvest early to avoid further spraying, which in turn compromises their yields.

3. Lack of storage facilities for seed and ware potatoes

With production mainly occurring during the rainy season, if there are insufficient storage facilities both for seed and ware potatoes, shortages are expected within a short period of time. Potato is a perishable crop and without proper storage a lot of post-harvest losses are expected. In terms of seed, the lack of proper storage facilities reduces the availability of quality seed for planting when it is needed.

4. Limited land

The smallholdings that are characteristic for the majority of the farmers are in danger of overuse for potato growing without an effective rotation plan. This presents a risk for the buildup of soil-borne diseases, such as bacterial wilt, which are a threat to potato production. Limited land availability also reduces the chances of engagement in seed production since the majority of farmers cannot meet the required land sizes recommended for sustainable, quality seed production.

5. Lack of developed seed potato certification scheme

Efforts towards the sustainable production of quality seed potato are anchored by a functional seed quality assurance scheme. To date, there has been no protocol for seed potato certification or guidelines for quality assurance. This creates the risk of continuous spread of disease through selling or exchanging of seed whose quality is unknown.

6. *Limited access to wider pool of varieties*

Most of the varieties currently registered are privately owned and farmers require permission or special arrangements with the seed owners to grow these varieties. These arrangements can involve the importation of seed, which presents logistical challenges leading to increased seed costs for farmers. This approach has been observed to be unsustainable since there is no reliable supply of seed. It also hinders the development of local capacity in EGS production. It takes a long time to successfully register varieties, hence this may not be achieved during this current project period.

7. *Conflict and insecurity in Plateau State*

The displacement and tensions due to constant conflicts and security issues can have a pronounced impact on agriculture. Various agricultural value chains are disrupted, which diminishes the capacity for self-sufficiency in the rural population. In some instances, training cannot be conducted, and crops cannot be attended to, leading to huge losses due to theft and the lack of management.

6. Lessons learned

1. The need for a holistic approach to address the seed bottleneck

Our seed system analysis reveals several issues that affect availability, access, and quality of seed. For instance, after varieties are released, the supply of EGS has not been good enough to match the need for further multiplications to higher classes of seed. Certified/quality seed production, awareness, seed distribution and regulatory requirements are equally important and yet they are generally overlooked in seed system development interventions. Policies play a critical role in driving seed systems and ensuring farmers get value for their money from the seed they purchase and use. It is therefore important to consider all the different components/actors holistically within the seed value chain for a sustainable seed system.

2. Collaborations and partnerships

Collaborations between the NPSSP project, GIAE and GPVCWG has shown great potential and opened opportunities for both local and international partnerships. Local partners have benefitted greatly from capacity building on new technologies and approaches. Fostering private–public partnerships in seed production by involving the private sector at early stages of seed production can increase the availability of seed more effectively and efficiently. Public–private, public–public, and private–private partnerships can all help to strengthen seed sector development. Leveraging the strengths of different partners through effective synergies for the rapid production and delivery of technologies and innovations can go a long way to increase the availability of seed, from EGS to certified seed.

3. Need for investment in local production of early generation seed

Seed importation has been observed to be unsustainable, and the local production of seed is considered preferable. However, investment in early generation seed production has been low and is considered unattractive, particularly by the private sector due to the perceived slow recovery of investments. Traditional methods of using sterilized soils were slow, expensive, and risky. The adoption of new technologies, such as sand hydroponics and RAC, provides a feasible alternative that is worthy of investment. RAC has proved to be a game-changing technology with the potential to revolutionize the seed system through rapid production and multiplication of EGS for further multiplication to other classes of seed.

7. Activities planned for the next reporting period (October 2021–March 2022)

Table 12. Activities planned for the next reporting period

Activities	Oct 2021				Nov 2021				Dec 2021				Jan 2021				Feb 2021				Mar 2021			
Objective 1: Enhanced capacity for potato EGS production by both public and private sector																								
Output 1: Screenhouse upgraded and equipped at NRCRI and private sector partner																								
Complete renovations of screen house at NRCRI					■	■	■	■																
RAC production at NRCRI and F&VGL	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Output 2: Capacity building and procurement of materials for tissue culture production																								
																						■	■	■
Output 3: Establishment of in-field multiplication (G2) of basic seed																								
G2 Seed multiplication at NRCRI and F&VGL	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Objective 2: Demonstration and training of on-farm seed management, soil fertility and other key agronomic innovations through IS																								
Output 1: Development and adaptation of CIP training material from East Africa																								
Completion of remaining animation videos					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
Output 2: CIP training of PADP extension staff (ToT)																								
Training PADP extension staff and lead farmers for dry season IS establishment					■	■																		
Output 3: Establishment of IS through lead-farmers and training of smallholder farmers																								
Establishment of dry season IS							■	■	■															
Conduct training and farmer field days at IS													■	■	■	■	■	■	■	■				
Objective 3: Testing, registration, and licensing of new CIP late-blight resistant varieties through public-private partnerships																								
Output 1: Multiplication of introduced CIP material																								
Seed multiplication at NRCRI and F&VGL	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Output 2: Field testing and assessment of introduced varieties under supervision of NRCRI at selected sites in replicated trials																								

Setting up on-station trials at NRCRI and F&VGL																								
Output 4: Introduction, multiplication, and demonstration by private-sector partners																								
Multiplication, and demonstration by F&VGL																								

8. Annexes

Annex 1. Characteristics of respondents of baseline study by LGA

		LGA						
Characteristic	**N**	**Barkin Ladi**	**Bassa**	**Bokkos**	**Jos South**	**Mangu**	**Pankshin**	**Total**
Gender								
Male (%)	(151)	73.2	90.0	80.0	67.5	65.0	90.0	75.1
Female (%)	(50)	26.8	10.0	20.0	32.5	35.0	10.0	24.9
Education level								
University (%)	(37)	15.0	15.0	20.0	21.1	7.5	47.4	18.8
College (%)	(40)	5.0	35.0	15.0	18.4	30.0	31.6	20.3
Secondary (%)	(74)	57.5	35.0	25.0	42.1	40.0	10.5	37.5
Primary (%)	(35)	15.0	10.0	30.0	13.2	20.0	10.5	17.8
None (%)	(11)	7.5	5.0	10.0	5.3	2.5	0.0	5.6
Age								
21-30 (%)	(15)	7.5	10.5	5.0	10.5	10.0	0.0	7.6
31-40 (%)	(43)	12.5	15.8	22.5	21.1	32.5	25.0	21.8
41-50 (%)	(72)	37.5	36.8	37.5	36.8	35.0	35.0	36.5
51-60 (%)	(59)	42.5	31.6	25.0	28.9	20.0	35.0	29.9
>60 (%)	(8)	0.0	5.3	10.0	2.6	2.5	5.0	4.1
Main Occupation								
Farming (%)	(173)	85.4	80.0	95.0	85.0	82.5	85.0	86.1
Other (%)	(28)	14.6	20.0	5.0	15.0	17.5	15.0	13.9

Potato farming experience								
< 3 years (%)	(3)	0	10.0	0	0	0	5.0	1.5
> 3 years (%)	(196)	97.6	90.0	100.0	100.0	100.0	90.0	97.5
None (%)	(2)	2.4	0	0	0	0	5.0	1.0
Land ownership								
< 1 acre (%)	(16)	10	0	7.9	10	10.0	5.0	8.1
1 to 5 acres (%)	(132)	67.5	65.0	57.9	75.0	65.0	70.0	66.7
5 to 10 acres (%)	(45)	22.5	35.0	21.1	15.0	25.0	25.0	22.7
> 10 acres (%)	(5)	0.0	0.0	13.2	0.0	0.0	0.0	2.5

Annex 2. Baseline information on training, seed acquisitions and sizes used by farmers in different LGAs

Activity	N	LGAs: Barkin Ladi	Bassa	Bokkos	Jos South	Mangu	Pankshin	Total
Training on seed production								
No (%)	113	61.0	50.0	40.0	60.0	67.5	55.0	56.2
Yes (%)	88	39.0	50.0	60.0	40.0	32.5	45.0	43.8
Source of training								
Farmers association (%)	20	5.3	47.1	5.9	25.0	0.0	20.0	16.1
Other farmers (%)	11	5.3	17.6	11.8	8.3	6.7	0.0	8.9
NGO (%)	46	63.2	0.0	44.1	29.2	20.0	60.0	37.1
NRCRI (%)	6	10.5	0.0	2.9	4.2	6.7	6.7	4.8
PADP Agricultural Officers (%)	37	15.8	29.4	35.3	33.3	53.3	6.7	29.8
Seed grower's cooperative (%)	4	0.0	5.9	0.0	0.0	13.3	6.7	3.2
Source of seed								
Farm saved (%)	162	82.9	65.0	75.0	85.0	87.5	80.0	80.6
Imported (%)	20	4.9	20.0	7.5	15.0	7.5	10.0	10.0
Local seed company (%)	5	0.0	15.0	5.0	0.0	0.0	0.0	2.5
NRCRI (%)	5	4.9	0.0	2.5	0.0	0.0	10.0	2.5
Open market (%)	3	7.3	0.0	0.0	0.0	0.0	0.0	1.5
PADP (%)	6	0.0	0.0	10.0	0.0	5.0	0.0	3.0
Seed size planted								
0-30mm (%)	58	63.9	57.9	5.4	40.0	0.0	31.6	30.4
30-60mm (%)	80	16.7	31.6	67.6	45.0	45.0	36.8	41.9
60-90mm (%)	53	19.4	10.5	27.0	15.0	55.0	31.6	27.7

Annex 3. Baseline information on seed production, replacement, and storage among farmers in the six LGAs

		LGAs						
Activity	**N**	**Barkin Ladi**	**Bassa**	**Bokkos**	**Jos South**	**Mangu**	**Pankshin**	**Total**
Seed storage								
Dark room (%)	118	57.5	45.0	50.0	69.2	52.5	90.0	59.3
Diffuse light room (%)	32	12.5	20.0	22.5	15.4	17.5	5.0	16.1
Open anyhow room (%)	49	30.0	35.0	27.5	15.4	30.0	5.0	24.6
DLS availability								
No (%)	167	87.5	85.0	71.8	87.2	85.0	95.0	84.3
Yes (%)	31	12.5	15.0	28.2	12.8	15.0	5.0	15.7
Seed production season								
Rainy season (%)	119	55.0	70.0	75.7	53.8	62.5	45.0	60.7
Both rainy and dry season (%)	77	45.0	30.0	24.3	46.2	37.5	55.0	39.3
Seed replacement								
After 1 season (%)	5	2.5	5.3	2.8	2.6	2.5	0.0	2.6
After 2 seasons (%)	42	20.0	26.3	8.3	28.9	25.0	26.3	21.9
After 3 seasons (%)	57	40.0	31.6	41.7	31.6	10.0	21.1	29.7
After 4 seasons (%)	27	15.0	10.5	11.1	13.2	15.0	21.1	14.1
After more than 4 seasons (%)	61	22.5	26.3	36.1	23.7	47.5	31.6	31.8