

Digital tool integration, biodiversity, and the potato value chain in Kenya

Results from a baseline survey

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EXECUTIVE SUMMARY

Potato farmers in Kenya grapple with various challenges along the value chain, including limited access to quality planting materials such as seeds and fertilizers, insufficient storage and postharvest handling facilities, fluctuating market prices, and unreliable market information systems. These challenges are further exacerbated for women and youth because of persistent social gaps in the agriculture sector. Digital tools can play a vital role in addressing these challenges by providing access to valuable agricultural information, weather forecasts, and best practices that help farmers make informed decisions and improve crop management. However, challenges persist in digital tool adoption within the agricultural value chains in sub-Saharan Africa.

The study aims to assess the impact of digital tool adoption and support on socioeconomic and agriculture-related outcomes in Kenya's potato value chain. It piggybacks on an ongoing digital tool integration program, Business Development and Coaching (BDEC), conducted by the Farm to Market Alliance (FtMA), which targets agripreneurs in Farmer Service Centers (FSCs). By comparing a treatment group that receives this training with a control group continuing business as usual, the study evaluates the effects of agripreneurs' adoption and expanded use of digital tools on farmers' agriculture-based livelihoods, income generation, and job creation metrics, with a focus on youth employment and gender disparities.

As shown in the baseline data, potato cultivation is widespread but not universal,¹ with 87 percent of households engaged in production, primarily focusing on a single variety (*Shangi*). However, environmental indicators reveal diverse cropping systems overall, with each household cultivating an average of 4.5 crops, contributing to soil fertility and resilience. Sex-disaggregated data show that food security and dietary diversity outcomes are consistent across gender. However, female-only asset ownership remains limited, particularly for land and advanced digital devices. Indeed, while women are more likely to own basic mobile phones, men dominate smartphone ownership, potentially limiting women's access to advanced digital tools.

Overall, the baseline findings provide a comprehensive overview of the socioeconomic, digital, agricultural, and gender dynamics within Kenya's potato value chain, establishing a robust foundation for future evaluations. The analysis reveals minimal baseline differences between FSCs and households served by BDEC-trained and non-BDEC-trained FSCs, suggesting a strong basis for causal inference in the forthcoming cluster-RCT. While digital tool adoption is widespread among both FSCs and farm households, its use remains largely concentrated in communication and financial applications (apps), with limited uptake of agriculture-specific tools. However, persistent challenges, such as limited smartphone access for women and barriers to app adoption, highlight areas where future targeted interventions could maximize impact. These findings shed light on the potential of digital integration to address structural challenges, promote inclusivity, and foster resilience within Kenya's potato value chain, while reaffirming the critical role of FSCs in particularly BDEC-trained ones, in bridging digital gaps, enhancing service delivery, and supporting farmers in both production and marketing activities.

¹ Non-potato growers are not included in this study.

RÉSUMÉ EXÉCUTIF

Les producteurs de pommes de terre au Kenya sont confrontés à divers défis tout au long de la chaîne de valeur, notamment un accès limité à du matériel de qualité comme les semences et les engrais, des installations de stockage et de manutention post-récolte insuffisantes, la fluctuation des prix du marché et un accès limité à des systèmes d'information fiables. Ces difficultés sont encore exacerbées pour les femmes et les jeunes en raison des inégalités sociales persistantes dans le secteur agricole. Les outils numériques peuvent jouer un rôle essentiel pour adresser ces défis, car ils permettent d'accéder à des informations agricoles précieuses, aux prévisions météorologiques et aux meilleures pratiques, aidant ainsi les agriculteurs à prendre des décisions éclairées et à améliorer la gestion des cultures. Cependant, l'adoption des outils numériques dans les chaînes de valeur agricoles en Afrique subsaharienne continue de poser des problèmes.

L'étude vise à évaluer l'impact de l'adoption et du soutien d'outils numériques sur les résultats socio-économiques et agricoles de la chaîne de valeur de la pomme de terre au Kenya, en s'appuyant sur un programme d'intégration d'outils numériques mené par le PAM/FtMA (Farm to Market Alliance) et ciblant les agripreneurs (Farmer Service Centers -FSCs). En comparant un groupe expérimental bénéficiant de cette formation à l'intégration numérique (BDEC) à un groupe témoin poursuivant ses activités habituelles, l'étude évalue les effets de l'adoption et de l'utilisation croissante des outils numériques par les agripreneurs sur les moyens de subsistance, la génération de revenus et la création d'emplois des agriculteurs, en mettant l'accent sur l'emploi des jeunes et les inégalités entre les sexes.

Sur la base des données de l'enquête de base, la culture de la pomme de terre est répandue, mais pas universelle: 87 % des ménages y participent, principalement sur une seule variété (la variété Shangji). Cependant, les indicateurs environnementaux révèlent une diversité globale des systèmes de culture, avec une moyenne de 4,5 cultures cultivées par ménage, contribuant à la fertilité et à la résilience des sols. Les données ventilées par sexe montrent que les résultats en matière de sécurité alimentaire et de diversité alimentaire sont cohérents entre les sexes. Cependant, en termes de propriété des actifs, la propriété exclusive des femmes reste limitée, notamment pour les terres et les appareils numériques avancés. En effet, si les femmes sont plus susceptibles de posséder des téléphones portables de base, les hommes dominent la possession de smartphones, ce qui limite potentiellement l'accès des femmes aux outils numériques avancés.

Globalement, les résultats de base fournissent un aperçu complet des dynamiques socio-économiques, numériques, agricoles et de genre au sein de la chaîne de valeur de la pomme de terre au Kenya, établissant une base solide pour les évaluations futures. L'analyse met en évidence des différences de base minimales entre les FSC et les ménages desservis par les FSC formés et non formés par le BDEC, suggérant une base solide pour l'inférence causale dans le prochain essai contrôlé randomisé. Si l'adoption des outils numériques est généralisée tant pour les FSC que pour les ménages agricoles, son utilisation reste largement axée sur les applications de communication et financières, avec une adoption limitée des outils spécifiques à l'agriculture. Les données soulignent le rôle essentiel des FSC, en particulier ceux formés par le BDEC, pour combler les fractures numériques, améliorer la prestation de services et soutenir les agriculteurs. Cependant, des défis persistants tels que l'accès limité aux smartphones pour les femmes et les obstacles à l'adoption des applications mettent en évidence les domaines dans lesquels de futures interventions ciblées pourraient maximiser l'impact. Ces résultats mettent en lumière le potentiel de l'intégration numérique pour relever les défis structurels, promouvoir l'inclusion et favoriser la résilience dans la chaîne de valeur de la pomme de terre au Kenya. En outre, ils soulignent également le rôle essentiel des FSC pour combler les écarts numériques, améliorer la prestation de services et soutenir les agriculteurs dans leurs activités de production et de commercialisation.

1. INTRODUCTION

Potato farmers in Kenya grapple with various challenges along the value chain, including limited access to quality planting materials such as seeds and fertilizers, poor storage and postharvest facilities, inadequate transport infrastructure, and pest infestations. These issues lead to low yields, high losses, and market vulnerability as a result of fluctuating prices and unreliable market information (KIPPRA 2025; Kaguongo et al. 2014). These challenges are further exacerbated for women and youth because of persistent social gaps in the agriculture sector, including limited access to finance (Adegbite and Machethe 2020), technology transfer, asset control, productive resources—especially land—and equitable participation in decision-making (Huyer 2016).

Digital tools and platforms can play a vital role in addressing these challenges. They can provide access to valuable agriculture-related information—such as improved methods for land preparation, input use, production, harvesting, postharvesting, and marketing management—as well as weather forecasts and best practices, thereby helping farmers make informed decisions and improve crop management. Mobile apps and platforms can facilitate market access by connecting farmers directly with buyers, reducing the negative impact of price fluctuations, and ensuring fair returns for their produce through more information-based decisions and strategies. Digital tools can also play a crucial role in addressing postharvest losses by providing real-time monitoring and management of storage conditions, helping farmers optimize storage facilities to reduce spoilage and waste. Additionally, digital platforms can provide information on proper postharvest handling techniques, including sorting, grading, and packaging, ensuring that potatoes are prepared for the market with minimal losses.

However, challenges persist in digital tool adoption in Kenya's agricultural value chains. Abate et al. (2023) assess the role of digital innovations in potentially revolutionizing Africa's agricultural markets, highlighting the gap between their promise and real-world scalability. They also point out that, despite high hopes, these technologies often fail to progress beyond small pilot projects to widespread adoption. Aker et al. (2016) likewise note that, despite the potential benefits of information and communication technologies (ICTs) for addressing informational and financial constraints in agriculture, their actual impact on adoption, behavioral change, and welfare remains inconsistent. Similarly, Aker and Cariolle (2022) argue that, despite the introduction of numerous digital public service initiatives—such as mobile money—enabled by the widespread adoption of mobile phones, the expected advantages of digital technology have been slow to manifest across various sectors, notably in agriculture. They attribute this delayed progress to a substantial digital divide arising from inadequate telecommunications and energy infrastructure coverage, particularly in rural areas, along with the high cost of internet services for the broader population and low literacy and numeracy rates.

Previous research by Keenan (2023) focused on evaluating the impacts of the KUZA Leadership Academy on Farmer Service Center (FSC) performance, primarily aiming to understand the determinants of FSC performance and assess whether the Leadership Academy improves FSC business practices and performance. The current project sheds light on the impact of training intensity on FSCs' adoption of digital tools and their capacity to support farmers, but more importantly, it provides a quantitative estimate on the effects of digitally empowered FSCs on outcomes such as postharvest management, farm-level socioeconomic impacts, youth employment, and gender inequality. Moreover, the present research could complement lessons learned from existing data by re-interviewing some of the previously interviewed FSCs. This approach would leverage existing information while expanding the scope of the research by addressing specific objectives.

This study aims to assess the impact of digital tool adoption and support on socioeconomic and agriculture-related outcomes in Kenya's potato value chain. It piggybacks on an ongoing digital tool integration program conducted by the Farm to Market Alliance (FtMA) in Kenya, which targets agripreneurs. By comparing a treatment group that receives this digital integration training with a control group continuing business as usual,² the study evaluates the effects of agripreneurs' adoption and expanded use of digital tools on farmers' agriculture-based livelihoods, income generation, and job creation metrics, with a focus on youth employment and gender disparities. The methodology follows a cluster randomized controlled trial (c-RCT) design and ensures adequate gender- and youth-specific representation across treatment and control groups. Relevant outcome dimensions include agricultural income and employment, crop yields and quality, reduction in postharvest losses, and gender-specific agricultural management.

The paper includes descriptive statistics and cross-tabulations, along with mean-difference tests of key indicators from the baseline survey, providing a reference point for estimating the impacts of the digital integration program on digital tool adoption, poverty reduction, increased biodiversity, food security, livelihoods, and jobs. The rest of the report is structured as follows. Section 2 presents the research questions, methodology, and detailed information on the survey design, coverage, and implementation. Sections 3 and 4 discuss the main analytical results, and Section 5 concludes.

2. RESEARCH QUESTIONS AND METHODOLOGY

2.1. Research questions

The main research questions this study aims to answer are:

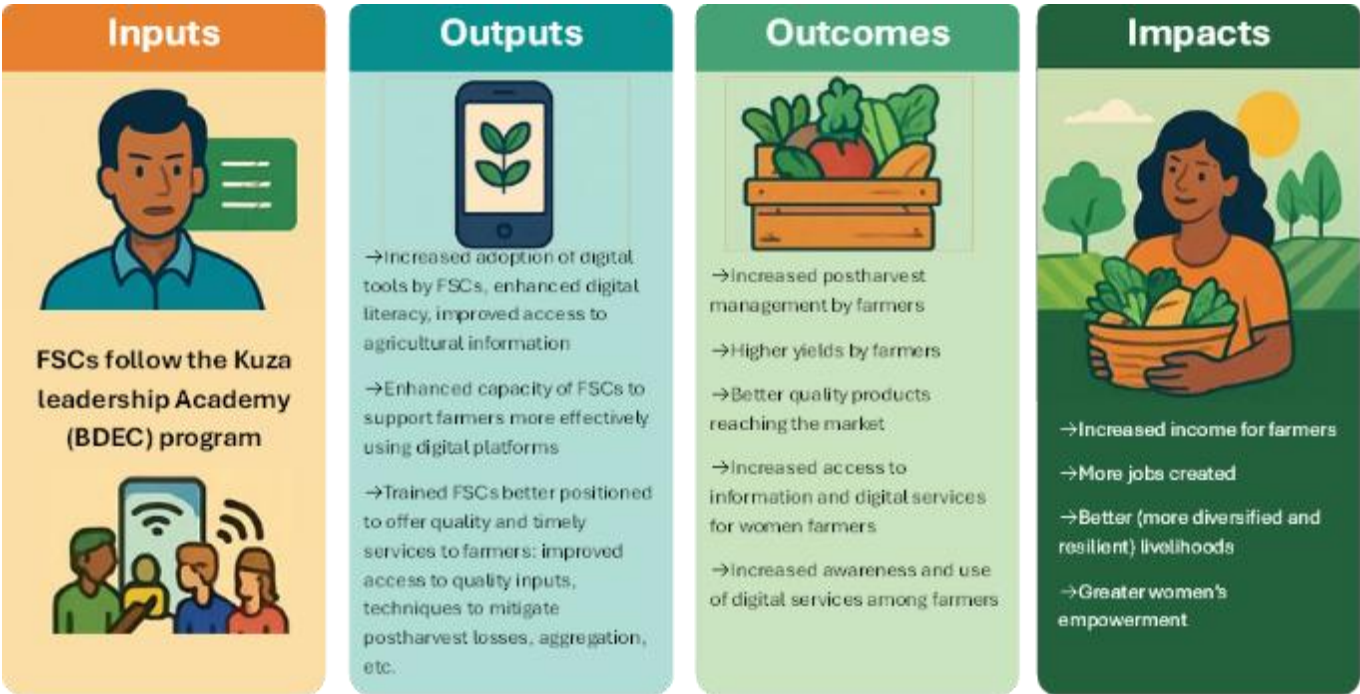
- ▶ How does the intensity of digital tools training impact the adoption of digital tools and literacy among FSCs, and what changes result in their capacity to support farmers effectively?
- ▶ What are the measurable effects of digitally empowered FSCs on serviced farmers' postharvest management, crop yields, product quality, biodiversity, and access to information and services for farmers—including women and youth—and, ultimately, on socioeconomic outcomes such as increased income, job creation, and enhanced livelihoods within agricultural communities?

Figure 1 presents the theory of change illustrating the pathway from inputs to impacts facilitated by the Business Development and Coaching (BDEC) Leadership Academy program. Although the BDEC is self-paced, participation is logged: All topics must be completed before participants can start the activities. In addition, FSC participants are required to take the quizzes and assessments to receive a course completion certificate. Uptake is boosted by three elements: (1) offline content that avoids data-bundle costs, (2) continuous support from dedicated Kuza coaches, and (3) peer-to-peer WhatsApp groups that help sustain motivation. Hindrances include the limited time available for high-performing FSCs. Effective transfer of knowledge from FSCs to farmers depends on business type (input dealer, aggregator, or service provider); engagement with Agribytes video modules, which some FSCs use in farmer training; and access to tools for field demonstrations.

² As further elaborated in Section 2.2, the control group comprises FSCs and the farmers they serve that were not initially exposed to the BDEC digital tools integration training. However, FtMA could train this group through BDEC after the study is completed, as part of future rollout plans to reach additional FSCs.

The basic premise of the BDEC Leadership Academy is that, as FSCs participate in the program, they develop greater digital tool adoption, heightened digital literacy, and improved access to agricultural information, which they can in turn pass on to farmers. This enhanced capacity enables FSCs to support farmers more effectively through digital platforms, offering services such as access to quality inputs, postharvest loss mitigation techniques, and aggregation methods. Consequently, farmers benefit from increased awareness and use of these services, leading to outcomes such as improved postharvest management, higher yields, and better-quality products delivered to the market. In addition, the digitally empowered FSCs facilitate increased access to information and services for women farmers. Ultimately, these outcomes result in significant changes, including higher farmer incomes, additional job creation, more diversified and resilient livelihoods, and greater empowerment of women.

Figure 1. Theory of change



Source: Authors' elaboration from personal communication with Farm to Market Alliance (FtMA) project implementers.
Note: FSCs = Farmer Service Centers; BDEC = Business Development and Coaching.

2.2. Research methodology

To comprehensively assess the impact of digital tools on socioeconomic and agriculture-related outcomes, we conduct a cluster-RCT comprising a treatment arm (G1) and a control group (G2):

- ▶ G1: 2025 BDEC-trained FSCs and their associated farmers (treatment)
- ▶ G2: Non-BDEC-trained FSCs and their associated farmers (control)
- ▶ G3: Previously BDEC-trained FSCs. This group is necessary to conduct additional heterogeneity analysis based on prior exposure to the BDEC program. By interviewing previously trained FSCs, the study can assess long-term effects and identify differences in outcomes, such as digital tool adoption, farmer support, and socioeconomic impacts compared to FSCs trained in 2025 (G1)

and non-trained FSCs (G2).³ This analysis is contingent on previously trained FSCs displaying baseline characteristics similar to those of non-trained FSCs and provides a more nuanced understanding of the BDEC program's impact.

In a nutshell, following the present baseline survey, non-trained FSCs were randomly allocated (stratified by age and gender to ensure balance across groups) to either a treatment arm that receives the 16-module BDEC digital leadership course (G1), or to a control arm that continues business as usual during the study period (G2). A third, non-random "long-exposure" group of FSCs that completed the BDEC program in earlier years (G3) is included only for exploratory heterogeneity checks and is not used in the core impact estimates.

We test two hypotheses:

- ▶ H1: BDEC training increases FSCs' digital tool adoption, literacy, and services provided.
- ▶ H2: Farmers linked to trained FSCs experience improvements in postharvest management,

After the endline survey, we estimate impact as the intention-to-treat difference between G1 and G2, using (1) simple ANCOVA regressions of end-line outcomes on the treatment dummy with baseline values as covariates, and (2) difference-in-differences estimation, where repeated measures are available (with standard errors clustered at the FSC level). In the randomization, contamination is minimized by maximizing geographic separation between treated and control FSCs and their villages of operation, with most control FSCs and their villages located at least 5 km away from any treated FSCs and their villages. Data were collected through primary quantitative baseline and follow-up household surveys, and potato quality assessments were conducted by the National Potato Council of Kenya (NPCK). A study timeline of all the activities is provided in Appendix 1.

3. DIGITAL SERVICES IN KENYA'S AGRICULTURE SECTOR

The study is conducted in partnership with FtMA.⁴ FtMA's primary objective is to assist African smallholder farmers in transitioning to commercial agriculture by providing comprehensive support throughout their journey, from seed to market. This support encompasses access to predictable markets, affordable finance, cutting-edge technologies, quality inputs such as seeds and fertilizers, and effective handling and storage solutions. FtMA's aim is to ensure that farmers can confidently plan, cultivate, store, and sell their crops, enhancing productivity, profitability, and resilience with a focus on empowering young farmers in the agricultural market. The program has been operating in Kenya, Rwanda, Tanzania, and Zambia.

In Kenya, FtMA has been particularly active in assisting smallholder farmers in the potato value chain, especially in Nakuru, Narok, Elgeyo-Marakwet, Meru, and Nyandarua counties. In particular, it operates through FSCs that employ individuals directly from the communities they serve, who serve as a conduit

³ In this report, we compare indicators' values at baseline, whereas after the endline data collection (at the end of 2026), we will measure the impact of FtMA training and activities on farmers' outcomes.

⁴ FtMA is a global consortium comprising public and private organizations, including AGRA, Bayer Crop Science AG, International Finance Corporation, Syngenta Crop Protection AG, Rabobank, Grow Africa, and Yara International ASA.

for knowledge transfer to farmers. These FSCs, operating on a commission-based structure, act as input and output aggregators, helping smallholder farmers access services and linking them with partners and service providers. This model facilitates FSCs' crucial role in bridging the gap among suppliers, farmers, and markets. By organizing farmers for aggregation and quality assurance, FSCs streamline the supply chain from farm to market.

In practical terms, FtMA forges partnerships with reputable agricultural suppliers, buyers, financial service providers, and other relevant entities. It then recruits and trains FSCs, connecting them with these stakeholders. The FSCs, in turn, engage directly with smallholder farmers, delivering inputs, agricultural expertise, and extension services. Concurrently, FtMA employs agribusiness coordinators who collaborate closely with FSCs. These coordinators facilitate connections with additional supply chain participants and gather valuable data to inform decision-making processes. At present, FtMA partners with a network of 1,729 FSCs, of which 1,329 are actively engaged in agricultural activities across 13 counties. Notably, 39 percent of these FSCs are youth between the ages of 18 and 35, while 58 percent are women. Focusing specifically on the potato value chain, FtMA collaborates with 524 FSCs operating in five counties, with 31 percent under the age of 35 and 44 percent of whom are women.

Digital tools play an important role in FtMA's initiatives, aiding FSCs in accessing and using services through digital platforms. In particular, FSCs are reaping numerous benefits from utilizing various mobile applications (apps) that provide critical information, including weather forecasts and information on accessing agricultural inputs such as seeds and fertilizers. These apps facilitate connections with markets, input providers, and mechanization services, enabling FSCs to earn both a stipend upon farmer registration and commissions from services rendered. Additionally, the apps simplify tasks for FSCs, enabling them to efficiently serve multiple farmers and thus increase their income. Communication features embedded in some apps facilitate seamless information-sharing with farmers, while others serve as valuable learning hubs for FSCs. Moreover, certain apps aid both FSCs and farmers in crop monitoring, providing detailed summary reports on the FSCs' activities.

Despite the significant benefits of using digital apps, however, FSCs face several challenges in their use. In particular, many FSCs have limited technical skills required to operate the apps effectively. To address these challenges, FtMA has been implementing the Business Development and Coaching (BDEC) hybrid program facilitated by the Kuza Leadership Academy (Box 1), a novel digital model that pioneers mentorship and coaching for rural agribusiness owners. Structured into 16 sessions, the program offers seamless accessibility without the need for data bundles, thus fostering a guided self-learning approach.

Kuza training is free, and FSCs earn a stipend after registering farmers in the app, as well as a commission from linkages to products and services. Within the Leadership Academy, FSCs gain access to a vast library of more than 400 mentorship videos available in both English and Swahili (Kenya's official languages), alongside peer-to-peer learning and support that promotes a collaborative and enriching environment for skill development and business growth. In addition to the BDEC program, Kuza takes proactive steps by providing interactive video-based guides on good agricultural practices through the Agribytes app for four key crops: potato, maize, sorghum, and soybean. These guides are offered as optional learning modules alongside the BDEC content and are available in both English and Swahili. FSCs have the opportunity to enroll in and engage with these knowledge products, which provide valuable insights and tips on cultivation, pest management, and disease control, further enhancing FSCs' agricultural expertise (FtMA and Kuza 2022).

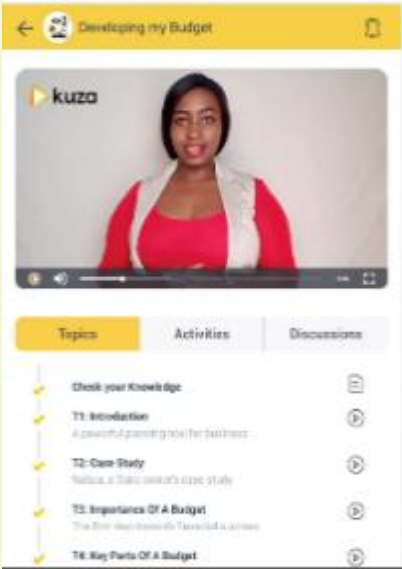
Beyond benefiting personally from the sessions, some FSCs have leveraged the knowledge and skills acquired through the Leadership Academy to train farmers and fellow community members, ensuring

they are equipped with the necessary tools and insights to effectively carry out their activities (FtMA and Kuza 2022). The FtMA FSC rapid digitization survey report, based on information from 90 FSCs, reveals unanimous agreement among FSCs on the importance of training farmers to generate additional income streams.

Box 1. Business Development and Coaching (BDEC) hybrid program

The BDEC program, facilitated by the Kuza Leadership Academy, is a pioneering digital platform offering 16 guided self-learning sessions for rural agripreneurs/Farmer Service Centers (FSCs). FSCs can also access more than 400 mentorship videos in English and Swahili, peer-to-peer learning, and optional Agribytes app modules on good agricultural practices for potato, maize, sorghum, and soybean, fostering skill development and business growth.

BDEC dashboard



Agribytes dashboard

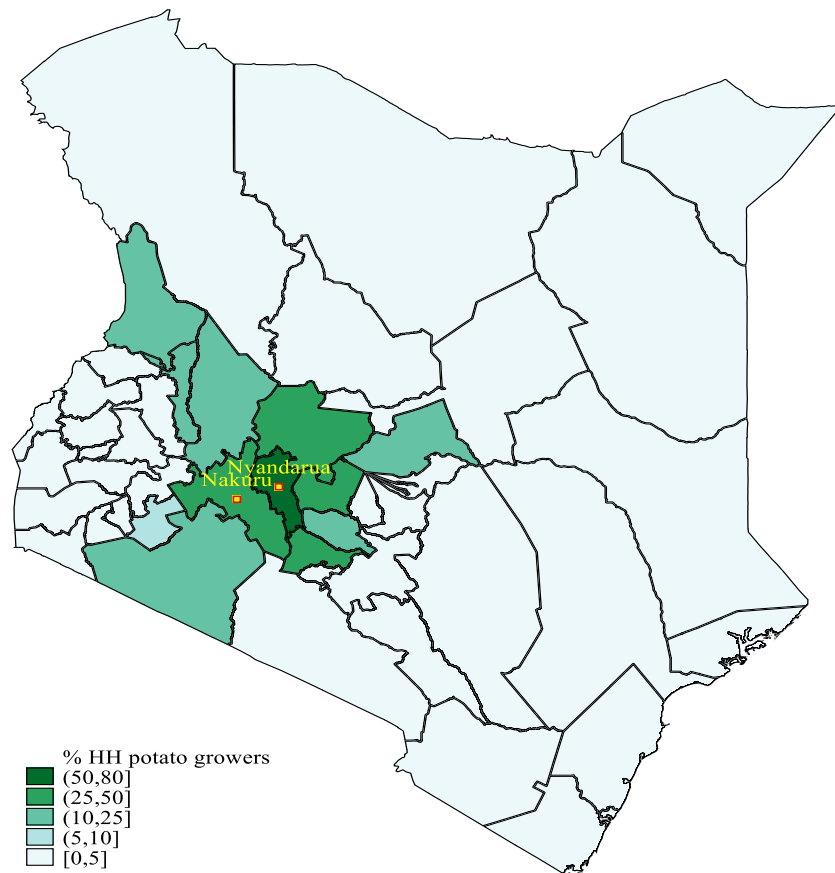


4. THE SURVEY

4.1. Coverage

The Republic of Kenya comprises 47 counties. Each county is divided into subcounties, which are further subdivided into wards, locations, sublocations, and villages. The survey was designed to cover FSCs working in Nakuru and Nyandarua counties, Kenya’s main potato-growing counties (Figure 1). The survey was conducted across the two counties in December 2024.

Figure 1. Potato-growing counties in Kenya (% of potato growers)



Source: 2015/16 Kenya Integrated Household Budget Survey (KIHBS).
Note: HH = household.

4.2. Sample design

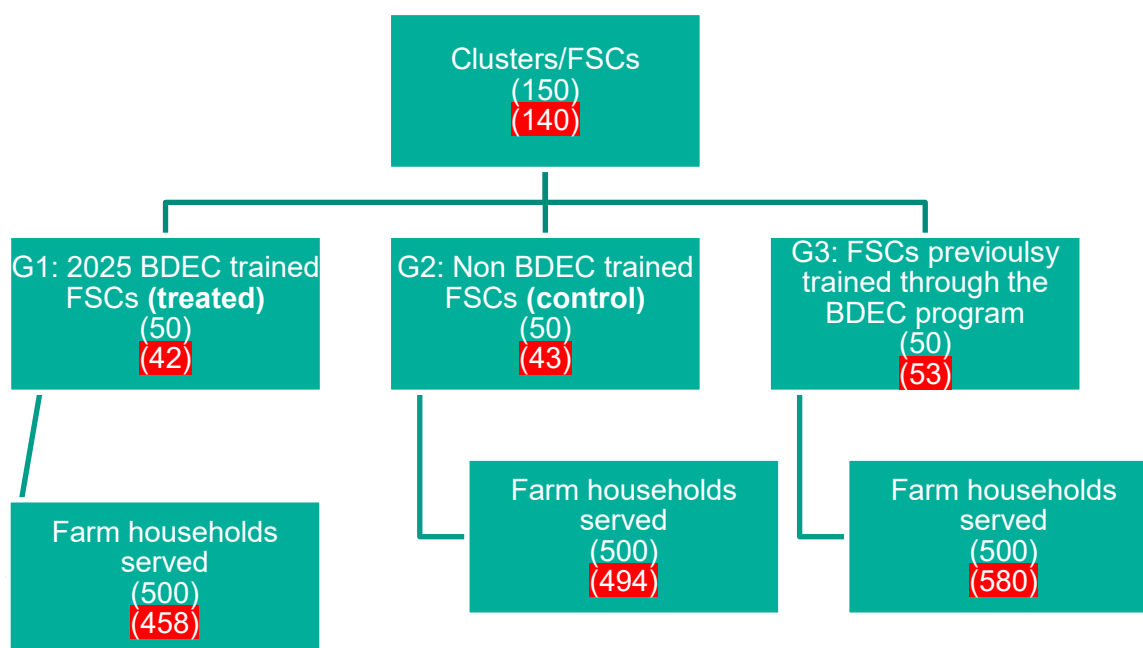
Based on power calculations, the ex-ante total number of FSCs (clusters) and households to be surveyed equaled approximately 150 clusters (FSCs) and 1,500 households. However, the ex-post number of FSCs and associated farm households sampled was different.

- ▶ **FSC survey:** According to monitoring and evaluation data provided by FtMA in June 2024, a total of 158 FSCs were operating in Nakuru and Nyandarua at the time, with 140 serving more than 10 farmers. Given our target of interviewing 150 FSCs, the survey included the entire population of FSCs in the two counties, eliminating the need for sampling and ensuring comprehensive coverage.
- ▶ **Household survey:** Households served by the sampled FSCs were randomly selected from the total population of farmers provided in the FtMA M&E database as of June 2024. With 140 FSCs included in the survey, 11 farmers per FSC were sampled to achieve a target sample size of 1,540 farm households, slightly exceeding the 1,500 required based on power calculations. However, during fieldwork, the data collection team encountered challenges with the outdated sampling frame. FSCs often reported not knowing or serving some of the sampled farmers, while others had relocated or were unavailable for interviews due to the festive period during which the survey

was conducted. As a result, many replacements were necessary, but the survey team successfully completed interviews with a final sample of 1,532 households.

Figure 2 compares the originally designed sample with the actual interviews completed (shown in red) during the survey, while Figure 1 and Table 2 present the detailed distribution of FSC and farmer sample by county and subcounty.

Figure 2. Sample design



Source: Authors' elaboration

Note: FSCs = Farmer Service Centers; BDEC = Business Development and Coaching.

Table 1. Sample distribution of FSCs

County / Subcounty	Total		G1: Treated FSCs		G2: Control FSCs		G3: Previously trained FSCs	
	# obs.	%	# obs.	%	# obs.	%	# obs.	%
Nakuru	53	38%	14	33%	14	31%	25	47%
Kuresoi south	16	30%	4	29%	5	36%	7	28%
Subukia	4	8%			2	14%	2	8%
Njoro	21	40%	8	57%	3	21%	10	40%
Molo	6	11%	1	7%	2	14%	3	12%
Kuresoi north	2	4%			1	7%	1	4%
Bahati	2	4%	1	7%	1	7%		
Rongai	1	2%					1	4%
Gilgil	1	2%					1	4%
Nyandarua	87	62%	28	67%	31	69%	28	53%
Kinangop	20	23%	2	7%	9	29%	9	32%
Ol Jorok	9	10%	3	11%	2	6%	4	14%
Kipipiri	24	28%	11	39%	6	19%	7	25%

Oi Kalau	16	18%	6	21%	5	16%	5	18%
Ndaragwa	17	20%	5	18%	9	29%	3	11%
Nyandarua central	1	1%	1	4%				
Total	140	100%	42	30%	45	32%	53	38%

Source: Authors' elaboration based on the 2024 baseline data.

Note: FSCs = Farmer Service Centers; obs. = observations.

Table 2. Farmer sample distribution

County / Subcounty	Total		G1: Treated FSCs		G2: Control FSCs		G3: Previously trained FSCs	
	# obs.	%	# obs.	%	# obs.	%	# obs.	%
Nakuru	579	38%	153	33%	154	31%	272	47%
Kuresoi South	167	29%	44	29%	49	32%	74	27%
Subukia	44	8%			22	14%	22	8%
Njoro	232	40%	88	58%	33	21%	111	41%
Molo	66	11%	11	7%	22	14%	33	12%
Kuresoi North	28	5%			17	11%	11	4%
Bahati	20	3%	9	6%	11	7%		
Rongai	11	2%					11	4%
Gilgil	11	2%	1	1%			10	4%
Nyandarua	953	62%	305	67%	340	69%	308	53%
Kinangop	224	24%	24	8%	100	29%	100	32%
Oi Jorok	99	10%	31	10%	24	7%	44	14%
Kipipiri	261	27%	120	39%	64	19%	77	25%
Oi Kalau	179	19%	70	23%	55	16%	54	18%
Ndaragwa	185	19%	55	18%	97	29%	33	11%
Nyandarua central	5	1%	5	2%				
Total	1,532	100%	458	30%	494	32%	580	38%

Source: Authors' elaboration based on the 2024 baseline data.

Note: FSCs = Farmer Service Centers; obs. = observations.

4.3. Questionnaires

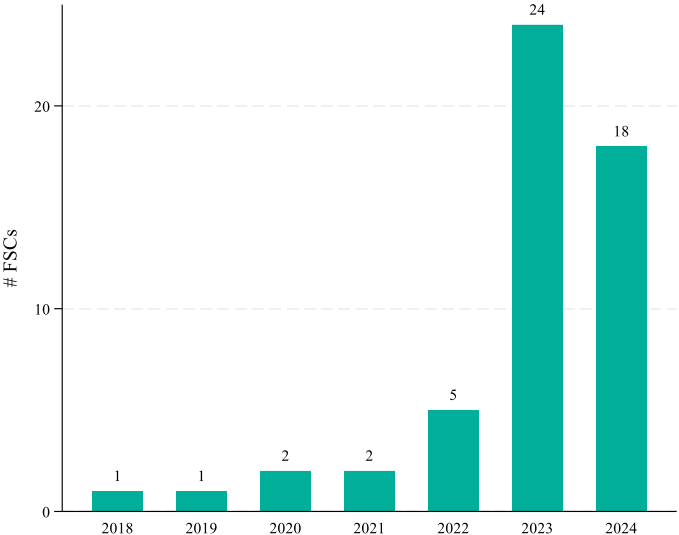
The baseline survey comprised both household- and FSC-level surveys, conducted using separate questionnaires. The FSC survey was designed to comprehensively capture the operations, characteristics, and service delivery of FSCs within the context of their role in the potato value chain. It included several key modules: FSC characteristics, which gathered sociodemographic information; FSC business, focusing on the economic and operational aspects of FSC activities; and services received, documenting the type and extent of support provided by FtMA Kenya to enhance FSCs' capacity. In addition, the questionnaire explored the perceived impact of BDEC training, assessing how participation in the training influenced FSC performance. It also captures details on the services provided by FSCs to farmers, highlighting their role as intermediaries in facilitating access to agricultural inputs, markets, and advisory services. Further, the survey examined the use of digital tools in FSC activities, shedding light on their adoption of technology to improve service delivery. Last, a credit module documented FSC access to financial services, including loans and accounts.

The household survey tool was designed to provide a comprehensive understanding of farming households' livelihoods, agricultural practices, and resilience. It collected detailed information on household composition, employment, and self-employment activities, as well as agricultural practices, including land use, water and energy management, crop inputs and outputs, and potato-specific cultivation practices. The survey also captured households' relationships with FSCs, their access to services, and their use and perception of digital tools in agricultural activities. To assess food security and nutrition, the survey included measures of dietary diversity (Household Dietary Diversity Score [HDDS]), food insecurity (Food Insecurity Experience Scale [FIES]), and women's diet diversity (Minimum Dietary Diversity for Women [MDD-W]). It also examined income sources and asset ownership, including agricultural and ICT assets, and how households adapted to shocks. Together, the survey provides an integrated perspective on the socioeconomic and agricultural dynamics shaping households' roles in the potato value chain.

5. FSC SURVEY: DESCRIPTIVE STATISTICS

As mentioned in Section 4.2, among a total of 140 FSCs, 53 reported having already completed the BDEC training program. As shown in Figure 3, the timeline of participation for these 53 FSCs indicates a gradual increase in the number trained each year, starting with small numbers in earlier years (6 during 2018 and 2021) and a slight increase in 2022 (5). A significant expansion occurred in recent years, with 24 FSCs trained in 2023 and 18 in 2024. This growth reflects the program's scaling efforts and its increasing reach among FSCs.

Figure 3. Number of BDEC-trained FSCs in Nakuru and Nyandarua counties



Source: Authors' elaboration based on the 2024 baseline data.
Note: FSCs = Farmer Service Centers; BDEC = Business Development and Coaching.

Table 3 is limited to the 35 FSCs that participated in the BDEC training between 2018 and 2023, as the latest cohort of FSCs trained in 2024 had only recently completed the program (October 2024) by the time of the baseline data collection (December 2024).⁵

Among the 35 FSCs trained prior to 2024, 100 percent reported increases in digital tool adoption and use, digital literacy, and access to agricultural information, highlighting the program’s effectiveness in equipping FSCs with critical digital skills and resources. Additionally, 91 percent experienced an increase in the number of services they provide to farmers, suggesting that the training positively impacted service delivery capacity.

In the use of mentorship and Agribytes videos, 74 percent of FSCs reported having used the mentorship videos, of which 58 percent did so regularly and 39 percent did so sometimes, indicating high engagement with this resource. Similarly, 74 percent used the Agribytes videos, with particularly high usage for the potato value chain (81 percent), reflecting the crop’s relevance in the region. Additionally, 81 percent shared Agribytes videos with farmers, showcasing the program’s potential to disseminate knowledge and best practices throughout their communities, as hypothesized in our study design.

Table 3. Perceptions of BDEC training by FSCs in Nakuru and Nyandarua counties

Indicator	(1)	(2)	(3)
	Mean		
	Overall	Nakuru	Nyandarua
Since BDEC training (%)			
Adoption/use of digital tools has increased	100	100	100
Digital literacy has increased	100	100	100
Access to agricultural info has increased	100	100	100
# of services provided to farmers has increased	91	94	88
Use of mentorship and Agribytes videos (%)			
Has used the mentorship videos (%)	74	78	71
Rarely (%)	4	7	0
Sometimes (%)	39	43	33
Regularly (%)	58	50	67
Has used the Agribytes videos (%)	74	72	77
For potato (%)	81	77	85
For maize (%)	69	69	69
Has shared the Agribytes videos with farmers (%)	81	92	69
# of observations	35	18	17

Source: Authors’ elaboration based on the 2024 baseline data.

Note: FSCs = Farmer Service Centers; BDEC = Business Development and Coaching.

Table 4 to 13 in this section and the next provide a detailed overview of the descriptive statistics for FSCs and their associated farmers. The tables are organized into columns that present overall averages (column 1), averages for G1 to-be-treated FSCs, or farmers served by G1 FSCs (column 2), and

⁵ Given the short time between the end of the BDEC training and data collection, the 2024 cohort lacked sufficient time to provide meaningful responses about their perceptions of the program’s impact or to have been significantly affected by the training. Therefore, the 2024 cohort was not asked the self-perception questions.

averages for G2 control FSCs (or farmers served by G2 FSCs) (column 3). Column 4 shows the difference in means between columns 2 and 3. Additionally, column 5 provides averages for previously trained FSCs G3 (or farmers served by G3 FSCs), while column 6 shows the difference in means between previously trained (G3) and all other FCSs (G1 and G2).

At the farmer level, statistical significance is denoted by asterisks for columns 4 and 6, as only the farmer survey was designed to be statistically representative. Finally, columns 7 and 8 provide averages for FSCs and farmers based in Nakuru and Nyandarua counties, respectively, allowing for a comparison of regional variations. This report primarily focuses on overall averages and differences among G1, G2, and G3 (columns 1 to 6). It is important to note that these differences provide only a preliminary glimpse into potential variations based on training status, as this is a descriptive analysis of the baseline data. The BDEC intervention, which will be rigorously evaluated through a c-RCT, has not yet been implemented. Therefore, the observed differences cannot be interpreted as causal effects of the training at this stage.

5.1. FSC characteristics and their business

Table 4 shows that the forthcoming treatment (G1) and control (G2) groups are highly comparable at baseline across nearly all dimensions. Average household size, agripreneur’s age, and share of female-led FSCs differ by less than 3 percentage points. In addition, although tertiary education is more common among control FSCs (56 percent vs. 36 percent), this difference is largely offset by the greater prevalence of secondary graduates among future trainees. Business metrics such as years in operation, average number of farmers served (202 vs. 212), proportion of months with high activity (about half the year), receipt of income in the past 12 months (nearly universal around 97 percent), and average workforce size are all strikingly similar, suggesting both groups are observationally comparable at baseline. Credit access is also similar: Roughly 9 in 10 FSCs hold a formal bank account, and about half have applied for and obtained loans, regardless of treatment status.

Financial and entrepreneurial practices such as recordkeeping and cash-flow monitoring exceed 70 percent in both arms, although they lag behind those of the earlier BDEC cohort (G3), whose superior managerial scores might hint at cumulative training benefits. County comparisons reveal only modest contrasts: Nakuru FSCs tend to serve more farmers, yet gender composition, credit uptake, and business intensity remain similar. Overall, the absence of substantial baseline differences between G1 and G2 reinforces the credibility of the forthcoming c-RCT evaluation design, although appropriate balance tests are reported at the farm household level.

Table 4. FSC characteristics

Indicator	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean			Diff. (2)–(3)	Mean	Diff. (5) – [(2) & (3)]	Mean	
	Overall	G1: Treated FSCs	G2: Control FSCs		G3: Previously trained FSCs		Nakuru	Nyandarua
Sociodemographic variables								
FSC household size	4.4	4.4	4	0.4	4.8	0.7	5.2	4
FSC is female (%)	45.7	42.9	44.4	-1.6	49.1	5.4	37.7	50.6
FSC age	43.9	45	42.3	2.7	44.4	0.8	40.8	45.7
Education of FSC (%):								
Never been in school	0	0	0	0	0	0	0	0

Primary not completed	2.1	2.4	2.2	0.2	1.9	-0.4	1.9	2.3
Primary	8.6	4.8	11.1	-6.3	9.4	1.4	9.4	8
Secondary not completed	37.9	35.7	28.9	6.8	47.2	15	41.5	35.6
Secondary	11.4	21.4	2.2	19.2	11.3	-0.2	11.3	11.5
Tertiary	40	35.7	55.6	-19.8	30.2	-15.8	35.8	42.5
FSC business								
# of years as an FSC	3.1	3	3.1	-0.1	3.3	0.3	3.4	3
# of farmers served by FSC	219	202	212	-10	238	31	284	179
FSC business is registered (%)	13.6	14.3	13.3	1	13.2	-0.6	17	11.5
FSC business is co-owned (%)	32.1	33.3	26.7	6.7	35.8	6	34	31
# of months (over the past 12 months) with:								
NO operation	1	1.2	1.2	0.1	0.8	-0.4	1.2	1
LOW operation	5.1	5	5.1	-0.2	5.2	0.2	4.7	5.4
HIGH operation	5.8	5.8	5.7	0.1	6	0.3	6.2	5.7
FSC business has hired workers (%)	69.3	69	62.2	6.8	75.5	10	71.7	67.8
# of workers in FSC business	13.2	7.6	15.9	-8.3	15.3	3.7	15.2	11.9
FSC received income from FSC business, last 12 months (%)	97.1	100	95.6	4.4	96.2	-1.5	96.2	97.7
FSC engaged in other businesses, last 12 months (%)	62.1	61.9	53.3	8.6	69.8	12.3	64.2	60.9
Credit (%)								
Has account at a bank or other formal institution	90	90.5	86.7	3.8	92.5	3.9	90.6	89.7
Has account registered in the name of FSC business	20.7	19	24.4	-5.4	18.9	-3	17	23
Has applied for one or more loans since becoming an FSC	46.4	45.2	42.2	3	50.9	7.3	43.4	48.3
Has obtained loan since becoming an FSC	47.9	45.2	44.4	0.8	52.8	8	43.4	50.6
FSC financial and entrepreneurial skill (%)								
Keeps financial records for FSC business	83.6	76.2	80	-3.8	92.5	14.3	83	83.9
Records every purchase and sale made by business	85	73.8	86.7	-12.9	92.5	12	83	86.2
Able to use records to monitor cash in FSC business	83.6	76.2	82.2	-6	90.6	11.3	84.9	82.8
Regularly uses records to monitor sales	82.9	76.2	82.2	-6	88.7	9.4	86.8	80.5
Sells goods on credit to farmers	54.3	38.1	64.4	-26.3	58.5	6.8	56.6	52.9
# of observations	140	42	45		53		53	87

Source: Authors' elaboration based on the 2024 baseline data.

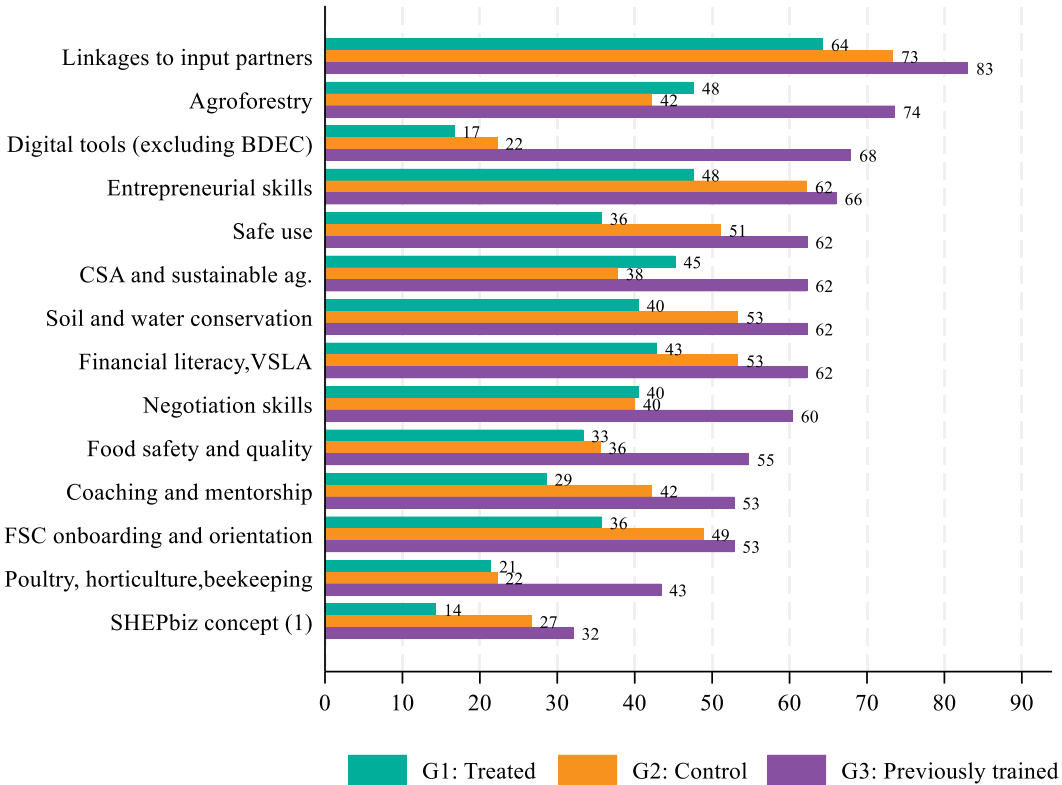
Note: Because of the small sample size, the statistical significance difference in averages cannot be estimated across the FSC groups. FSCs = Farmer Service Centers; BDEC = Business Development and Coaching; Diff. = difference.

Figure 4 highlights the differences in services received by BDEC-trained (orange) and non-BDEC-trained (green) FSCs, showcasing a clear advantage for BDEC-trained FSCs across nearly all service categories. BDEC-trained FSCs report significantly higher access to key services, especially training on digital tools (62 percent vs. 25 percent), but also negotiation skills (62 percent vs. 40 percent), and coaching/mentorship sessions (56 percent vs. 35 percent). These services underscore the comprehensive nature of the BDEC program in equipping FSCs with the skills and tools necessary to enhance their effectiveness. The consistently higher exposure to FtMA services among BDEC-trained FSCs reflects the training program's emphasis on building capacity through diverse and targeted

interventions, focusing on the use of digital tools that, under our hypothesis, likely contributes to their improved performance and preparedness to support farmers effectively.

Figure 4 highlights the differences in services received across the three groups: the new BDEC cohort (G1, green), the controls (G2, orange) and the cohort that completed BDEC in previous years (G3, purple). A consistent pattern emerges. The previously BDEC-trained FSCs exhibit far broader service exposure than either baseline group, topping every category, from basic linkages to input suppliers (83 percent vs. 64 percent in G1 and 73 percent in G2) to more specialized offerings such as agroforestry guidance (74 percent vs. 48 percent and 42 percent) and digital tool training outside the BDEC curriculum (68 percent vs. 17 percent and 22 percent). They are also markedly ahead in entrepreneurial upskilling: 60 percent report FtMA support on negotiation skills and 55 percent on food quality and safety, compared with roughly 40 percent and 33 percent, respectively, among the two BDEC-untrained arms. The gaps between the forthcoming trainees (G1) and controls (G2) in services received are variable but usually favor G2, as the future trainees (G1) outpace G2 in only a few technical service areas (such as agroforestry and climate-smart and sustainable agriculture training), whereas G2 leads in services linked to business formalization (such as financial literacy). Overall, the figure reinforces the conclusion that long-term engagement with the BDEC program is associated with a much richer bundle of FtMA services.

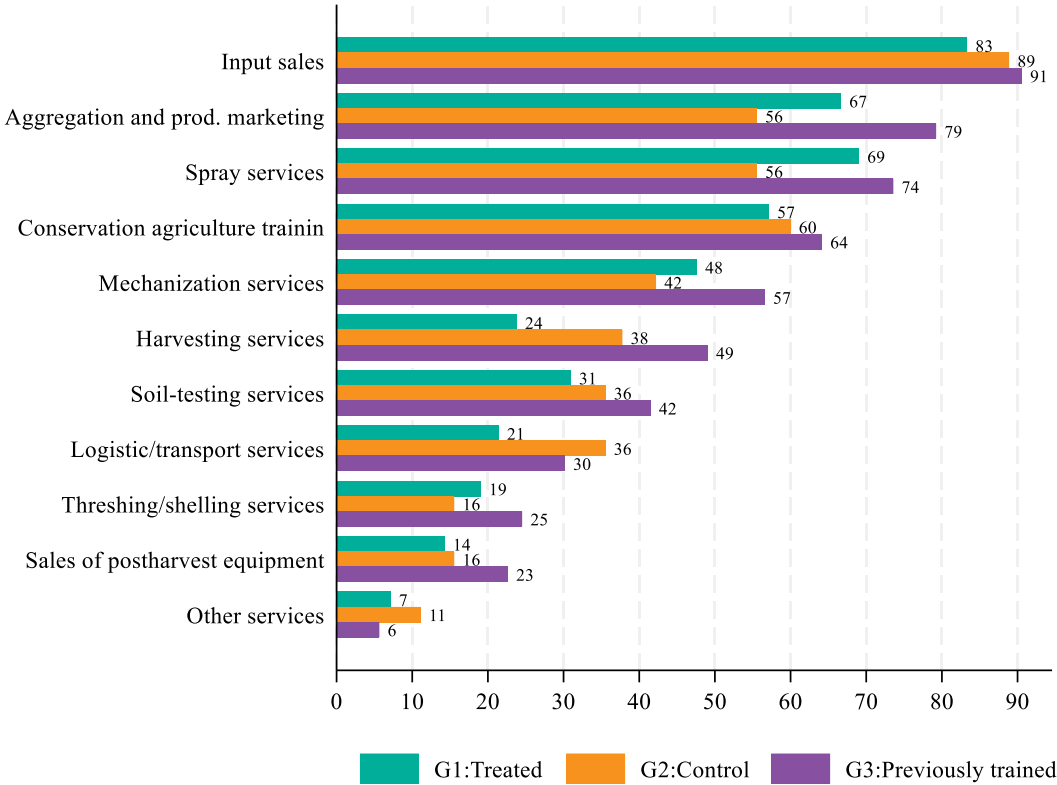
Figure 4. Services received from FtMA (% of FSCs)



Source: Authors' elaboration based on the 2024 baseline data.
Note: (1) The SHEPbiz concept is a training on smallholder farmers' empowerment. FSCs = Farmer Service Centers; BDEC = Business Development and Coaching; CSA = climate-smart agriculture; ag = agriculture; VSLA = Village Savings and Loan Association.

Figure 5 compares the range of services that FSCs currently deliver to farmers and reveals three clear patterns. First, all groups prioritize basic input sales, with uptake exceeding 80 percent and almost no gap between forthcoming trainees, controls, and previously BDEC trained FSCs. Second, once again the previously trained FSCs (G3) consistently outperform the two baseline groups, offering the highest rates across all service categories except logistic and transport services, suggesting that the benefits of the BDEC program accumulate over time. Third, differences between the forthcoming BDEC cohort (G1) and the controls (G2) are modest and service-specific: G1 provides more aggregation and marketing services on average (67 percent vs. 56 percent) and spray services (69 percent vs. 56 percent), whereas G2 leads in harvesting services (38 percent vs. 24 percent) and logistics (36 percent vs. 21 percent). Specialized services such as soil testing, threshing, or sales of postharvest equipment remain under 40 percent across all groups, indicating room for future expansion. Overall, the figure confirms that while the two experimental arms start from a broadly similar service base, extended exposure to BDEC is associated with a markedly richer service portfolio—an encouraging sign that the forthcoming BDEC training round could likewise broaden the scope of support FSCs provide to farmers.

Figure 5. Services provided to farmers (% of FSCs)



Source: Authors' elaboration based on the 2024 baseline data.
Note: FSCs = Farmer Service Centers; Prod = product; Ag = agriculture.

5.2. Use of digital tools in FSC business and BDEC

Table 5 underscores the widespread adoption of digital tools among FSCs. Nearly 86 percent of FSCs already use at least one app for business purposes, with forthcoming BDEC trainees more likely to do so

than controls (86 percent vs. 76 percent). The breadth of app use is similar, as both groups average roughly five apps, yet soon-to-be trainees rely more heavily on communication and mobile money platforms: WhatsApp (79 percent vs. 67 percent) and M-PESA (76 percent vs. 58 percent) dominate the G1 and G2 digital portfolio, alongside higher uptake of SMS and Viazzi Soko apps. In contrast, controls show greater use of other specialist agricultural tools, such as KuzaOne, Hello Tractor, and Yara Connect.

The earlier BDEC cohort provides a useful benchmark: 94 percent use apps—on average more than six per FSC—and show the highest engagement across almost every app category (particularly finance, crop and livestock management, and extension services), suggesting that the training’s effects might accumulate over time. Finance (76 percent) and communication (81 percent) remain the most common functional categories overall, whereas use of mechanization, recordkeeping, and aggregation apps is still emerging, with fewer than one-third of FSCs adopting them. Only 19 percent of FSCs report frequently needing help to navigate apps, although that share rises to a quarter among the previously trained group, perhaps reflecting the more complex digital mix they employ.

County-level differences in use are modest. Nakuru FSCs exhibit slightly higher uptake of input-ordering and finance apps, while Nyandarua leads in the use of recordkeeping tools. Both counties, however, share the dominance of WhatsApp and M-PESA. Overall, these descriptive results confirm a solid digital foundation on which BDEC can build, while highlighting opportunities for the program to deepen the adoption of agronomy-specific applications beyond the current communication and finance core.

Table 5. Use of digital tools in FSC business

Indicator	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean			Diff. (2)–(3)	Mean	Diff. (5)– [(2) & (3)]	Mean	
	Overall	G1: Treated	G2: Control		G3: Previous ly trained		Nakuru	Nyandarua
General use of digital tools								
FSC uses apps for FSC business (%)	85.7	85.7	75.6	10.2	94.3	13.9	84.9	86.2
# of apps used by FSC for FSC business	5.28	4.76	4.84	-0.08	6.06	1.25	5.25	5.3
FSC often needs help to use apps (%)	18.6	14.3	13.3	1	26.4	12.6	17	19.5
Main apps used (%)								
WhatsApp	75.7	78.6	66.7	11.9	81.1	8.7	77.4	74.7
M-PESA	72.9	76.2	57.8	18.4	83	16.4	77.4	70.1
SMS	63.6	66.7	53.3	13.3	69.8	10	60.4	65.5
Facebook	36.4	28.6	35.6	-7	43.4	11.2	39.6	34.5
KuzaOne	23.6	11.9	20	-8.1	35.8	19.8	26.4	21.8
Equity	22.1	21.4	15.6	5.9	28.3	9.9	32.1	16.1
Yara Connect / Yara Bodega	20	9.5	24.4	-14.9	24.5	7.3	15.1	23
Hello Tractor	20	11.9	28.9	-17	18.9	-1.8	22.6	18.4
Viazzi Soko	16.4	21.4	8.9	12.5	18.9	3.9	22.6	12.6
Syngenta	13.6	7.1	13.3	-6.2	18.9	8.5	7.5	17.2
Type of apps used (%)								
Ordering inputs	40.7	38.1	40	-1.9	43.4	4.3	43.4	39.1
Aggregating products	12.1	11.9	11.1	0.8	13.2	1.7	9.4	13.8

Mechanization	22.9	16.7	31.1	-14.4	20.8	-3.4	22.6	23
Extension services	32.9	23.8	28.9	-5.1	43.4	17	35.8	31
Recordkeeping	18.6	16.7	13.3	3.3	24.5	9.6	15.1	20.7
Weather	31.4	28.6	33.3	-4.8	32.1	1	32.1	31
Crop and livestock management	24.3	19	15.6	3.5	35.8	18.6	22.6	25.3
Finance	75.7	76.2	64.4	11.7	84.9	14.8	79.2	73.6
Communication	81.4	83.3	71.1	12.2	88.7	11.7	81.1	81.6
# of observations	140	42	45		53		53	87

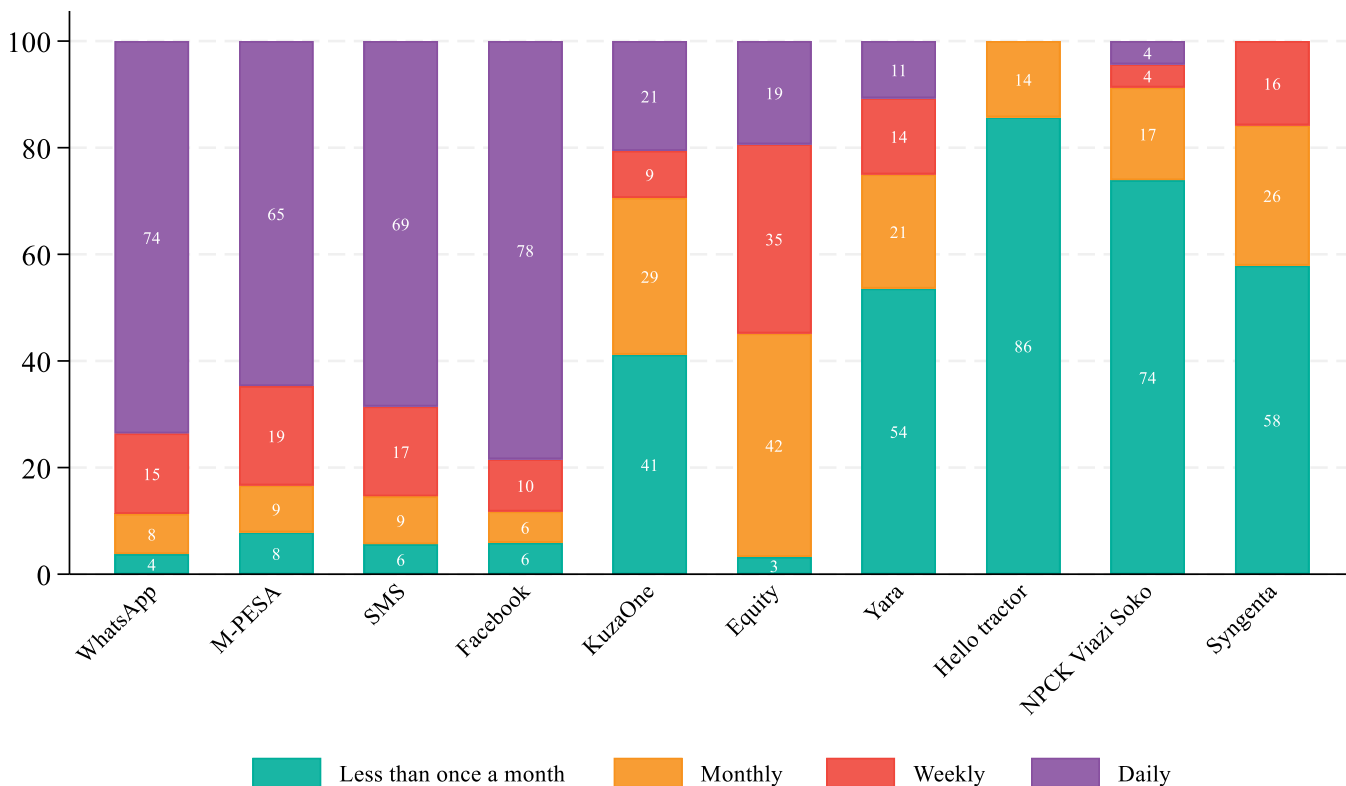
Source: Authors' elaboration based on the 2024 baseline data.

Note: Because of the small sample size, the statistical significance difference in averages cannot be estimated across the FSC groups. FSCs = Farmer Service Centers; Diff. = difference.

Figure 6 illustrates the frequency of use—among app users only—of the top 10 apps used by all FSCs for their business operations cited above. WhatsApp emerged as the most frequently used app (with 74 percent reporting daily usage), highlighting its central role in communication and coordination with farmers and other stakeholders. Similarly, M-PESA, a critical app for financial transactions, shows 65 percent daily usage, signaling its importance among FSCs.

In contrast, more specialized apps such as KuzaOne, aligned closely with BDEC training objectives, show lower daily usage (21 percent), despite exhibiting notable engagement levels at weekly and monthly frequencies. This result indicates that while these apps are valuable for specific purposes, such as agricultural advice and capacity building, their use is not as common in daily operations compared with communication or financial apps.

Figure 6. Frequency of app use among all FSCs (top 10 apps used)



Source: Authors' elaboration based on the 2024 baseline data.

Note: FSCs = Farmer Service Centers.

Apps such as Equity, Hello Tractor, and Viazzi Soko show significant variability in usage patterns. The majority of Hello Tractor users engage with it less than once a month (86 percent), which may reflect its niche functionality related to mechanization and tractor services. Similarly, Yara and Syngenta, primarily associated with input provision and advisory services, show limited daily usage but higher engagement on a monthly or less frequent basis, indicating their supplementary rather than core role in FSC operations.

The variation in app usage frequency underscores the diversity of tools employed by FSCs: Communication and financial apps are integral to daily activities, while agricultural advisory and input-related apps are used as needed.

6. HOUSEHOLD SURVEY: DESCRIPTIVE STATISTICS

6.1. Household characteristics and relationship with FSC

Table 6 provides important sociodemographic and living standard characteristics of the surveyed households. It confirms that farmers linked to the forthcoming BDEC trainees (G1) and those linked to the control FSCs (G2) are statistically comparable across most baseline attributes.

Table 6. Household characteristics

Indicator	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean			Diff. (2)–(3)	Mean	Diff. (5)– [(2) & (3)]	Mean	
	Overall	G1: Treated	G2: Control		G3: Previously trained		Nakuru	Nyandarua
Sociodemographic variables								
HH size	4.6	4.8	4.5	0.3**	4.6	-0.03	5.2	4.3
Female-headed HH (%)	20.4	17	21.1	-4	22.6	3.5	16.6	22.8
Age of HH head	53	53	52.7	0.3	53.1	0.2	49.9	54.8
Ratio of children to adults in the HH	0.53	0.5	0.51	-0.01	0.57	0.07**	0.62	0.48
Marital status (%)								
Married (monogamous)	74.7	78.8	72.5	6.4**	73.4	-2.1	76.7	73.6
Widowed	12.9	10.7	12.3	-1.6	15	3.4*	10.2	14.5
Separated	4.2	3.5	5.3	-1.8	3.8	-0.6	3.6	4.5
Married (polygamous)	2.3	1.7	3	-1.3	2.1	-0.3	3.6	1.5
Divorced	1.5	1.1	1.6	-0.5	1.7	0.4	0.9	1.9
Never married	4.4	3.9	5.3	-1.3	4	-0.7	5	4
Education of HH (%)								
Never been in school	3.1	3.9	2.6	1.3	2.9	-0.3	3.5	2.9
Primary not completed	15.5	14.6	15.6	-1	16	0.9	16.6	14.8
Primary	32.3	34.9	33	1.9	29.7	-4.3*	26.9	35.6
Secondary not completed	8	7.2	7.3	-0.1	9.3	2.1	9.2	7.3

Secondary	27.3	23.4	30.4	-7**	27.8	0.8	27.3	27.3
Tertiary	13.7	15.7	11.1	4.6**	14.3	1	16.6	12
Living standards								
Income and wealth								
Durable asset index (PCA)◆	0.18	0.18	0.17	0.01*	0.18	0.003	0.18	0.18
Total gross household income (KSH)	317,514	319,894	305,983	13,910	325,457	12,781	355,224	294,604
Total net household income (KSH)	190,755	200,997	184,297	16,700	188,167	-4,164	204,007	182,704
Income diversification								
# of different income sources (1)	2.9	2.9	3	-0.04	2.9	-0.03	2.9	2.9
Income diversification index: Gini-Simpson index◆	0.427	0.43	0.426	0.005	0.424	-0.004	0.409	0.437
# of observations	1,532	458	494		580		579	953

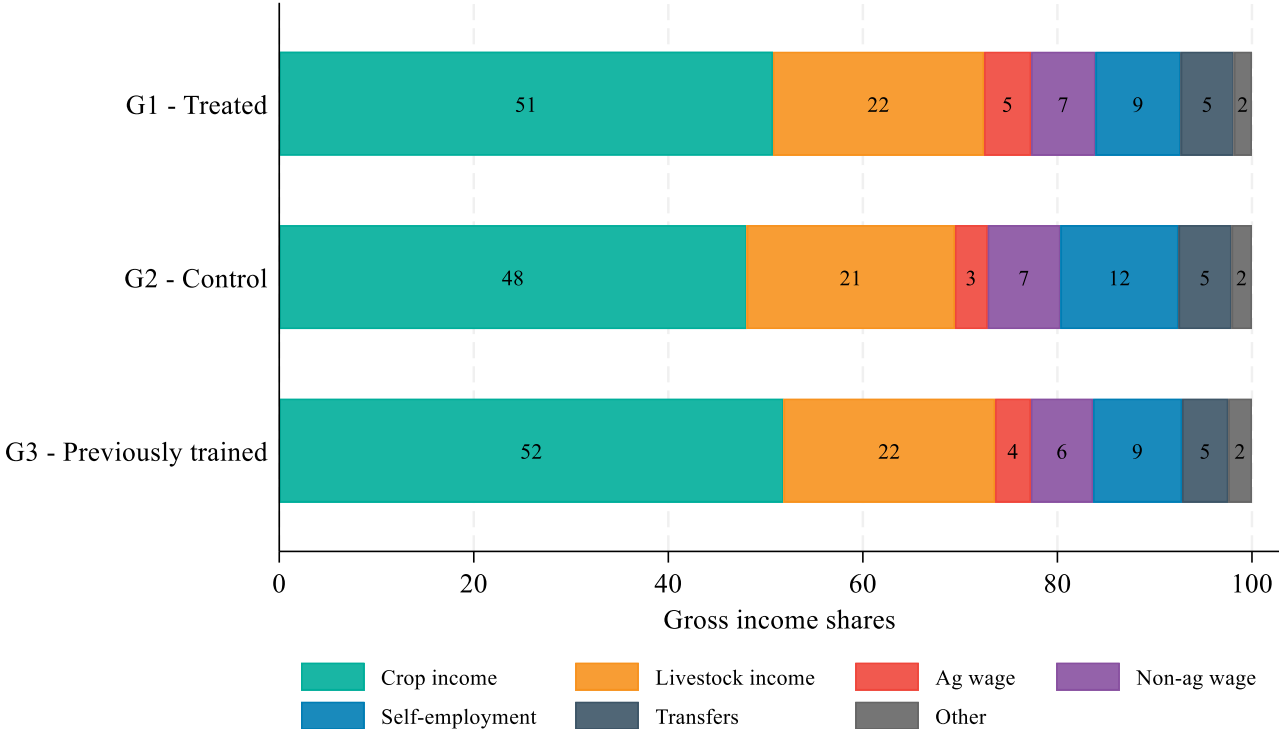
Source: Authors' elaboration based on the 2024 baseline data.

Note: HH = household; Diff. = difference; PCA = principal component analysis; KSH = Kenyan shilling (1), including crop, livestock, self-employment, wage, transfers, and other income sources. ◆ see glossary (Appendix 2). Asterisks indicate statistical significance levels for the t-test of differences in means: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Average household size is 4.8 for G1 and 4.5 for G2, heads of household are in their early 50s, about one in five households is female-headed, and the child-to-adult ratio averages are around 0.5 in both groups. These differences are not statistically significant, except for household size. Marital status is dominated by monogamous unions in both groups, although G1 shows a higher prevalence (79 percent vs. 73 percent). Educational attainment is also similar across groups; indeed, while despite tertiary education is more prevalent among G1 (16 percent vs. 11 percent), this figure is offset by the greater prevalence of secondary education among G2 households. Living-standard indicators mirror this balance: The durable-asset index averages 0.2 for both arms, and neither gross nor net household income differs significantly. Income diversification is likewise uniform, with households reporting around three distinct income sources and a Gini-Simpson index of 0.43. Similarly, there is little variation in socioeconomic indicators between G3 and the non-BDEC-trained FSCs (G1 and G2). County comparisons show that households in Nakuru have higher incomes than their Nyandarua counterparts, reflecting broader regional economic disparities. Overall, the lack of systematic baseline differences between G1 and G2 supports the internal validity of the evaluation design and the forthcoming impact analysis.

Similarly, Figure 7 illustrates the gross income shares for households among the three groups. Crop income dominates everywhere, contributing just over half of total earnings (51 percent for G1 farmers, 48 percent for G2 farmers and 52 percent for G3 farmers), while livestock income accounts for about one-fifth (21 percent to 22 percent). The remaining income is distributed across a series of secondary sources: Agricultural wages contribute to only 3 percent to 5 percent, nonagricultural wages 6 percent to 7 percent, self-employment 9 percent to 12 percent, transfers 5 percent, and other income 2 percent. The near-identical shares for every category confirm that households served by treatment and control FSCs share a similar livelihood structure, reinforcing the credibility of the forthcoming experimental design. The previously trained group exhibits the same profile, suggesting that any future income gains attributable to BDEC are likely to arise from growth within existing activities (particularly crops and livestock) rather than from a fundamental reordering of income sources—or that a potentially higher difference has yet to materialize for most previously BDEC-trained FSCs, given their very recent participation in the program.

Figure 7. Household gross income shares



Source: Authors' elaboration based on the 2024 baseline data.
Note: Ag = agriculture.

Table 7 provides insights into farmers' relationships with FSCs, focusing on the frequency of service use and their perceptions of FSC digital literacy. 39 percent of all respondents interact with an FSC less than once a month, another 36 percent do so monthly, and fewer than 15 percent engage weekly or more. Usage patterns are comparable for G1 farmers and G2 farmers: The shares associated with weekly, fortnightly, or daily visits differ by barely two percentage points, and the only statistically detectable gap refers to a lower incidence of monthly interactions among the G1 cohort. In contrast, G3 farmers report significantly more frequent contact at the monthly cadence.

Indicators of perceptions of digital competence are all balanced across the two experimental arms: 40 percent in G1 and 42 percent in G2 assess their FSC's digital literacy as excellent, and fewer than 2 percent deem it poor. G3 farmers score slightly higher, with five percentage points more in the excellent category than either baseline group.

Farmers in Nakuru and Nyandarua exhibit slight differences. Nakuru farmers are slightly less likely to report using FSC services regularly but are more likely to perceive FSC digital literacy as excellent (48 percent) compared to farmers in Nyandarua (41 percent). These variations may reflect regional differences in FSC engagement and availability of digital resources.

Table 7. Relationship with FSCs

Indicator	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean			Diff. (2)–(3)	Mean	Diff. (5)– [(2) & (3)]	Mean	
	Overall	G1: Treated	G2: Control		G3: Previous ly trained		Nakuru	Nyandar ua
Frequency of FSC services use (%)								
Daily	2.9	3.6	2.6	1	2.7	-0.4	2.1	3.4
Weekly	11.7	13.2	11	2.2	11.1	-1	10.7	12.3
Fortnightly	10.5	10.7	9.4	1.3	11.5	1.5	12.7	9.2
Monthly	36	29.9	36.8	-6.8**	40.2	6.7**	32	38.3
Less than once a month	38.9	42.6	40.3	2.4	34.6	-6.8* *	42.5	36.7
HH perception of FSC digital literacy (%)								
Excellent	43.5	40.4	42.4	-2	46.9	5.5*	47.8	40.9
Good	38.8	41.4	38.6	2.7	36.9	-3.1	37.2	39.8
Fair	15.7	16.2	17.1	-0.9	14.1	-2.5	12.7	17.5
Poor	1.9	2	1.9	0.2	1.8	-0.1	2.1	1.8
Very poor	0.08	0	0	0	0.2	0.2	0.21	0
# of observations	1,300	392	424		484		482	818

Source: Authors' elaboration based on the 2024 baseline data.

Note: FSCs = Farmer Service Centers; Diff. = difference. Asterisks indicate statistical significance levels for the t-test of differences in means: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

6.2. Ownership and use of digital tools

Table 8 provides insights into household ownership and use of digital tools, adoption challenges, and perceived benefits of using apps, particularly in potato cultivation. It paints a mixed picture of digital engagement, revealing high baseline ownership but limited use of agriculture-specific apps. Basic access is almost universal, with 74 percent of households owning a mobile phone and 71 percent already using an app in their farming, with no statistically meaningful differences between G1 farmers and G2 farmers. Smartphone penetration is around 71 percent on average, but ownership of laptops, tablets, or desktop computers remains below 6 percent, underscoring the fundamental role of handheld devices. Among farmers not using apps, the dominant barriers reported are lack of awareness (72 percent) and weak digital literacy (53 percent), while poor connectivity trails well behind.

Finance and communication tools (principally M-PESA, WhatsApp, and SMS) account for most of the usage (65 percent and 36 percent, respectively) and again show no significant G1 and G2 gaps. In contrast, adoption of truly farm-focused apps (weather, input ordering, recordkeeping, extension services, crop management, and mechanization) remains below 5 percent, indicating that such tools are far more common among FSCs than among the farmers they serve. Reported challenges reinforce this digital divide: More than half the sample cites inadequate skills, and almost half mention data costs, with little variation across experimental arms.

However, G3 farmers show statistically significant differences in their greater appreciation of potential benefits, especially toward apps with enhanced market access benefits, improved decision-making, cost reductions, and agronomic improvements, pointing to higher expectations even before training effects

materialize. These results highlight two opportunities for BDEC: (1) Leverage digitally competent FSCs to raise farmers' baseline literacy and awareness; and (2) shift app portfolios from a narrow focus on payments and messaging toward richer agronomic and management functions that can unlock further benefits.

Table 8. Ownership and use of digital tools

Indicator	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean			Diff. (2)– (3)	Mean	Diff. (5)– [(2) & (3)]	Mean	
	Overall	G1: Treated	G2: Control		G3: Previous ly trained		Nakuru	Nyan darua
Ownership and general use of digital tools								
HH owns mobile phone (%)	74	76.2	72.1	4.1	73.8	–0.3	72.7	74.7
HH owns smartphone (%)	70.6	70.3	73.7	–3.4	68.3	–3.8	71.5	70.1
HH owns laptop (%)	5.2	5.5	3.4	2	6.6	2.1*	6.9	4.2
HH owns tablet (%)	1.6	1.5	1.2	0.3	1.9	0.5	2.4	1
HH owns desktop computer (%)	0.5	0.2	0.4	–0.2	0.7	0.4	0.7	0.3
HH uses apps for farming activities (%)	71.3	72.3	69.4	2.84	72.1	1.27	72.9	70.3
HH often need someone else's help to use apps (%)	8.6	8.2	8.3	–0.1	9.3	1	7.2	9.6
Reasons for not using apps (%)								
Lack of awareness	71.5	71.9	73.1	–1.2	69.7	–2.8	70.4	72.2
Lack of digital literacy	52.9	52.9	55.2	–2.3	50.7	–3.5	57.2	50.4
Don't see benefits	12	12	14	–2	11	–2	14	11
Poor connectivity	4.8	5.8	6.2	–0.4	2.6	–3.4	3.9	5.3
Prefers traditional methods	22.7	19	22.8	–3.8	25.7	4.6	19.7	24.4
Type of apps used (%)								
Finance	65.2	67.9	63.6	4.3	64.5	1.2	68.2	63.4
Communication	36	36.9	33.4	3.5	37.6	2.5	38.3	34.6
Weather	4	3	5	–1	3	–1	3	4
Ordering inputs	1.9	2.4	1.8	0.6	1.6	–0.5	1.7	2
Recordkeeping	0.8	0.9	1.2	–0.3	0.5	–0.5	1	0.7
Extension services	0.7	0.7	0.8	–0.2	0.5	–0.2	0.5	0.7
Aggregating products	0.6	0.9	0.2	0.7	0.7	0.2	0.9	0.4
Crop and livestock management	0.6	0	1	–1**	0.7	0.2	0.2	0.8
Mechanization	0.5	0.9	0.6	0.3	0.2	–0.6	0.5	0.5
Other	0.3	0.2	0	0.2	0.7	0.6*	0	0.5
Challenge in adopting/using digital tools for farming (%)								
Lack of digital literacy	51.6	53.3	51.8	1.5	50.2	–2.3	47.8	53.9
High cost of devices/data	47	48.5	48.4	0.1	44.7	–3.8	45.4	48
Difficulty in using complex apps	24.9	28.2	21.1	7.1**	25.5	1	23.8	25.5
Lack of trust in digital information	20.6	23.1	20.6	2.5	18.4	–3.4	20.2	20.8
Poor internet connectivity	13.4	12.9	16.2	–3.3	11.6	–3*	15.2	12.4
Lack of relevant content in local language	7.8	7.4	6.9	0.5	8.8	1.7	7.8	7.8
Other	3.7	3.5	3	0.5	4.3	1.1	3.3	3.9
Benefits of app use in potato cultivation (%)								
Time-saving	51.5	55.2	51.6	3.6	48.4	–4.9*	50.6	52
Enhanced market access and pricing	37.8	42.4	34.2	8.1***	37.2	–0.9	35.8	39

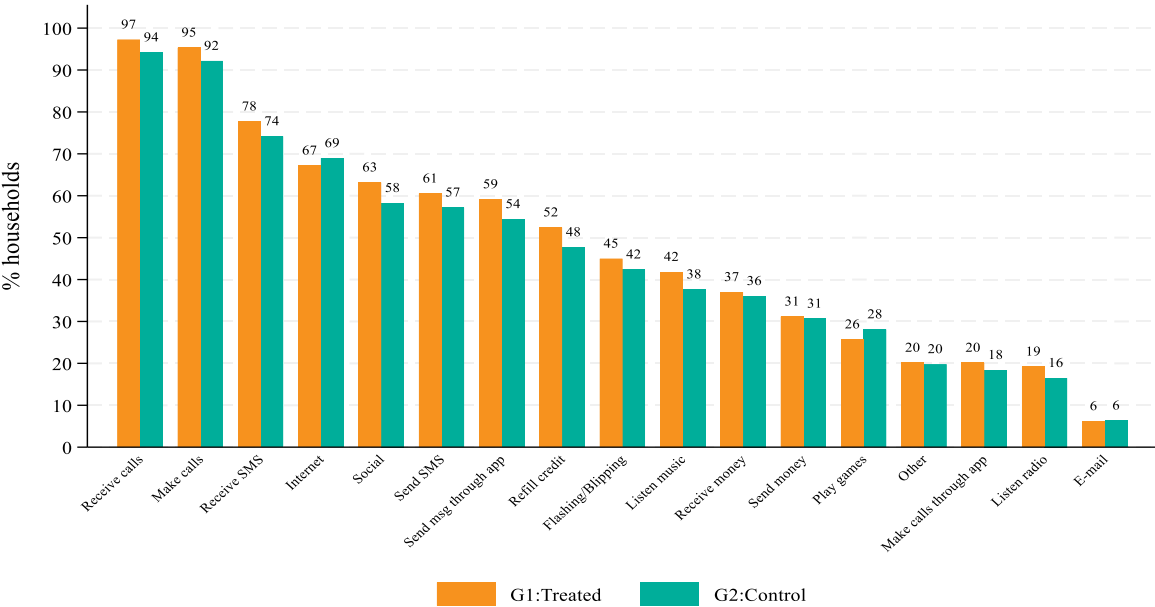
Improved decision-making	30.6	37.3	27.3	10***	28.1	-4*	27.1	32.7
Cost reduction	28	31.4	25.7	5.7*	27.2	-1.2	26.3	29.1
Enhanced customer engagement	21	24	19	6**	22	0	23	20
Increased crop yield	16.3	17	16.2	0.8	15.7	-0.9	14.9	17.1
Better resource management	14.2	14.8	12.6	2.3	15	1.3	13.6	14.5
Improved crop quality	11.9	15.1	9.3	5.8***	11.6	-0.5	11.2	12.3
Enhanced pest and disease management	13.1	16.6	12.1	4.4*	11.2	-3.1*	12.6	13.4
Other	4.8	4.6	4.9	-0.3	4.8	0.1	4	5.2
None	5.4	5	6.3	-1.3	4.8	-0.8	4.5	5.9
Don't know, N/A	1.8	1.3	1.6	-0.3	2.2	0.8	1.4	2
# of observations	1,532	458	494		580		579	953

Source: Authors' elaboration based on the 2024 baseline data.

Note: HH = household; Diff. = difference. Asterisks indicate statistical significance levels for the t-test of differences in means: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Figure 8 presents a detailed breakdown of household usage of ICT devices, highlighting their specific functionalities among households associated with the forthcoming BDEC trainees (G1, orange) and the controls (G2, green), with overlapping frequency bars across the two groups. Basic communication functionalities are universal: 97 percent of G1 and 94 percent of G2 use a phone to receive calls, while 95 percent and 92 percent, respectively, make calls, followed by widespread reliance on SMS (receiving: 78 percent vs. 74 percent; sending: 61 percent vs. 57 percent). Internet access (around 68 percent) and social media engagement (63 percent vs. 58 percent) are similarly distributed in both arms, confirming that most households already use ICTs for information and networking. App-based messaging (59 percent vs 54 percent) and airtime top-ups (52 percent vs. 48 percent) also register substantial uptake. Financial transactions via mobile channels are well established: About 37 percent use ICTs to receive money and 31 percent to send it, mirroring earlier findings on the dominance of M-PESA. Entertainment ranks next: Roughly 40 percent listen to music and just over one-quarter play games, with only minor G1 and G2 differences. In sum, the figure underscores highly similar communication and finance-oriented digital behavior at baseline among treatment and control households, providing a solid platform for assessing whether BDEC can push farmers beyond basic services toward more sophisticated, agriculture-specific digital tools.

Figure 8. Prevalence of households using ICTs (%)



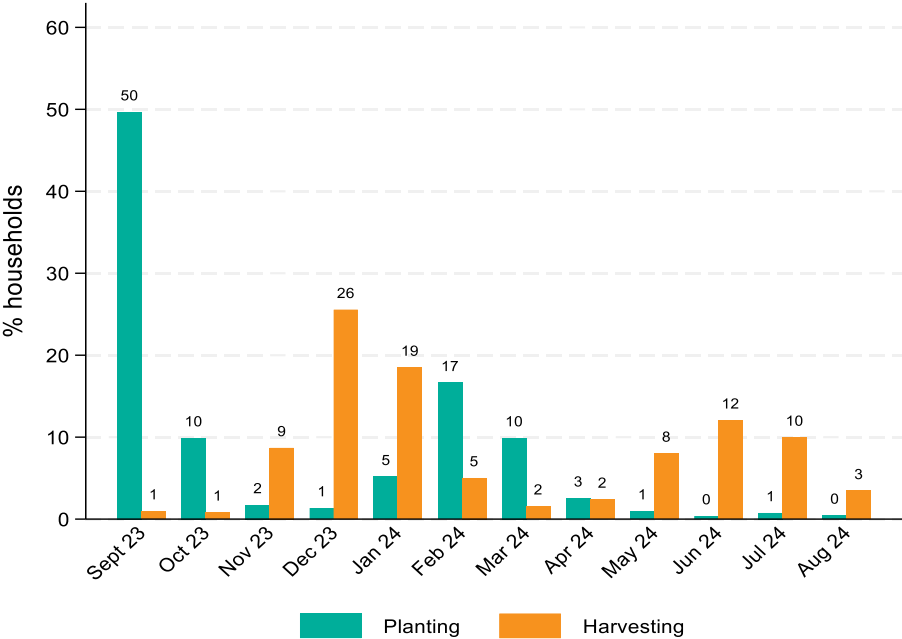
Source: Authors' elaboration based on the 2024 baseline data.
Note: ICTs = information and communication technologies.

6.3. Potato cultivation, environmental health, and biodiversity

Error! Reference source not found. highlights the distribution of potato planting and harvesting activities across the 12-month period (September 2023 to August 2024) prior to data collection. Potato cultivation in Kenya occurs in two main seasons, corresponding to the country’s bimodal rainfall patterns. Within our study population, the first planting season corresponded to the period September/October 2023 and was followed by harvesting in December 2023/January 2024, with 60 percent of households planting in September/October 2023 and 45 percent harvesting in December 2023/January 2024, the later period aligning with the short rains. The second planting season occurred in February/March 2024, with 27 percent of households planting during these months. This was followed by the harvesting season in June/July 2024, when 22 percent of households harvested their potatoes, corresponding to the long rains, ensuring a second production cycle in 2024.⁶

⁶ The data allowed for only one answer for “when did you start” planting and harvesting; hence, these percentages might be affected by the combined single answer per household (not broken down between major and minor seasons).

Figure 9. Potato-planting and harvesting dates (September 2023–August 2024)



Source: Authors' elaboration based on the 2024 baseline data.

Further exploring other aspects of potato cultivation, Table 9 reveals that while potato farming is widespread among households surveyed, with 87 percent growing potatoes, not all farmers are involved in potato production. *Shangi* remains the dominant variety grown by nearly all potato growers (89 percent). Soil analysis is relatively uncommon, with only 11 percent of households reporting its use, though this percentage is significantly higher among G3 households served by previously BDEC-trained FSCs (16 percent vs. 9 percent).

Box 2: *Shangi* potato variety

The *Shangi* potato variety is popular in Kenya due to its fast maturity, relative disease resistance, and high yields (30,000 kg to 40,000 kg per acre). It dominates more than 80 percent of the potato market and is valued for both table and industrial use. However, it has a short shelf life of less than a month, with postharvest losses caused by sprouting, weight loss, and greening. Harvesting peaks in January to March and August to September, often leading to market oversupply and price drops, followed by price spikes due to scarcity. Limited storage options force farmers to sell quickly at low prices, making them vulnerable to opportunistic buyers (Irungu et al. 2022, NPCK 2021).



Source: Study field visit, March 11–12, 2024.

Input-intensity indicators diverge only at the margin: Both groups apply fertilizer about twice per year and pesticides roughly four times, but G1 records a statistically higher spray count (2.6 vs. 2.2 applications of fertilizer and 4.2 vs. 3.8 applications of pesticide and herbicides). The main statistically significant difference lies in planting material: G1 farmers are less likely than G2 farmers to rely on certified seed (33 percent vs. 40 percent). Mechanization is limited overall: Just around 23 percent of households use machinery for land preparation, and group contrasts are small, although G1 shows marginally greater uptake for ploughing and mounding.

Virtually all producers sell directly from the farm gate, with half transacting with brokers and the other half with traders. Around 79 percent of households commercialize at least part of their harvest and market an average 59 percent of crop value. However, there are statistically significant contrasts in how G1 and G2 farmers reach potato markets. G1 farmers are more likely to sell at the farm gate (98 percent vs. 95 percent) and to transact primarily with brokers (65 percent vs. 45 percent). Conversely, G2 farmers rely more on local market stalls (8 percent vs. 3 percent) and on traders rather than brokers (53 percent vs. 37 percent). These differences translate into higher overall market participation and a larger marketed share of harvest among treatment group (G1) households. Taken together, data suggest that farmers served by the soon-to-be-trained FSCs are starting from a more commercialized position relying on brokers, whereas those in the control arm are more integrated into organized local markets.

Table 9. Potato cultivation

Indicator	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean			Diff. (2)–(3)	Mean	Diff. (5)– [(2) & (3)]	Mean	
	Overall	G1: Treated	G2: Control		G3: Previously trained		Nakuru	Nyandarua
HH potato cultivation								
HH grows potatoes (%)	87.1	89.3	87.7	1.6	85	–3.4*	80.1	91.4
# of different potato varieties grown	1	1	1.1	–0.1**	1	0	1	1.1
<i>Shangi</i> variety	89	89	91	–2	87	–3*	83	92
Super <i>Shangi</i> variety	11.9	13.2	9.9	3.3	12.6	1.1	9.7	13.1
Dera Mwana (local) variety	7.4	7.6	8.3	–0.7	6.5	–1.5	10.8	5.6
Stephen (local) variety	3	0.7	3.7	–3***	4.3	2**	7.8	0.5
Other varieties	1.2	0.7	0.7	0	2	1.3**	1.3	1.1
HH obtained soil analysis (%)	11.4	8.3	11.3	–3	14	4.1**	15.3	9.3
Irrigation method in potato cultivation (%)								
None	80.9	81.9	80.8	1.1	80.2	–1.1	76.9	83.3
Other	6.3	7.4	6.9	0.5	4.8	–2.3*	3.3	8.1
# of fertilizer applications in a year	2.3	2.6	2.2	0.3**	2.2	–0.2	2.2	2.4
# of pesticide/herbicide applications in a year	3.9	4.2	3.8	0.4*	3.7	–0.2	4.5	3.5
Planting material (%)								
HH mainly used seeds	39.1	33	40	–6.9**	43.4	6.8**	40.9	38.1
HH mainly used ware potatoes	53.2	59.4	52.4	7**	48.7	–7.1**	48.5	55.7
HH mainly used both seeds and ware potatoes	7.7	7.6	7.6	0	7.9	0.3	10.6	6.2
HH used mechanical equipment for... (%)								

Land preparation	22.8	23	23.6	-0.6	21.9	-1.4	25.4	21.4
Ploughing	21.4	22.2	17.3	4.9*	24.3	4.6**	28	17.9
Transportation	5.5	6.6	6.5	0.1	3.9	-2.7**	7.1	4.7
Chemical application	3.9	4.9	3.5	1.4	3.4	-0.7	4.3	3.7
Mounding	1.9	3.2	1.4	1.8*	1.2	-1	3.2	1.1
Planting	1	1	1	0	0	-1**	1	0
Harvesting	1	0.5	0.9	-0.4	1.4	0.7	1.9	0.5
Fertilizer application	0.9	1.2	1.4	-0.2	0.2	-1.1**	0.9	0.9
Weeding	0.4	0.5	0.7	-0.2	0	-0.6*	0.6	0.2
Market access								
Main selling place (%)								
On farm	96.8	97.9	94.7	3.2**	97.7	1.4	97.7	96.3
Local market	5.1	3.3	7.8	-4.5**	4.3	-1.2	3.6	6
Other	0.8	0.9	1.3	-0.3	0.3	-0.8	0.5	0.9
Main buyer (%)								
Broker	53.1	65.3	45.3	20***	49.2	-6.2*	67.8	44.4
Trader	47.4	37.4	52.5	-15.1***	51.5	6.7**	34	55.3
Farmer/consumer	7.1	4.9	11.9	-7***	5.1	-3.2*	4.9	8.4
Potato market participation (= 100 produces and sells; = 0 produces and does not sell)	79	81.4	75.1	6.3**	80.3	2.1	84.2	76.2
Potato marketed share (value of harvest) (%)	58.9	61	54.9	6.2**	60.8	2.9	67.7	54.2
# of observations	1,337	409	434		494		465	872

Source: Authors' elaboration based on the 2024 baseline data.

Note: HH = household; Diff. = difference. Asterisks indicate statistical significance levels for the t-test of differences in means: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Table 10 shows the challenges faced by potato-growing households during cultivation and the pre- and postharvest stages. Diseases emerge as the most common challenge, reported by 58 percent of households, cited by 63 percent of G1 farmers vs. 57 percent of G2 farmers. G1 farmers also report markedly higher exposure to frostbite (61 percent vs. 44 percent), although the two groups show similar statistics on flood, rot, infestations, and drought exposure. These agronomic stresses translate into greater preharvest losses for G1 (68 percent vs. 60 percent). In contrast, overall experience of postharvest losses does not differ, but the underlying reasons do, with spillage far less common among G2 farmers (18 percent vs. 8 percent), hinting at differing handling practices even before training begins.

Regional patterns mirror local agroecology: Nyandarua farmers are far more prone to flooding (36 percent vs. 18 percent in Nakuru) and to preharvest losses overall (67 percent vs. 52 percent), whereas Nakuru faces slightly higher disease pressure. Meanwhile, households served by FSCs that previously completed BDEC (G3) report significantly lower incidence of exposure to frostbite, floods, and preharvest losses, suggesting that sustained engagement with the program could mitigate some production risks.

Table 10. Challenges in potato cultivation

Indicator	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean			Diff. (2)–(3)	Mean	Diff. (5)– [(2) & (3)]	Mean	
	Overall	G1: Treated	G2: Control		G3: Previous ly trained		Nakuru	Nyand arua
Main challenges (%)								
Diseases	58.4	63.3	56.6	6.7**	56	–3.9	62.1	56.5
Frostbite	49.2	61.1	44.3	16.8***	43.6	–8.9***	50	48.8
Flood	30.2	31.1	35.3	–4.3	24.9	–8.3***	18.8	36.3
Rot	17.8	15.9	19.2	–3.3	18.1	0.5	14.9	19.3
Infestations (insects/worms)	16.9	19.1	15	4.1	16.6	–0.4	19.6	15.4
Drought	9.5	9.5	9.5	0.1	9.5	0	12.5	7.9
Other	9.3	7.9	9.7	–1.9	10.2	1.3	9.7	9.1
Pre- and postharvest losses (%)								
HH experienced preharvest losses	61	67.7	60.1	7.6**	56.6	–7.2***	51.8	66.6
Climatic conditions	80.1	81.4	83	–1.6	76.3	–5.9**	78.7	80.8
Microbes/diseases	39.3	38.3	37.3	0.9	41.9	4.1	46	36.1
Physical damage	14	15.1	11.7	3.4	15.2	1.8	17	12.7
Other	14.2	12.9	15.8	–2.9	14	–0.3	12.7	15
HH experienced postharvest losses	26.7	27.1	27.7	–0.7	25.5	–1.9	26.3	27
Physical damage	76.8	75	78.1	–3.1	77	0.4	77.6	76.3
Microbes/diseases	23.7	23.4	19	4.4	28.4	7.3*	25.7	22.6
Climatic conditions	18.6	16.9	22.6	–5.7	16.2	–3.7	17.1	19.5
Spillage	13.4	8.1	19	–10.9**	12.8	–1	11.8	14.4
Other	9.8	10.5	7.3	3.2	11.5	2.7	7.9	10.9
# of observations	1,337	409	434		494		465	872

Source: Authors' elaboration based on the 2024 baseline data.

Note: HH = household; Diff. = difference. Asterisks indicate statistical significance levels for the t-test of differences in means: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Table 11 provides valuable insights into environmental health and biodiversity, particularly through the indicators of natural capital, crop diversity, and input use among all sampled farmers. The average farm size (1.1 hectares) and the widespread ownership of land (92 percent of households) reflect the extent of land resources available to smallholder farmers, while the data on crop diversity highlight the richness of agricultural systems. With households cultivating an average of 4.5 different crops and maintaining consistent Gini-Simpson (0.6) crop diversity index across groups, the findings suggest a relatively diverse cropping system. This diversity is a key indicator of environmental health, as it promotes soil fertility, pest control, and resilience to climatic shocks.

Natural-capital endowments are also broadly comparable between G1 and G2 farmers: They cultivate just over 1 hectare on average, and more than 90 percent of each group owns at least some land. The only significant difference is in land fragmentation. Control households manage a greater number of parcels (2 on average) than their treatment counterparts (1.7). Moreover, while G1 farmers grow a significantly wider mix of crops (4.8 vs. 4.4), Gini-Simpson indices are identical, suggesting that G1 farmers might plant slightly more crops but distribute area evenly across them.

Data also reflect sustainable practices in input use. High rates of organic fertilizer application (69 percent) and near-universal use of improved seeds (97 percent) indicate efforts to enhance productivity while potentially minimizing environmental degradation. Organic fertilizer use is particularly high in Nyandarua (78 percent), which may contribute to improved soil health and long-term sustainability in the region. However, widespread use of pesticides (91 percent) and herbicides (55 percent) raises questions about potential environmental trade-offs, such as soil and water contamination or impacts on non-target organisms. No statistically significant difference is observed between G1 and G2 on input use.

Table 11. Environmental health and biodiversity

Indicator	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean			Diff. (2)–(3)	Mean	Diff. (5)– [(2) & (3)]	Mean	
	Overall	G1: Treated	G2: Control		G3: Previously trained		Nakuru	Nyandarua
Natural capital								
Total farm size (hectares)	1.1	1.1	1	0.04	1.1	0.07	1.4	0.9
# of parcels per HH	1.9	1.7	2	-0.2***	1.9	0	1.9	1.8
HH owns some land (%)	91.8	91.7	90.3	1.4	93.1	2.1	91	92.2
Crop diversity index♦								
Richness (# of different crops)	4.5	4.8	4.4	0.4***	4.4	-0.2**	4	4.8
Gini-Simpson index	0.6	0.6	0.6	0	0.6	0	0.5	0.6
Input use (%)								
HH used improved seeds	97.4	98.5	97.2	1.3	96.7	-1.1	97.2	97.5
HH used improved seeds for Irish potato	71.7	74	70.7	3.4	70.7	-1.6	72	71.5
HH used organic fertilizers	68.9	67	69.8	-2.8	69.7	1.2	54.4	77.8
HH used inorganic fertilizers	96.9	97.4	97.2	0.2	96.2	-1.1	97.9	96.2
HH used pesticide	90.8	90.4	89.3	1.1	92.4	2.6*	91	90.7
HH used herbicide	55.2	58.5	54.7	3.9	52.9	-3.6	55.3	55.1
# of observations	1,532	458	494		580		579	953

Source: Authors' elaboration based on 2024 baseline data

Note: HH = household; Diff. = difference. ♦ see glossary (Appendix 2). Asterisks indicate statistical significance levels for the t-test of differences in means: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

6.4. Digital services and outcomes for women and youth

Sex- and age-disaggregated data provide critical insights into the extent of female participation in income-generating activities among the different household groups. These data, collected through questions on asset ownership and decision-making roles, highlight key aspects, such as women's involvement in income-related decisions, control over earnings, and asset ownership. While these indicators may not fully capture the complexity of women's empowerment, they play an essential role in addressing the unique experiences and challenges faced by women, ensuring that their perspectives are accounted for in the analysis.

Table 12 presents a selection of sex-disaggregated indicators across food security, nutrition, and asset ownership dimensions. It shows that households linked to forthcoming BDEC trainees and those linked to controls share very similar characteristics. The FIES averages just above 2 for both male and female

members, with no statistically significant gap between the two arms. Dietary quality is uniformly high (HDDS of 7.9; MDD-W of 8.1), indicating that diets are broadly adequate and gender neutral at baseline. Land ownership remains male dominated: Half the parcels are registered to men only, roughly one-third to men and women jointly, and fewer than one in five to women alone, with this sex-specific distribution not varying by treatment status. However, the distribution of durable assets is such that joint ownership is the norm (76 percent), although G1 households display a significantly lower share of female-only ownership, suggesting that women in these households have slightly lower exclusive control over important items.

The digital divide is even sharper. Women are more likely than men to be the sole owners of basic mobile phones (36 percent vs. 22 percent), whereas smartphone ownership tilts decisively toward men: One-third of G1 households report a male-only smartphone owner, compared with just 17 percent reporting a female-only owner, a significant (though less extreme) gap mirrored in the control arm. Agricultural equipment is overwhelmingly shared, but male-only ownership still accounts for nearly one-third overall. In sum, the table underscores three main findings crucial for the future evaluation: Food security and diet do not differ across study arms, land and high-value assets remain skewed toward men, and women's limited access to smartphones could constrain their uptake of advanced digital services.

Table 12. Descriptive statistics of sex-disaggregated variables

Indicator	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean			Diff. (2)–(3)	Mean	Diff. (5)– [(2) & (3)]	Mean	
	Overall	G1: Treated	G2: Control		G3: Previous ly trained		Nakuru	Nyandarua
Food security and nutrition								
Food Insecurity Experience Scale (FIES)								
Male HH members	2.2	2.4	2.3	0.05	2	-0.3**	2.2	2.2
Female HH members	2.2	2.2	2.3	-0.12	2.1	-0.19	2.3	2.2
Household Dietary Diversity Score (HDDS; 24-hour recall)								
Household (HDDS)♦	7.9	7.9	7.9	0.1	8	0.1	7.9	7.9
Female HH members (MDD-W)♦	8.1	8.2	8.1	0.08	8.1	0.01	8	8.2
Asset ownership (%)								
Parcel ownership								
Male only	49.4	50.2	48.9	1.4	49.3	-0.3	52	47.9
Female only	18.6	15.7	18.4	-2.7	21.1	4*	15.6	20.5
Joint	31.9	34	32.7	1.3	29.4	-3.9	32.4	31.5
Durable assets								
Male only	12.5	14	10.8	3.2	12.8	0.5	14.6	11.3
Female only	12.3	8.1	13.5	-5.4***	14.7	3.8**	8.9	14.5
Joint	75.1	77.9	75.7	2.1	72.4	-4.3*	76.6	74.2
<i>Mobile phones</i>								
Male HH member(s) only owners	22.1	25.2	17.4	7.8**	23.4	2.1	21.6	22.3
Female HH member(s) only owners	35.7	34.4	34.6	-0.2	37.9	3.4	37.5	34.7
Both HH member(s) owners	42.2	40.4	48	-7.6**	38.8	-5.5*	40.9	43
<i>Smartphones</i>								
Male HH member(s) only owners	31.5	33.2	30.8	2.5	30.8	-1.1	38.9	26.9

Female HH member(s) only owners	21.1	17.1	25.5	-8.5***	20.2	-1.4	12.8	26.2
Both HH member(s) owners	47.4	49.7	43.7	6	49	2.5	48.3	46.9
Agricultural assets								
Male only	31.6	34.7	28.5	6.2**	31.7	0.2	37.7	27.9
Female only	21.4	16.4	24.3	-7.9***	22.9	2.4	16.9	24.1
Joint	47	48.9	47.2	1.7	45.3	-2.7	45.4	48
# of observations	1,532	458	494		580		579	953

Source: Authors' elaboration based on 2024 baseline data

Note: HH = household; Diff. = difference. ♦ see glossary (Appendix 2). Asterisks indicate statistical significance levels for the t-test of differences in means: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Table 13 contrasts descriptive statistics of variables among youth-headed households⁷ (roughly 1 in 10 across the whole sample) with those headed by older adults, showing that at baseline, the two experimental arms are almost identical in youth headship (around 11 percent each). Nakuru has a noticeably larger share of youth-headed households (15 percent) than Nyandarua (8 percent), but no other regional or treatment imbalance emerges. Nutritionally, youth-headed households display a marginally higher dietary-diversity score (HDDS of 8.1 vs 7.9 for non-youth). Other differences lie in asset ownership and digital engagement. Youth-headed households manage fewer tangible resources, with their livestock, productive assets, and especially durable assets indices slightly lagging behind those of older household heads. In contrast, digital adoption is stronger among youth: 83 percent of youth-headed households already use apps for farming, compared with just 70 percent among non-youth, a pattern replicated in both the treatment and control arms. Overall, the table indicates that young farmers enter the program with stronger digital engagement but more limited physical capital, suggesting that BDEC's digital-extension content may resonate quickly with them, while complementary asset-building support might be needed to translate that forward-looking aptitude into sustained productivity gains.

Table 13. Descriptive statistics for youth- vs. non-youth-headed households

Indicator	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean			Diff. (2)-(3)	Mean	Diff. (5) - [(2) & (3)]	Mean	
	Overall	G1: Treated	G2: Control		G3: Previously trained		Nakuru	Nyandarua
Youth-headed HH (%)	10.4	11.4	11.1	0.22	9.1	-2.1	15.4	7.5
Dietary Diversity Scale (24-hour recall)								
Youth-headed HH	8.1	8	8.1	-0.13	8.2	0.14	8.2	7.9
Non-youth-headed HH	7.9	7.9	7.8	0.1	7.9	0.06	7.9	7.9
Livestock Asset Index								
Youth-headed HH	0.08	0.07	0.07	0	0.09	0.02	0.08	0.07
Non-youth-headed HH	0.09	0.1	0.08	0.01	0.09	0	0.1	0.08
Agricultural asset index								
Youth-headed HH	0.09	0.1	0.09	0.01	0.1	0.01	0.09	0.1
Non-youth-headed HH	0.11	0.11	0.11	0	0.11	0	0.11	0.11
Durable asset index								
Youth-headed HH	0.14	0.14	0.13	0.01	0.16	0.03**	0.13	0.15
Non-youth-headed HH	0.18	0.19	0.18	0.01	0.18	0	0.19	0.18

⁷ Youth-headed households are defined as households headed by individuals who are 35 years old or younger.

Crop diversification index (Gini-Simpson)								
Youth-headed HH	0.53	0.53	0.54	-0.01	0.52	-0.01	0.48	0.6
Non-youth-headed HH	0.6	0.61	0.6	0.01	0.59	-0.01	0.56	0.62
HH uses apps for farming activities (%)								
Youth-headed HH	83.1	86.5	76.4	10.17	86.8	5.48	84.3	81.7
Non-youth-headed HH	69.9	70.4	68.6	1.88	70.6	1.12	70.8	69.4
# of observations	1,532	458	494		580		579	953

Source: Authors' elaboration based on the 2024 baseline data.

Note: HH = household; Diff. = difference. Asterisks indicate statistical significance levels for the t-test of differences in means: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

7. CONCLUSIONS

Kenya's potato farmers face significant challenges across the value chain, including limited access to quality inputs, inadequate storage facilities, and market price fluctuations, which negatively affect yields, income, and sustainability. These issues are particularly acute for women and youth, who encounter additional barriers in the agriculture sector. Digital tools present a promising solution by offering access to agricultural information, enhancing market connections, and reducing postharvest losses. Despite their potential, digital tools face limited adoption in sub-Saharan Africa due to infrastructure gaps, high costs, and literacy challenges.

In collaboration with WFP/FtMA in Kenya, IFPRI was commissioned by the Mastercard Foundation to evaluate the impact of a digital integration program (BDEC) targeting agripreneurs/FSCs on farmers' agricultural outcomes in Kenya's potato value chain. This study focuses on socioeconomic impacts, digital tool adoption, and gender and youth outcomes in the important potato-growing counties of Nakuru and Nyandarua. Its methodology employs a c-RCT comprising three groups: G1 (newly BDEC-trained FSCs and their associated farmers), G2 (non-BDEC-trained FSCs and their associated farmers serving as a control group), and G3 (previously BDEC-trained FSCs and their farmers, included for heterogeneity analysis). This report presents the findings from the baseline survey that includes two key components: an FSC survey covering 140 FSCs and a farmer-level survey including 1,532 households.

The FSC survey results provide an in-depth understanding of the characteristics, business operations, service delivery, and digital tool adoption among FSCs in the study area. Of the 140 FSCs surveyed, 53 percent participated in the BDEC training program, with an increasing trend in enrollment in recent years, indicating the program's scaling efforts. Notably, baseline sociodemographic and operational characteristics reveal minimal differences between BDEC-trained and non-BDEC-trained FSCs. Both groups served a comparable number of farmers, demonstrated similar operational intensities, and exhibited parity in access to credit and income generation. While BDEC-trained FSCs showed slightly better financial and entrepreneurial practices, the overall comparability suggests that the training program is inclusive and reaches a broad spectrum of FSCs. Statistical significance of averages was assessed at the household level, as per the study design, given that the selected sample is representative at this level. Statistical differences at the FSC level are difficult to detect, given the small FSC sample size (N = 140).

A key finding is that previously BDEC-trained FSCs received more extensive FtMA services, including training on digital tools (other than BDEC), negotiation skills, and mentorship. This enhanced capacity is also reflected in the broader array of services offered to farmers, particularly in aggregation, soil testing,

and harvesting, extending beyond traditional input sales. Digital tool adoption is notably high among all FSCs, with 86 percent using apps for business. BDEC-trained FSCs demonstrated leadership in both the number and diversity of apps used, with a strong reliance on communication (such as WhatsApp) and financial tools (such as M-PESA) as well as relatively high adoption of specialized agricultural apps such as KuzaOne.

The household survey highlights that households served by future BDEC-trained (G1) and non-BDEC-trained (G2) FSCs were largely and statistically comparable in sociodemographics, household size, age of household heads, and income structure. This comparability at the farmer level strengthens the basis for assessing causal impacts in the forthcoming evaluation of the program using our evaluation design and sampling strategy. Digital tool adoption among households is widespread, with 71 percent of smartphone ownership and high usage of communication (WhatsApp, SMS) and financial (M-PESA) apps for farming activities. However, adoption of agriculture-specific applications remains limited, primarily due to lack of awareness and digital literacy barriers.

Potato cultivation is prevalent among 87 percent of households, with the *Shangi* variety being dominant. Environmental indicators show diverse cropping systems, with an average of 4.5 crops cultivated per household, contributing to soil fertility and resilience. Sex-disaggregated data reveal consistent food security and dietary diversity outcomes across gender. However, significant disparities persist in asset ownership, particularly for land and advanced digital devices, with men dominating smartphone ownership. This finding suggests a potential limitation for women's access to advanced digital tools and services. Youth-headed households, while having fewer physical assets, demonstrate higher digital aptitude, indicating a potential receptiveness to digital extension content.

In summary, baseline findings offer a comprehensive snapshot of the socioeconomic, digital, agricultural, and gender dynamics within Kenya's potato value chain. The observed minimal baseline differences among FSCs and households served by BDEC-trained and non-BDEC-trained FSCs establish a strong and comparable foundation for robust causal inference in the forthcoming cRCT. While digital tool adoption is widespread among both FSCs and farm households, its use remains largely concentrated in communication and financial apps, with agriculture-specific apps having limited uptake.

The data underscore the important role of FSCs, especially those benefiting from BDEC training, in bridging existing digital gaps, enhancing service delivery, and providing critical support to farmers. Nevertheless, persistent challenges—such as limited smartphone access for women and broader barriers to adoption of specialized apps—highlight key areas where future targeted interventions would prove crucial to maximize impact. These findings shed light on the significant potential of digital integration to address structural challenges, enhance inclusivity, and build greater resilience within Kenya's potato value chain.

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Appendix 2. Glossary

Indicator name	Definition
Gini-Simpson index (GSI) of diversification (for income, crop, or livestock)	<p>Measures the diversity of income sources, crops grown, or livestock raised within a household by assessing how evenly income, land area, or livestock population is distributed across different income sources, crop types, or different livestock species. Higher values indicate greater diversification:</p> $GSI = 1 - \sum a_i^2$ <p>where a_i is:</p> <ul style="list-style-type: none"> Income: The gross income share from the ith household income source Crop: The land share from the ith cultivated crop Livestock: The proportion of the total livestock population attributed to the ith livestock species
Wealth index (for assets and livestock)	Using principal component analysis (PCA) normalized between 0 to 1, the index measures a household's wealth based on the ownership of assets (durable or productive) or livestock. It helps to create a single composite score that reflects the economic status of households by considering various assets or livestock.
Food Insecurity Experience Scale (FIES) – raw score	<p>The Food Insecurity Experience Scale (FIES) is a statistical tool used to measure the severity of food insecurity at the household or individual level. It relies on eight yes/no questions about access to adequate food, similar to other scales used for psychological and social assessments. A raw score (0–8) is calculated based on the number of affirmative responses, with higher scores indicating more severe food insecurity. When validated, this score provides an ordinal measure, and further statistical analysis allows for international comparisons of food insecurity levels.</p> <p>FIES questions:</p> <ol style="list-style-type: none"> 1. You were worried you would not have enough food to eat? 2. You were unable to eat healthy and nutritious food? 3. You ate only a few kinds of foods? 4. You had to skip a meal? 5. You ate less than you thought you should? 6. Your household ran out of food? 7. You were hungry but did not eat? 8. You went without eating for a whole day?
Minimum Dietary Diversity for Women (MDD-W) and Household Dietary Diversity Score (HDDS)	Simple count of food groups that a household has consumed over the past seven days, based on 12 food groups: 1/cereals; 2/starches, tubers, and roots; 3/vegetables; 4/fruits; 5/meat; 6/eggs; 7/fish; 8/legumes; 9/milk and other dairy; 10/oil; 11/sweets; and 12/condiments.

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