Potato Value Chain Capacity Building Project

END-OF-PROJECT REPORT
MARCH 2018-DECEMBER 2022

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INTERNATIONAL FERTILIZER DEVELOPMENT CENTER
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Acronyms

AAK	Agrochemicals Association of Kenya
CSA	Climate-Smart Agriculture
DLS	Diffused Light Store
FFBS	Farmer Field Business School
GAP	Good Agricultural Practice
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
ICT	Information and Communications Technology
IFDC	International Fertilizer Development Center
KALRO	Kenya Agricultural and Livestock Research Organization
KEPHIS	Kenya Plant Health Inspectorate Service
NPCK	National Potato Council of Kenya
NPT	National Performance Trial
PCB	Potato Value Chain Capacity Building (project)
SFSI	Sustainable Food Systems Ireland
SSP	Spraying Service Provider

EXECUTIVE SUMMARY

In December 2022, the Potato Value Chain Capacity Building Project (PCB) closed after five years of successful implementation. The pilot project was implemented by the International Fertilizer Development Center (IFDC) from 2018 to 2022 and funded by the Irish government through the Embassy of Ireland in Kenya.

The project used a public-private partnership (PPP) approach, integrating various components to attain a sustainable increase in potato productivity, strengthen the potato seed sector, and raise income for potato smallholder farmers in Nyandarua County. This was to be achieved through providing farmer education, strengthening the potato seed supply chain, and facilitating market and input linkages. Following the PPP approach, the project forged key partnerships with 10 agro-input companies; six soil nutrition, soil health, and soil fertility companies; four development partners; three research institutions; three organized market actors; and two seed companies in Kenya. PCB also forged partnerships with private sector firms, such as Donegal Investment Group, IPM, and the government institutions Sustainable Food Systems Ireland (SFSI) and Teagasc. Through these agreements, the project leveraged the private sector firms' and organizations' own interests and investment opportunities to drive more inclusive growth along the potato value chain.

The project interventions, focused on four thematic areas, improved the livelihoods of 6,541 smallholder farmers (62.7% female, 37% men, and 33% youth) directly and 12,379 (51.9% female) indirectly, against a target of 4,500. Through adoption of climate-smart agricultural practices and improved technologies in potato production, productivity increased significantly to an average of 90 50-kg bags per acre from a baseline average of 34 bags per acre, an increase of 165% (compared to the project target of 50%).

Net income from potato farming among farmers increased to Ksh 185,430 per household per season from a baseline value of Ksh 69,785, an increase of 166%. This has led to improved livelihoods and an increase in farmers' ability to meet their basic needs. Though there has been a reduction in the land size under potato cultivation of individuals due to the steady population growth rate, the overall proportion of land under potato increased from 33% at baseline to 38% at the end of the project. This is because more farmers are now willing to venture into potato farming and existing farmers are expanding their area under potato because of the increased productivity and income they are realizing.

In the five-year implementation period, the project worked with Kirinyaga Seed Limited and was able to introduce three new potato varieties into Kenyan markets. Java variety has already been certified by Kenya Plant Health Inspectorate Service (KEPHIS). Bulking and commercialization of this variety were heavily affected by drought occurring in the country for the last couple of years

because of climate change. Maverick and Buffalo have been certified by KEPHIS and are awaiting gazetting.

The end-term evaluation report showed that there was a significant increase in farmer adoption of existing varieties, such as Shangi. This was the result of two major outstanding characteristics with regard to yield and marketability. To ensure that farmers have access to clean and certified seeds of this locally dominant variety, the project injected 130 metric tons (mt) of certified seeds and made 33,804 mt of clean seeds available. This led to an increase in the uptake of clean seeds from 33% to 61% and certified seeds from a baseline of 7% to 18% after multiplication. There was a significant decline in the use of recycled seeds from 60% at baseline to 21% at the end of the project. The average distance required to access clean seed was reduced to 1.9 kilometers (km). The adoption of clean and certified seeds has led to an increase in productivity because farmers can access and afford the seeds without traveling far.

By integrating nutrition through training on kitchen gardening and planting of fruit trees, the household dietary diversity score (HDDS) score increased from 6.4 to 7.1, meaning that households consumed an average of about 7 food groups out of the possible 12, an increase from 6.4 at baseline. Most of the vegetables consumed were sourced from their own farm or kitchen garden, an initiative promoted by the project to address the level of malnutrition in Nyandarua, which is above the national average of 26%.

With regard to good agricultural practices (GAPs), 96% of the farmers confirmed having received training on these. Adoption levels increased from 18% at baseline to 55% at the end of the project, with crop rotation, proper spacing, and the use of certified and clean seeds driving the change. To address post-harvest losses, the project supported the construction of storage facilities, with 24.5% of the farmers adopting this technology. This led to a decrease in post-harvest losses from 40% at the baseline to 8% at the end of the project. Thus, farmers are now getting more returns from their potato enterprises.

Through trainings conducted by the project, women have been empowered, with 99% reporting to have decisionmaking autonomy, especially on how they spend income, the farming methods they use, what crops are grown and where on the land, and sales of farm produce.

Through the Farmer Field Business School (FFBS) model, 104 lead farmers were trained on GAPs and they have gone on to train others. This extension model has greatly impacted the surrounding community members and households, as the trained farmers can share the knowledge with their neighbors.

One of the major lessons learned is that investment in seed multiplication is risky because of farmers' low demand and lack of willingness to pay for seed potato every season.

There is a need to engage sources of sector-wide leadership and advocacy, especially when it comes to policy issues around seed certification and sector regulation, because the process of seed production and multiplication is long and expensive.

PCB has demonstrated the importance of the PPP model in the delivery of certified seeds, extension services, and soil health technologies to farmers as well as the construction of storage facilities. Another lesson learned is that there is a need to integrate the private sector for upscaling the technologies.

During the learning events, it was evident that knowledge is scattered, so there is a need to package this information appropriately and develop strategies for dissemination and incorporating information and communications technology (ICT) because most farmers have mobile phones.

Through the project, the need to determine ways to address transactions that are not handled by offtakers was identified, since 95% of ware potato goes to the market through this unregulated marketing channel. One of the recommendations stemming from this is that initiatives to improve the knowledge and business practices of traders/brokers should be piloted in Nyandarua. Projects that avoid working with brokers/traders will significantly limit their results. However, engaging the brokers to improve their business practices to be more transparent and to enforce quality standards is a significant challenge. Future programs should pilot several interventions through an iterative design process to identify how to best support the trading function and shift incentives to improve unstructured market transactions.

Based on the final evaluation, utilization of the constructed storage facilities was low. The project recommends that the construction of storage facilities should be done in conjunction with operationalization trainings, so that farmers can make maximum use of the stores in a commercially viable way. Further, exit strategies and sustainability models need to be incorporated early in the life of the project and involve both the public and private sectors. Integrating the private sector in upscaling technologies is key.

One of the major challenges faced by the project was that its implementation was disrupted by the COVID-19 pandemic, which persisted for over 18 months. Government restrictions affected international and local movement and the implementation of the FFBS model, which used a group approach for training. To overcome this, the project digitized the training curriculum through the Arifu platform. This ensured that members continued to get training and advice online through e-extension.

The end-of-project evaluation concluded that the project was relevant and well designed. It showed that the interventions had positive results that fed into the overall project goal. In terms of project efficiency and value for money, the evaluation considered PCB a pilot project, with a focus on productivity, linkage to markets and inputs, strengthening the seed production and supply chain,

and institutional capacity building. The project, therefore, had limited resources in terms of time and budget but ambitious reach.

The success of the PPPs established under the PCB project have led to partnerships with the government, national research and certification institutions, market offtakers, seed companies, farmers, and farmer cooperatives in Nyandarua County. This demonstrates IFDC's capability as a convener, private sector partner, grantee capacity builder, and implementation supporter. With the success of these partnerships, IFDC has proved to be an effective partner for implementation support to deliver results effectively and efficiently.

1. INTRODUCTION

The Potato Value Chain Capacity Building (PCB) project, funded by the Embassy of Ireland in Kenya, was originally designed as a three-year (2018-2020) initiative that sought to improve productivity and incomes and link smallholder farmers to inputs and markets in Nyandarua County. The project anticipated to increase the income and production of potatoes for 4,500 smallholder farmers by enhancing farmer education, strengthening the seed production and supply chain, increasing market knowledge and access, and facilitating institutional capacity building and policy regulation by working together with the county government, National Potato Council of Kenya (NPCK), Teagasc, Sustainable Food Systems Ireland (SFSI), and IPM Group.

Due to delays brought by COVID-19 and policy bottlenecks around seed certification, in 2021 PCB was granted a one-year extension (April 1, 2021-March 31, 2022) to complete activities under a revised timeline and strategy. The project was extended for another nine months to December 31, 2022, to enable IFDC to consolidate PCB activities in alignment with the original exit strategy's sustainability goals, while undertaking a discrete set of activities to gather, validate, and showcase PCB results, successes, and lessons learned, in line with Embassy of Ireland priorities. These additional knowledge management components were meant to inform future programming and create synergies with other donors, implementers, and stakeholders operating locally.

The PCB pilot project was implemented through a public-private partnership (PPP) approach. The project activities took place in Nyandarua County, with the overall objective of improving the livelihoods of smallholder farmers by increasing productivity by 40-50% through the adoption of new technologies, including the use of certified seed potatoes and new varieties that are more productive and marketable, consistent use of good agricultural practices (GAPs), improved farm management skills, and increased market access.

PCB utilized an inclusive, locally driven, market systems approach to pull farmers more effectively into the potato value chain, increasing access to and use of quality inputs and catalyzing market growth through the promotion and deepening of forward and backward linkages along the potato value chain. PCB's PPP model relied on market forces, linkages, and knowledge, rather than subsidies or other market disruptors, to spur demand and ensure lasting sustainable impact. IFDC nurtured private sector partners and relationships with local partners, which resulted in numerous commitments of technical support and other key infrastructural investments. This has provided a solid foundation for continued cooperation and potential future expansion of the PPP model into other regions.

Toward the end, the PCB project focused on integrating nutrition and climate-smart agriculture (CSA) into farmer education through the Farmer Field Business School (FFBS) model, strengthening the potato seed production system, creating market linkages and knowledge transfer, and providing institutional capacity building.

2. RESULTS, MILESTONES, AND INDICATORS

As PCB reached its end, significant strides had been made toward improving the livelihoods of smallholder farmers through the project's four thematic areas.

1. Farmer education
2. Strengthening the potato seed production and supply chain
3. Linkages to inputs and markets
4. Knowledge management and institutional capacity building

According to the 2022 project evaluation report, PCB was instrumental in all of the above.

2.1 Farmer Education

a. Development of training materials

Over the years, potato production in Nyandarua County had been decreasing due to factors such as overrecycling of potato seeds, continued use of traditional farming methods, resistant pests and diseases, post-harvest losses, and climate change. This resulted in low returns and decreased household income for the small-scale farmers who are dependent on potato farming.

To address this, the PCB project adopted the FFBS model in training and demonstration of new technologies in potato farming to farmers for increased productivity and improved food and nutrition security, environmental conservation, and alleviation of poverty. This called for development of training materials. IFDC reviewed the FFBS manual that was developed and published by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and, without changing the content, came up with two sets of manuals, i.e., a trainer manual and a farmer manual. This led to the adoption of common training materials by different partners in the county. Thus, it became easy to coordinate, standardize, and assess the trainings being carried out in the county by the various partners.

b. Establishment of demonstration plots

One of the project's strategies to introduce and integrate climate-smart agriculture practices was to establish demonstration plots on farmer or group plots. The project established 354 demonstration plots to give farmers hands-on experience and pilot the adoption of CSA practices and technologies. These technologies included soil testing, the use of certified seeds, appropriate use of inputs, and spraying programs. The demonstrations provided an excellent field learning venue, where techniques and practices were promoted. Along with soil fertility improvement practices, other related good agricultural practices, such as the use of certified seeds and timely planting and weeding, were also taught and demonstrated. Certified seed varieties, such as Unica, Shangi, Java, Buffalo, and Maverick, were used for demonstrations.

The demonstration results showed significant agronomic performance as compared to farmers' conventional practices. Based on observation of the results of the new practices and available data from the demonstration sites, the technologies and practices that were introduced enabled smallholder farmers to attain a remarkable yield advantage over the local practices. Yield increased from 34 50-kg bags to 90 50-kg bags, translating to a 165% increase.

Table 1. Annual Demonstration Sites Hosting FFBSs

Year	Staff-Led	Farmer-Led	Total
Y1 (2018)	11	12	23
Y2 (2019)	51	41	92
Y3 (2020)	46	35	81
Y4 (2021)	55	53	108
Y5 (2022)	3	47	50
Total	**166**	**188**	**354**

c. Participation in farmer field days

Farmer field days are one of the platforms through which farmers show the performance of the new practices to other members of the community. Field days were organized at different stages of plant growth, so others in the nearby community could evaluate the performance of the technologies and practices promoted by the project. This raised their awareness of new technologies and practices and provided an opportunity for creating input linkages, whereby input suppliers presented the different agricultural input products available in the markets. The platform provided farmers the opportunity to gain an in-depth understanding of the formulations of the different agrochemicals, correct handling, accessibility, and method of application. This served a important role in ensuring last-mile delivery of major farm inputs and farm services, including agrochemicals, organic and synthetic fertilizers, farm mechanization, and soil testing services. Overall, 134 field days were organized and 12,379 farmers participated during the five years of the project, as shown in Table 2.

Table 2. Farmers Trained Through Field Days

Year	No. of Field Days	Male	Female	Total
Y1 (2018)	10	556	542	1,098
Y2 (2019)	40	2,105	2,184	4,289
Y3 (2020)	22	847	991	1,838
Y4 (2021)	60	2,338	2,603	4,941
Y5 (2022)	2	111	102	213
Total	**134**	**5,957**	**6,422**	**12,379**

d. Training of lead farmers and spraying service providers

To reach out to as many smallholder farmers as possible and contribute to sustainability, the project trained and mentored 104 lead farmers through an intensive training of trainers. They learned to successfully implement the FFBS model and to cascade the training to other farmers through the support of county agricultural officers. The lead farmers were further trained to assist in creating demand by setting up demonstration sites and training farmers on the FFBS model. To backstop the lead farmers, the project conducted a refresher training for 33 ward agricultural officers on the FFBS model, with additional modules on marketing, financial literacy, and potato value addition.

Table 3. Lead Farmers Trained as Trainers

Sub-County	Male	Female	Total
Kinangop	19	4	23
Kipipiri	9	7	16
Olkalou	14	13	27
Oljoro-orok	7	12	19
Ndaragwa	7	12	19
Total	**56**	**48**	**104**

The lead farmers continue to create awareness of good agricultural practices by assisting farmers to cultivate, follow recommended practices, and eventually produce more for their household consumption and income generation. They also serve as model farmers and early adopters of the improved practices and new technologies.

Through partnerships with the Agrochemicals Association of Kenya (AAK), the project conducted training for 14 spraying service providers (SSPs) on safe handling and correct use of agrochemicals, management of pests and diseases, and proper disposal of empty containers.

The SSPs were entrusted with sensitizing farmers on the production of safe foods and offering spray services within their community.

Farmers who accessed services from SSPs reported improved yields, which they attributed to the effectiveness of service provision in addressing the pests and diseases in addition to the on-farm advice on agronomic practices and improvements.

At the end of the project, 14 SSPs (70% youth) had been trained and were actively offering services to the farmers through their individual networks. They make an average of Ksh 15,000 each per season. This is a potential business opportunity that can be explored and improved upon for income generation.

e. Climate-smart agriculture

Climate change is a major threat to global food security, and production systems often lack the resources to manage an effective response to climate threats and risks.

Due to the prolonged drought and unpredictable weather patterns, the project introduced CSA technology training, seeking to integrate approaches that sustainably increase agricultural productivity, adaptation, and resilience to climate change and help the farmers adapt to the changes that significantly impact the production cycle.

The technologies include the use of improved potato varieties that are drought tolerant, soil fertility management, such as organic manure application, conservation agriculture involving minimum tillage, mulching, and planting of cover crops, water-harvesting technologies, making use of weather data, agroforestry, use of improved storage facilities, and use of renewable energy sources.

Through this, the project reported an increase in the adoption rate from 18% to 55%, which has enabled the farmers to become more resilient and adaptive to climate change.

f. Kitchen garden training

In Nyandarua County, the malnutrition level for children under 5 years of age stands at 29% against 26% countrywide. Therefore, integrating kitchen gardening activities and nutrition training in the FFBS model brought about a healthy community that is food and nutrition secure.

Scholastica Thuo at her kitchen garden with IFDC field staff

Through the PCB project, 960 farmers (232 male, 728 female [75.8%]) were trained on CSA, crop rotation, kitchen gardening, and nutrition concepts. The farmers were trained on the establishment of conical, multistory gardens and raised and sunken beds, as well as planting in containers, with a variety of nutritious vegetables, such as kale, spinach, cowpea, amaranth, and cabbage. This ensured increased productivity and a consistent supply of fresh vegetables throughout the year and provided a source of income through sales of surplus vegetables, boosting food and nutrition security and diversifying their income sources.

Integrating nutrition through kitchen garden training and planting of fruit trees raised the household dietary diversity score from 6.4 to 7.1, meaning that households consumed an average of about 7 food groups out of 12, up from 6.4 at baseline. Most of the vegetables were sourced from their own farm or kitchen garden.

g. Nutrition training

Good nutrition and healthy feeding are key to a healthy and strong community. In 2018, stunted growth for infants was common in Nyandarua County. Caregivers, especially young mothers, needed to be enlightened on healthy feeding for the infants and their families.

The PCB project integrated topics on potato production with good nutrition activities and value addition of potatoes. Through this approach, farmers were able to learn about safe production and safe consumption, the importance of balanced diets, food preparation, and cooking methods to ensure nutrients are retained in every meal.

The training was conducted by Ministry of Health and sub-county home economics officers and greatly impacted the community, especially when a strong wave of COVID-19 surged through the county. The project was able to reach 960 beneficiaries (232 male, 728 female) through nutrition training.

2.2 Strengthening the Potato Seed Production and Supply Chain

2.2.1 Introduction of New Varieties into the Kenyan Market

Farmers harvesting potato from a demonstration plot

The PCB project focused on offering solutions to challenges in potato production, such as the lack of availability and affordability of certified and clean potato seed.

To address the challenge, the project partnered with Kirinyaga Seed Limited to introduce Irish potato varieties into the Kenya market by carrying out various assessments at the National Performance Trials and releasing them for commercialization. As a result, the Java variety has been gazetted and listed in the 2021 NPCK Potato Catalogue. Two other

varieties (Buffalo and Marverick) have been certified by KEPHIS and will appear in the 2023 NPCK Potato catalog.

Seed bulking and commercialization of the released varieties were affected by drought, which has been prevalent in the country since 2020. To create awareness of the new varieties, demonstration plots of the new potato varieties were established by every FFBS group.

2.2.2 Increasing Access and Availability of Certified and Clean Seeds

To increase the availability of certified seeds of common varieties such as Shangi for smallholder farmers, the project made 157 mt of certified seeds available and introduced apical rooted cuttings to serve as breeder materials through 10 youth groups and five individual young people.

The youths established on-farm seed plots to multiply clean seed. In three seasons, they were able to produce 33,804 mt of seed, which was sold directly to the community and through lead farmers. This created a high demand for quality seed by farmers, which translated to increased business potential for the youth groups and individual seed merchants.

Table 4. Quantity of Clean Seed Made Available to Farmers

Certified Seeds Distributed		Seasons of Multiplication		
		1	2	3
Number of 50-kg Bags	3,130	18,780	112,680	676,080
kg	156,500	939,000	5,634,000	33,804,000
mt	157	939	5,634	33,804

This well-organized and structured approach to seed multiplication attracted support from other actors along the potato value chain, which boosted seed multiplication systems and improved their capacity of availing clean seed free from pests and diseases to other farmers. Through this approach, the adoption of clean seed increased from 33% to 61% and the use of certified seed increased from 7% to 18%. Farmers' use of recycled seeds decreased from 60% to 21%. With these changes, production per unit area increased and the distance required to access the seeds decreased to 1.9 km.

2.2.3 Construction of Storage Facilities

To stabilize ware potato prices and reduce post-harvest losses, the project piloted the construction of two storage facilities. A 40-mt capacity store was constructed at Kenya Agricultural and Livestock Research Organization (KALRO) Tigoni. The store was equipped with plastic crates and a data logger for research purposes. Key parameters, such as water loss and starch content,

will be collected to advise farmers on how long produce can be stored without losing quality and facilitate their decisionmaking. A 120-mt capacity storage facility was constructed at Pesi cooperative. Although not yet completed, it will be an aggregation center for 840 farmers who are members of the society.

2.2.3.1 Simple Storage Facility for Ware Potato

Almost half of the smallholder farmers (48%) store their saved potato seed in gunny bags, on the dry floor of their houses, or in field pits. Thus, the project also trained farmers on how to construct simple storage facilities for both ware and seed potato.

Simple storage facility using local materials

The biggest challenge to marketing potatoes is the fluctuation in prices, affected by the law of supply and demand, as potato production is highly dependent on rain. Farmers will normally plan their crops at the onset of rains and thus end up harvesting almost same time. This leads to high supply, thus lowering prices at harvest time.

To address this, the project has been successful in building the capacity of farmers on the construction of simple storage facilities using readily available materials.

2.2.3.2 Construction of Diffused Light Store for Seed Potato

The project further trained the Royal Youth FFBS group, together with 15 others, on establishing a diffused light store (DLS) using readily available local materials. A DLS is a low-cost seed potato storage structure with indirect sunlight (diffused light) and sufficient ventilation. Potato tubers are stored on shelves or in trays or crates up to three layers deep for up to four months, thus suitable for bimodal and extended rain farming systems.

The group was able to produce clean potato seed on 1 acre and then held the produce in the store for one to two months for the tubers to sprout. The tubers were then sold to farmers within their community. The group members also used the store as an aggregation center for their produce.

After the promotion of DLS, adoption by seed multipliers within the region, small- and medium-scale farmers, farmer groups, and cooperatives who produce and/or store large quantities of seed potato either for sale or to plant during the subsequent cropping season increased by 25%. This has led to reduced post-harvest and storage losses and allowed potato tubers to produce multiple strong sprouts that lead to faster field crop establishment and thus greater yields.

2.2.4 Support for Policies and Regulation

PCB supported the enactment of the potato packaging regulation of 2019. This entails the enforcement of sales of a maximum of 50 kg and pricing of potatoes by weight. The PCB project supported NPCK to continually engage the national and county governments.

Although implementation of the law has faced challenges, once these are resolved, it will provide for quality assurance and marketing of Irish potatoes, standards in grading, sampling and inspection, tests and analysis, specifications, units of measurement, code of practice and packaging, preservation, conservation, and transportation of crops. This will ensure proper trading and promotion of best practices in the Irish potato sub-sector, which will be beneficial to smallholder farmers in the long term.

2.3 Linkages to Markets and Inputs

2.3.1 Linkage to Markets

Marketing remains one of the most complex segments of the potato value chain due to the bulky and perishable nature of potatoes. To address this challenge, the project partnered with several market actors to offer a market for the farmers' produce at a reasonable price, through contract farming or walk-in deliveries to processors.

Farmers were trained on contract farming and understanding various aspects of contracting – prices, logistics, negotiation, conducting simple market surveys, the different models of contract farming, and the advantages and challenges of entering into a contract. As a result of the training, 222 farmers were contracted by Sereni Fries and Kinangop Fries to produce specific potato varieties that are good for processing. Through the contract, they were able to deliver 481,455 kg

of ware potato worth Ksh 15,269,277 at an average price of Ksh 27/kg, which was far better than the prevailing market price of Ksh 22/kg.

To build trust among the actors and assess the progress of the partnership, three roundtable meetings between the buyers and farmers were facilitated. This provided a platform to review the previous engagement period and identify challenges and areas of improvement for both parties. The buyers conducted refresher training on the quality and quantity requirements, packaging, variety, mode of delivery, and time lag in payment.

2.3.2 Linkage to Inputs

To ensure that farmers get quality farm inputs and services, which are the key determinants of the quality and quantity of the produce generated from the farming business, the project focused on linking the input and service providers with the farmers to ease the logistics of accessibility. Through this activity, there has been continued engagement and trade between the actors along the potato value chain and the farmers because of the direct connections. This has led to farmers being able to easily access inputs at an affordable price.

The project further partnered with Yara and Baraka fertilizer companies in promoting access to crop-specific fertilizer for potato and enabling safe and correct use of agrochemicals through the SSP model. The blended fertilizers were developed after performing soil analysis and were tailored to the specific nutrient needs of potatoes. These fertilizers recently entered the market.

Through the partnerships, 354 demonstration plots were established to compare the performance of the crop-specific fertilizers to the ones already on the market. The sensitization and farmer training resulted in a 60% increase in sales for Yara and Baraka as well as an improved distribution network.

In partnership with NPCK, PCB developed the Viazi Soko platform, which provides real-time information to farmers and actors along the potato value chain. This platform has enabled farmers to make queries and receive feedback on seed production information and book and order certified seeds. It also allows them access to the

recommended fertilizers and agrochemicals, soil testing, mechanization and spraying services, extension advisory services on GAPs, and weather information and forecasts.

The farmers can access important information from the platform in three different ways: a mobile phone by dialing *483*331#, an Android app, and the website www.npckviazisoko.com.

2.4 Knowledge Management and Institutional Capacity Building

2.4.1 Institutional Capacity Building

The project facilitated an exchange visit for the KEPHIS technical team to learn from Teagasc, IPM, and other private and government institutions about the propagation and certification of seed potato in Ireland. This served to familiarize the KEPHIS team on the procedures and systems in place in Ireland in the certification of seed potato, enabling them to build their capacity and improve Kenyan certification processes.

2.4.2 Knowledge Management

Sharing knowledge and information is key to ensuring continuous learning and both within the team and externally. Through this, the PCB team deepened its understanding of seed certification, storage, and creation of market linkages, both in theory and practice. They in turn shared their knowledge in numerous events such as the World Potato Congress, Africa Potato Day, and National Potato Day.

Knowledge management activities involved the development of a communication and knowledge management strategy, documentation of success stories, and organization of learning events.

1. Documentation of success stories and best practices

The project's communication officer collected information for success stories through questionnaires, key informant interviews, and desk reviews of progress reports. The project manager made several field trips to ground-truth the good practices, success stories, and processes. The field visits were also opportunities for the field-level experts to verify the shortlisted good practices and fill the gaps. These practices and other success stories were then subjected to validation.

One of the best-ranked practices was selecting lead farmers for community training and technology dissemination using innovative approaches. Several farmers benefited from the lead farmer training. One beneficiary noted, "Now the community selects a lead farmer who has an interest in agriculture, an active farmer, and the community listens to because of his or her knowledge of agriculture. This is a major shift for us." In addition, one of the lead farmers in Oljororok said, "We are chosen by the community to do the first trials. I decided to try the use of certified seeds and CSA practices after the training of trainers offered to us by the project."

Another success story was from Mwireri FFBS in Kinangop sub-county, a group formed through IFDC in 2020. It has 25 members (5 male, 20 female). Before the group came together, each member was producing individually and planting seeds they had recycled. They did not have any knowledge of good agricultural practices. As a result, they were getting only 17 50-kg bags per acre, which is far below the expected output. The production levels clearly indicated that they were not farming as a business, but just for subsistence purposes. This was a result of the use of unclean and uncertified seeds as well as poor agronomic practices.

To address the seed challenge and to train the members on good agricultural practices, IFDC and the county government supported the establishment of a demonstration plot. They were supported with certified seeds to plant on the 0.25 acre demonstration plot. Training was carried out by the ward agricultural officer.

From the demonstration plot, the members harvested 2.5 mt of potatoes, preserved the seeds, and scaled up their production to 2 acres From the 2 acres, they produced 12.5 mt of clean seed. Each of the 25 farmers of the group received 400 kg, and the remaining seed was sold to other local potato growers. This has ensured that farmers continuously eliminate the recycled seed that is diseased and less productive from their seed stash. Through the multiplication of the certified seeds, the members have been able to access and embrace highly productive seed.

With the availability of clean seed and the new knowledge on good agricultural practices, the group members have realized increased income from their farms as a result of increased productivity, from 34 bags to 90 bags, a 165% increase.

The members have also brought change in their communities, with at least two members in every group specializing in seed production and supplying these to local people. These specific farmers recorded better incomes from the seed production enterprise compared to ware potato production, with average sales of U.S. $17.09 per 50-kg bag. Farmers selling the same amount of ware potato average $10 per bag.

The extension model has also impacted the surrounding community members and households greatly, as every trained farmer can share the knowledge with immediate relatives, neighbors, and church members.

2. Dissemination and learning workshop

To facilitate learning and sharing, a workshop was organized in Nakuru, which brought together various stakeholders. The workshop included a field visit, and participants expressed their appreciation for the critical role played by the project. The event also acted as an avenue to showcase the project's progress and lessons learned, which will inform future programming. Input and market linkage opportunities were also created because input suppliers and other market players exhibited their products.

The networking platforms facilitated the identification and mapping of potential stakeholders for current and future engagements, which has expanded project partnerships' scope of sustainability.

3. Online presence

Through various social media platforms and the IFDC website, the project has published success stories and project achievements, step-by-step implementation processes, and project outcomes through articles and videos.

3. IMMEDIATE IMPACT OF THE PCB PROJECT

PCB project interventions generally had positive results that fed into the overall goals of the project. The project eased access constraints faced by smallholder farmers. As a result, demand for certified seed has grown, with its use in Nyandarua rising from 7% to more than 18% in 2022. Significantly, these efforts have also improved partnerships between private seed companies (Kirinyaga Seed Limited) and public research and regulatory institutions (KEPHIS).

Throughout the project, a farmer-friendly technology dissemination mechanism was used. The project disseminated technologies largely through mounting farmer-managed demonstration plots and field day events at those sites. The promotion of certified seed use and demonstration of climate-smart practices increased farmers' productivity and incomes.

From the evaluation of the project, there was consensus that generally productivity has improved in the project areas over time from 34 to 90 50-kg bags per acre for the farmers. The project has been successful in demonstrating to farmers that yield increases when using improved practices and has succeeded in inculcating this knowledge among farmers.

Market-led adoption of project interventions is a key sustainability pathway, and the adoption of good agricultural practices has been satisfactory. The interventions are likely to be continued by key stakeholders due to the demonstrated opportunities. Farmers have seen a strong market to produce clean seeds, and agro dealers have seen a large and growing market for farm inputs, seeds, and fertilizer.

It is also worth mentioning some of the cross-cutting issues that PCB brought to light. First, the success of the public-private partnerships that were established led to partnerships with the government, national agricultural research systems, seed companies, financial institutions, farmers, and farmer cooperatives.

4. PROJECT FINANCIAL REPORT

The Embassy of Ireland disbursed €1,525,000 during the project implementation period. By the end of the project, budget utilization was at €1,524,812, which is 99.98%. The remaining €188 will be used to make the final payment for the end-term evaluation consultancy.

Cost Contribution by Partners

The PCB project brought together public and private actors along the potato value chain. Government organizations at the county and national level, private fertilizer and agrochemical companies, research institutions and development partners, financial institutions, and potato processing companies participated actively in implementing project activities. During the FFBS and field days, farmers sacrificed their valuable and productive time that could have been used elsewhere and were not paid. Through contributions in cash or in kind by the project, partners brought about the immense success of and visibility to the project. As of December 2022, the project had recorded a total of €1,662,250 as a contribution in kind by the private and public partners.

5. MONITORING AND EVALUATION

During the implementation period, PCB held several meetings with partners to assess the progress of project implementation and achievement of key milestones against baseline indicators. An end-term evaluation was conducted, and this guided in addressing challenges and taking advantage of any opportunities. It also provided an opportunity for remedial actions.

The final evaluation of the project was commissioned to generate knowledge from the project experience. The project commissioned Devinsight Solutions to conduct the end-of-project evaluation. The evaluation focused on the entire implementation period, with the objective to assess the overall program performance with regard to its objectives and the effectiveness and efficiency of the project.

The evaluation effectively captured lessons learned and provided information on the nature, extent, and effect of the PCB project. The emphasis on lessons brought about an understanding of what worked and what did not work to serve as a guide to future planning and to scrutinize other gaps and opportunities.

The project design and implementation incorporated exit strategies and sustainability measures for after the five years of interventions. The PPP approach of the project was designed with strong linkages to private and public actors in the potato value chain whose engagements and trade continue to thrive after the project life.

The existing relationships between the farmers and seed, fertilizer, agrochemical, and soil testing companies will continue seeing profitable businesses.

The farmer associations acquired strong intangible skills in management, farm commercialization and profitability, and entrepreneurship, as well as the skills required for sustainable agribusiness to thrive.

The ward agricultural officers, lead farmers, SSPs, and other service providers had their capacity built on GAPs in ware and seed potato production, marketing and information intelligence, and climate change and mitigation for sustainable agriculture. The trained team will continually offer extension and education services to other farmers in the county and beyond. Over the phases of project implementation, the process has continually built up a cadre of well-trained extension technicians who have helped create demand for professional extension services by farmers. The lead farmer approach worked well in Nyandarua and was a critical factor in the success of the project.

6. LESSONS LEARNED, BEST PRACTICES, RECOMMENDATIONS, AND CONCLUSION

6.1 Lessons Learned and Best Practices

Risk of investment in seed multiplication

Farmers primarily use local varieties that have satisfactory traits and do not invest in seed potato every season. Although the project reported an increase in the use of clean and certified seeds, the demand and willingness to pay for seed potatoes by farmers every season remained low.

Engagement of sector-wide leadership and advocacy

One of the key lessons learned from PCB was the important role that NPCK plays in sector coordination. In partnership with PCB, NPCK convened a significant number of pre-season dialogues, stakeholder workshops, investment forums, trade fairs, and other events that played an enormous role in improving market linkages among market system actors and facilitating joint responses to threats and challenges. Because these events were organized by NPCK, although often with co-investment by PCB, NPCK's role as a key industry player is largely sustainable.

Investment in public-private partnership

PCB has demonstrated the importance of the PPP model in the delivery of certified seeds, extension services, and soil health technologies to farmers. Working with Kirinyaga Seed Limited and KEPHIS, three new potato varieties that are tolerant to potato blight were introduced into the Kenyan market.

Extension service provision through farmer field business schools

The FFBS model proved successful due to the partnership with the county government. Lead farmers were able to reach more farmers with their farms acting as demonstration sites. This reduced the travel distance to obtain the services of an extension officer and has proved to be an excellent sustainability strategy.

Widely scattered knowledge and technologies

From the learning day events, the project found learned that good information and knowledge were widely scattered among various institutions and researchers. In this regard, information must be packaged in an appropriate form, and strategies for disseminating this through the existing extension channels must be developed. Then, ICT tools must be leveraged, as most farmers have a mobile phone.

Transactions that are untouched by offtakers

In Nyandarua, only 5% of potato produce goes through structured channels and 95% goes through unstructured market channels. These unstructured markets are dominated by brokers who take advantage of farmers because of asymmetrical market information. Therefore, a path is needed to address underlying systemic issues of poor governance in these unstructured markets.

6.2 Recommendations

Pilot initiatives to improve the knowledge and business practices of traders/brokers.

Unstructured markets absorb over 95% of ware potato in Nyandarua. Future projects that avoid working with brokers/traders will significantly limit their results. However, engaging the brokers to improve their business practices to be more transparent and enforce quality and standards is a significant challenge. Future programs should pilot several interventions through an iterative intervention design process to identify how to best support the trading function and shift incentives to improve unstructured market transactions. Then, programs can foster the development of effective business strategies and assist in scaling up.

Operationalize storage facilities.

In future programming, there is a need to come up with a business model for operationalizing the constructed stores so that farmers can make maximum use of them. In the final evaluation, it was found that most of the stores are not fully utilized commercially and sustainably.

Develop a learning agenda.

Future programs should design and implement a learning agenda from the start of implementation to outline specific strategies for achieving internal and external knowledge sharing. Internal learning should focus on building the capacity of the project team to better serve the needs of its private sector partners. The learning agenda should also address all relevant stakeholders in an iterative knowledge-sharing processes. The agenda should incorporate a combination of dynamic

and static knowledge-sharing techniques, such as learning events utilizing participatory strategies and online modules.

Integrate the private sector.

Given that the project's PPP approach was successful, future programs should integrate the private sector for upscaling of technologies and addressing the farm-level institutional and policy barriers to adoption.

Identify and leverage market drivers for gender inclusivity.

To integrate gender cohesively into the market systems approach, future programs should identify and leverage areas where women can be included as market actors.

Incorporate exit strategies and sustainability models.

Exit strategies and sustainability models involving both the private and public sector need to be incorporated early in projects.


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