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Selling Better Rather than Growing More

**Mixed-Methods Evidence on a Private Digital Advisory
Platform for Smallholders in Northern Nigeria**

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Abstract

Private digital agricultural platforms have proliferated across sub-Saharan Africa, yet rigorous evidence on farm-level outcomes and the conditions necessary for equitable distribution of benefits remains scarce. This paper provides a mixed-methods evaluation of Crop2Cash (C2C), a Nigerian agri-fintech enterprise delivering bundled “phygital” services—comprising AI-powered and human advisories, input marketplaces, credit scoring services, and e-wallet services accessible on basic feature phones. Combining a quasi-experimental research design, household survey, and qualitative data across Kaduna, Jigawa, and Niger States, we estimate the average and heterogeneous treatment effects of C2C services. Users averaged NGN 161,520 (USD 106) more in crop sales value than comparable non-users. These sales gains were driven primarily by marketing improvements—stemming from better price information, postharvest techniques, and market linkages—along with productivity gains for some crops and farmers. Conversely, we find no significant average effect on crop productivity or the adoption of 19 promoted sustainable agricultural practices. Despite high reported registration numbers, actual service uptake remains limited, particularly among women.

Keywords: Digital tools, private sector extension, extension services, outcome evaluation, quasi-experiment

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1. INTRODUCTION

Digital agricultural advisory services (DAAS) have emerged as a transformative force in global development, with promise for bridging the information gap for millions of smallholder farmers through mobile technology. By providing real-time data on weather, market prices, and agronomic practices, these platforms aim to increase productivity and resilience where traditional extension systems have often struggled to deliver. However, while the theoretical potential for digital tools to disseminate information is vast and generating significant excitement, the actual effects on farm yields and household income remain poorly documented and, where data exist, largely inconsistent (see review by Abate et al., 2023; Ragasa et al., 2026). Many pilots fail to move beyond localized success stories, a challenge highlighted in recent systematic reviews (Baumüller, 2018; Ragasa et al., 2026; Tsan et al., 2019). A significant knowledge gap persists regarding the causal link between digital information delivery and long-term behavioral change, as “top-down” digital messaging often fails to account for the complex, localized socioeconomic constraints that prevent farmers from acting on even the most accurate advice (Aker et al., 2016; Fabregas et al., 2019). Evidence is even scarcer on whether “phygital” models, the most common form of these platforms, which combine digital advisory with physical outreach and other bundled services, reach and benefit the most resource-constrained farmers. This paper addresses these gaps through a rigorous mixed-methods evaluation of one such platform in Nigeria, with implications that can be applied to digital platforms operating in similar contexts globally.

The proliferation of digital platforms in the agrifood sector has driven diverse actors to embrace these technologies, with new social enterprise models, both for-profit and nonprofit, emerging over the last decade (Kenney & Zysman, 2016; Ragasa et al., 2026; Tsan et al., 2019). For-profit entities are particularly important, as they leverage hybrid financing models and provide bundled services for farmers and value chain actors, which potentially contribute to platform sustainability and localized value co-creation (Fabregas et al., 2019; Florez et al., 2026).

A central debate in the current literature revolves around the shift from publicly funded models to private-sector-led initiatives (Birner et al., 2021; Knierim et al., 2017). Proponents suggest that private firms can bring the innovation, agility, and scalability necessary to reach remote populations that state actors often miss. Yet, this transition introduces a tension between social impact and commercial viability that has sparked a debate over whether “freemium” models (where users can access core features for free, but must pay a premium fee to unlock advanced functionalities), data-monetization strategies, or bundled services (combining advice with credit or insurance) can truly reach the poorest farmers (Florez et al., 2026). Critics argue that a market-driven approach may exacerbate the digital divide, prioritizing high-value crops and

tech-savvy producers while leaving marginalized communities further behind (Mehrabi et al., 2021; Sutherland & Labarthe, 2022; Steinke et al., 2021).

A significant knowledge gap remains around the sustainability of DAAS, particularly as many of these initiatives struggle once initial donor funding or venture capital expires, revealing a lack of proven revenue models (Ragasa et al., 2026; Tsan et al., 2019). Current research is frequently limited to short-term outcome evaluations, leaving a vacuum in our understanding of how these business models evolve or integrate into the broader agricultural value chain to ensure their financial independence without compromising service quality (Aker et al., 2016; Fabregas et al., 2019). Research is also lacking on whether farmers continue to adopt recommended practices over several seasons (Ragasa et al., 2026). Furthermore, the integration of private platforms with national agricultural policies remains fragmented, raising concerns about data privacy, ownership, and potential monopolies over local knowledge (Mehrabi et al., 2021). Ultimately, the literature is polarized between techno-optimism and skepticism regarding the scalability of private sector solutions, creating a critical need to evaluate evidence on how market incentives align or clash with the developmental goals of food security and rural resilience (Steinke et al., 2021).

This paper addresses these interconnected challenges by synthesizing the evidence on how private sector DAAS operate within the unique constraints of developing countries, using the case study of Crop2Cash (C2C), a private enterprise providing bundled phygital financial, marketplace, and advisory services to a reported 357,466 fully registered individuals (as of September 2025) in Nigeria. By examining the intersection of technical feasibility, business model innovation, and institutional support, this study seeks to identify the conditions under which a digital advisory can become both a profitable venture and a reliable public good. Drawing on data from C2C users, a comparable control group, and stakeholder interviews, and applying rigorous econometric techniques, our results indicate that C2C services are gaining traction and significantly increasing crop sales in northern Nigeria. Key drivers of these returns include increased use of inorganic fertilizers, the purchase of quality seeds, and the use of weather and market advisories to optimize planting and harvesting. Sales proportion, volume, and value are also higher among users than non-users, driven by higher production as well as greater access to advice on prices and market opportunities. In addition, the C2C e-wallet facilitated faster, more efficient transactions. However, critical areas for improvement remain, including enhancing the functionality and increasing awareness and uptake of the AI-based advisory tool, ensuring timely input delivery, and strengthening the company's niche and competitive edge over other service providers. In sum, the study assesses the services of a digital-based social enterprise that has moved beyond the pilot phase of digital agriculture and has reached medium scale and provides a synthesis of evidence on how it is performing in terms of both profitability and social outcomes as it continues to navigate these twin objectives as a social enterprise.

2. CROP2CASH IN NIGERIA

Crop2Cash (C2C), founded in 2018, is an agri-fintech startup bridging the financial divide and addressing information gaps for smallholder farmers. Services they provide include:

- i. *Unstructured Supplementary Service Data (USSD) Payments (CashCard)*: An e-wallet system enabling digital banking transactions via basic feature phones.
- ii. *Credit Scoring*: Proprietary machine-learning models that build financial identities for bank-led lending.
- iii. *Software-as-a-Service (SaaS)*: A digital application to streamline supply chains and supplier payments, with agro-processors as their main target enterprise-clients.
- iv. *Online Input Marketplace*: A USSD-based digital platform offering quality-assured seeds, fertilizer, and chemicals.
- v. *AI-powered advisory*: The National Hotline for Agriculture (NHFA), a 24/7 toll-free service in Yoruba, English, and Hausa. Unlike traditional, rigid interactive voice response (IVR) systems that only allow users to press numbered keys or listen to pre-recorded menus, the AI-powered hotline combines AI with voice communication to allow farmers to freely speak to a system that acts as a personalized agricultural expert. It requires no internet connection or smartphone; farmers simply dial the toll-free number from any mobile device.

C2C's services and focus have evolved and continue to evolve to adapt to market conditions and investment opportunities. For example, they have expanded their input marketplace and now follow a phygital approach (online and via human agents). Similarly, they have expanded their advisory services to a phygital approach, combining call center, SMS, in-person training, and physical interactions with human agents. In-person training is structured and mostly delivered to groups, whereas human agents interact with farmers one-on-one through home or farm visits, often complemented by phone calls. None of these channels requires a smartphone. These advisory services, as well as the e-wallet transactions, are fully subsidized and provided for free to farmer-users.

C2C has raised capital through a combination of equity funding, convertible notes, and significantly, grants, including support from FCDO, GSMA, and USAID. In 2021, the company received funding and cloud credits from the Google for Startups Black Founders Fund, allowing them to scale up during the COVID-19 pandemic. In 2024, they secured funding from Village Capital to expand their reach to smallholder farmers. They have also partnered with institutions such as First City Monument Bank (FCMB) to facilitate loan delivery. C2C operates as a platform and machine-learning-based credit scoring service that helps banks and financial institutions lend directly to verified farmers. C2C earns commercial revenue

from commissions on input sales, credit scoring analytics, and software services provided to agro-processors and enterprises to help digitize their operations.

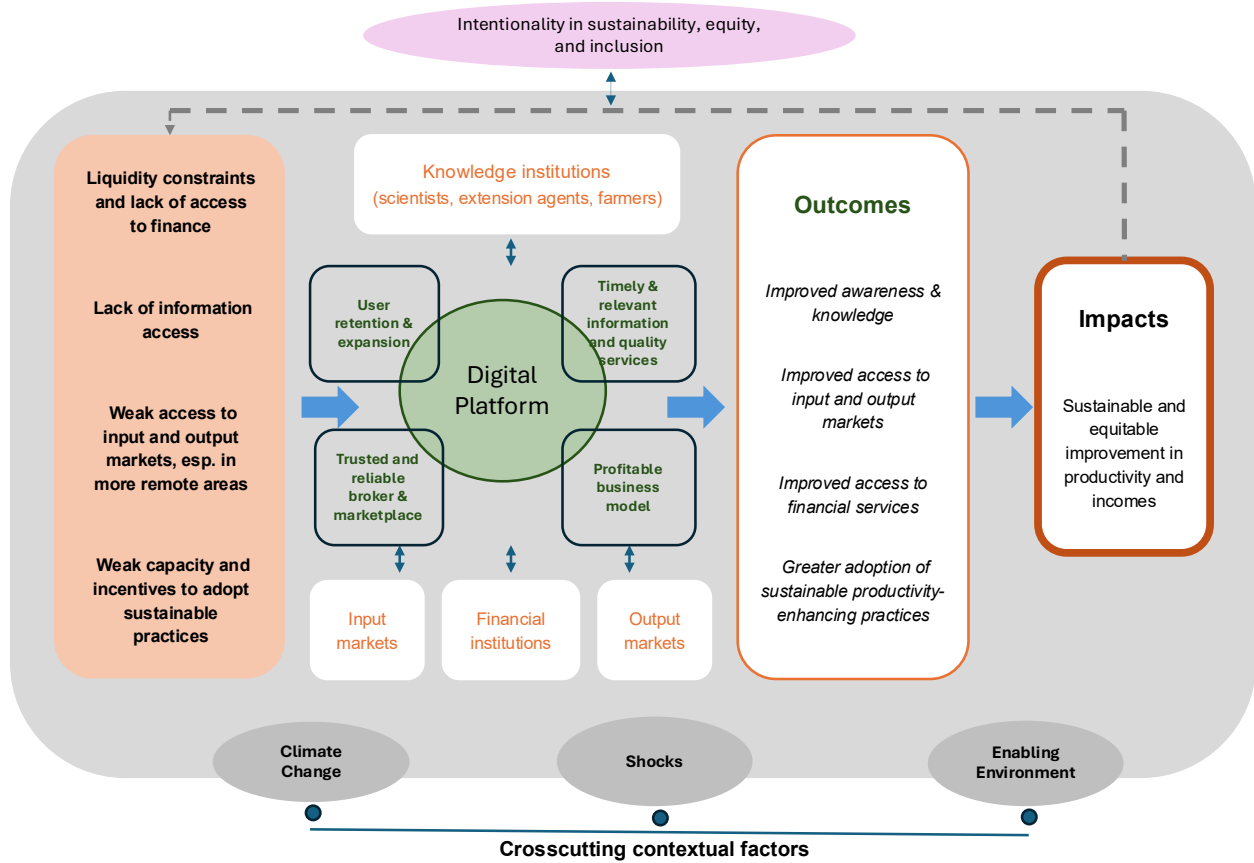
As of September 2025 (during the time of the tracking and sampling exercise), C2C reports 357,466 fully registered individuals nationwide (80,136 in Kaduna, Jigawa, and Niger—our study focus states). A total of 28,827 farmers were actively using C2C services in the last 12 months (7,454 farmers in the three focus states). In the last two years, the most used services are as follows:

- i. *USSD-based e-wallet*: This is by far their most popular and used service. In the three focus states, 78% of tracked users utilize the C2C e-wallet. While OPay and Moniepoint dominate the broader e-wallet market, C2C seems to maintain a small share in the three focus states based on the survey and qualitative data collected in this study. Interviews with extension agents and focus group discussions in 23 diverse communities in the three states indicate that 10–40% of farmers in these communities use some kind of e-wallet; and our survey data indicate that the average user typically uses two e-wallet platforms simultaneously (ranging from 1 to 10).
- ii. *AI-powered hotline*: Launched in July 2024 in Yoruba, English, and Hausa, this is the second most popular service. Based on C2C’s internal monitoring data, the hotline handles roughly 100 calls per day, with 700 repeat users. C2C reports that they have a system in place for regular monitoring and evaluation of their AI model and product (see **Annex 1** for the performance metrics and results reported by C2C). C2C is currently exploring a subscription-based model for AI and human-led advisory services.
- iii. *Other advisory services*: C2C also organizes training sessions through government extension agents as part of development project grants. For example, through a grant in 2024, C2C provided SMS services to about 3,100 farmers in Jigawa. Two to three SMS alerts were sent weekly for about three months, accessible on any basic feature phone.
- iv. *USSD-based input marketplace*: C2C also acts as intermediary linking input suppliers to retailers and farmers. An estimated 989 farmers nationwide (122 in the three focus states) use the online platform. More farmers bought input in person via C2C-affiliated agents. In 2024, C2C reported that it sold 10 tons of maize seeds. This translates to a very small number of farmers (~200 farmers), assuming an average purchase of 50 kg of seeds per farmer.
- v. *Credit and loans*: C2C partners with banks to provide credit scoring and farmer monitoring. In 2023, 700 farmers in Kaduna received input financing facilitated by C2C. In 2024–2025, 150 farmers in Southwest Nigeria were supported via the Agric Fast Cash (AFC) program, facilitated by C2C. However, no loans were issued in northern Nigeria during 2024–2025 due to market volatility caused by cheap crop imports, which hindered farmers’ ability to repay.

To date, no formal due diligence or rigorous assessment of development outcomes exists for C2C services. Evidence available is largely based on self-reported experiences and perceived benefits. For example, a study by 60 Decibels (2023), using structured interviews with 155 C2C users, found that about two-thirds of users reported benefits, while several studies indicate that low repayment rates remain a significant threat to sustainability of C2C services (see Ambler et al. 2024, 2025). A GSMA project report (2024) shows wide reach of C2C services based on C2C's self-reported user metrics; and most users interviewed were satisfied with the services and reported benefits from them. The GSMA report did not include information on the number of respondents interviewed or what the sample represented.

Our study rigorously measures C2C's outcomes using a quasi-experimental evaluation design, stakeholder feedback, and robustness techniques to ensure internal validity. Our analysis is guided by the theory of change (ToC) illustrated in **Figure 1**. C2C has twin objectives: a commercial objective of increasing its own profits and market share, and a social objective of empowering smallholders through improved access to information, digital services and finance, and higher farm incomes. Its profitability thus depends on the strength of its digital platform, user retention, and the ability to curate a knowledge base that is validated with local producers in a timely and inclusive manner. Furthermore, the sustainability of its marketplace and financial services hinges on maintaining a competitive edge. While there is no direct service for the output market, accessing lucrative markets for the surplus harvest and generating income would make the commercial services more competitive and the advisory services more practical and beneficial. On the other hand, C2C's development outcomes depend on explicit strategies for inclusion, equity, women's empowerment, and climate resilience; without this intentionality, these social objectives risk being buried by the drive for profit maximization. The more detailed ToC and list of outcome indicators used in this evaluation are presented in **Annex 2**.

Figure 1. Theory of change and pathways from C2C services to outcomes



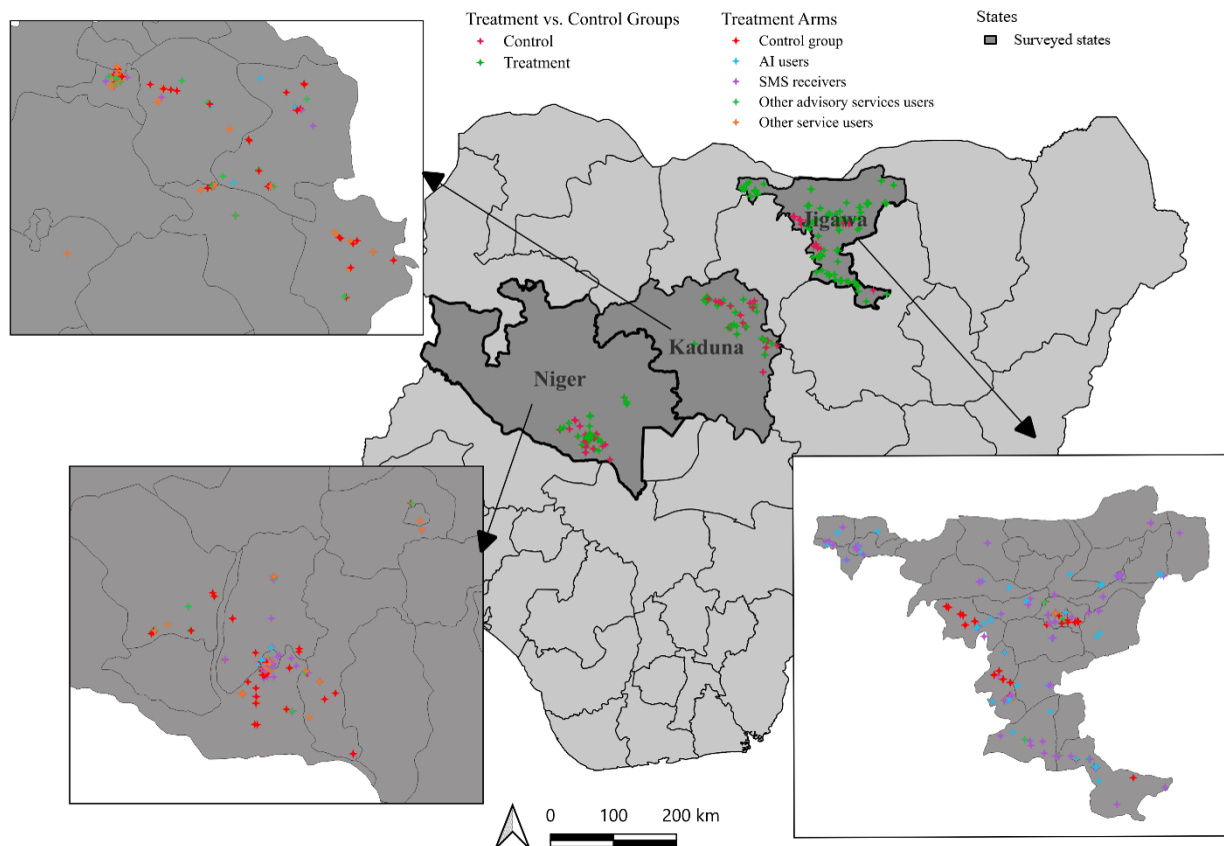
Source: Authors' illustrations.

3. METHODS

3.1. Study area

Our study focuses on 3 states (Kaduna, Jigawa, and Niger), where C2C has been concentrating their service promotion in the last two years and where they are experimenting with working through government extension agents for service promotion.

Figure 2. Map of the study sites and C2C service groupings



The three focus states share several core agricultural characteristics. Agriculture is the mainstay of all three economies, typically contributing 35–60% of state GDP. In each state, the vast majority of the population (ranging from ~60% to over 85%) is engaged in agriculture as their primary livelihood. While each state has a “signature” crop, they all overlap as major producers of Nigeria's essential food staples including:

- Rice and maize
- Industrial crops such as soybeans, sesame, sugarcane, and cotton

- Vegetables, including commercial cultivation of tomatoes, peppers, and onions

Each state faces structurally similar but locally differentiated challenges: input costs have risen sharply across all three states following the naira devaluation of 2023; government extension services have largely collapsed under budget pressure and high farmer-to-agent ratios estimated at over 1:4,000 in Kaduna; and seasonal flooding in Niger State in 2024 and 2025 destroyed large areas of farmland, disrupting production outcomes for a substantial share of the evaluation sample. Rural insecurity—primarily banditry in Niger and Kaduna—constrains farmers’ access to fields and impedes safe transport of harvested produce to markets (see **Annex 3** for detailed comparison).

Mobile phone penetration ranges from 66% in Jigawa to 98% in parts of Kaduna, but the vast majority of rural farmers use basic feature phones. Smartphone ownership is estimated at 22–37% across the three states, and rural telecom reliability is poor. A smartphone is not needed to use C2C services: the AI-powered voicebot, the USSD e-wallet, and the USSD-based input marketplace all work on basic feature phones. These infrastructure realities are not incidental to the evaluation; rather, they directly shape the accessibility of C2C’s digital service channels and are central to interpreting the pattern of heterogeneity in the outcomes.

3.2. Assessment approach

This study adopted a three-phase mixed-methods design integrating both exploratory and explanatory sequential frameworks. A qualitative exploratory phase was first conducted to inform the survey design and questionnaire. This was followed by a quantitative survey phase. Finally, an explanatory qualitative phase was deployed to unpack the mechanisms and underlying “how and why” driving the quantitative survey results. We utilized household surveys, stakeholder interviews, and platform metrics. This allows us to triangulate user data and product evaluations with feedback from the entire value chain to assess utility and service benefits. While perceived benefits reported by users can be useful feedback, these perceptions are also prone to social desirability bias. To address social desirability bias, we gathered diverse perspectives from different stakeholders and constructed a comparable control group. To ensure high internal validity, we employed advanced matching and weighting techniques to compare 1,276 users against 545 non-users, minimizing selection bias. We used qualitative insights from 68 key informant and in-depth interviews (KIIs; 42 before and 26 after the survey) with all value chain actors, and 23 focus group discussions (FGDs) with 172 farmer-participants in diverse communities in the three focus states to contextualize the findings and uncover the “why” behind the outcomes (see **Annex 4** for the sample size). Finally, by situating these findings in a broader market and institutional landscape, we focused on understanding the comparative advantage or competitive edge of C2C services over several other service providers in the study areas.

3.3. Survey sampling design

C2C provided a master list of 7,454 active users across the three states. We narrowed our focus to 13 Local Government Areas (LGAs) with the highest user concentration, identifying 2,777 farmers. Of these, we successfully tracked 54% (1,513), while 46% were not reached: 35% had invalid mobile numbers and 11% were misclassified (incomplete or failed registrations)¹ (see **Annex 5** for more details of the survey sampling method). Because untracked numbers could not be reached at all, we treat the 1,513 tracked users as the population of reachable users in the 13 LGAs rather than as a random sample of all listed users. Tracked users may be more engaged than untracked users, so our estimates apply to farmers who remain reachable through C2C's records (see Section 3.7).

Of the 1,513 tracked registered individuals, two-thirds were active users, while one-third had registered but had not yet used C2C services. This latter group serves as the closest available counterfactual for our outcome evaluation; since they had the means and capacity to register and had chosen to register, they likely share many of the same “unobservable” motivations as active users, differing only in their actual service utilization. The covariate balance shows strong overlap between the two groups, and only small differences between them in terms of education, age, and asset indicators (Annex Table 7.3 and Annex Figure 7.1 show covariate balance and the overlap of propensity scores before and after weighting). To assess whether they are a valid counterfactual, a key question is why registered non-users have not used C2C services. The overwhelming response from the qualitative interviews was the timing of the C2C promotion and cropping season. Mobilization and promotion of C2C registration in some communities seem to have happened after the planting season and when intensive farming activities were almost completed. Qualitative data confirm the strong similarities between these two groups and the main differentiating factor is the timing of the registration and use. This time gap in registration and use does not seem to be a reflection of distrust or lack of interest on the part of the farmers or systematic difference between those using and not using; rather, it results from scheduling failure and timing mismatch between promotion and farming season when services are mostly needed. Randomly selected registered non-users who were re-interviewed post-survey explicitly stated that they plan to use C2C in the coming season (see **Annex 6** for more details).

“The reason is that when they approached us, it was not the right time to provide inputs. It was delivered to us after activities. However, we are currently waiting and hoping to start this activity.”
— Non-user, FGD Kubau, Kaduna

¹ Unfortunately, we do not have data on the untracked individuals from the initial list. Based on key informant interviews, changing cellphone numbers, and numbers becoming non-functional—mainly due to new network product promotions—are common in the study area. These occurrences are likely random; hence, they are unlikely to contribute to attrition bias or survivorship bias. In addition, we expanded our inclusion criteria for C2C users to include any user (not necessarily only active ones), thereby minimizing attrition and survivorship bias.

Our control group (545 farmers) thus consists of a random selection from a longer list of farmers based on the tracking and listing exercise: (1) registered non-users (75% of the control); and (2) farmers with basic phones in the same or nearby communities who did not initiate or complete registration (25%) (**Figure 3**). Barriers to participating in and using C2C advisory services are minimal; access to a basic feature phone is sufficient to call the AI-powered hotline for advisory services and to register on the C2C platform. Registration unlocks USSD-based services, including an e-wallet and an online marketplace. Consequently, the minimum criteria for inclusion in the study required that a farmer reside in the same ward as active C2C users and have access to a basic feature phone. As demonstrated by our covariate balance (Annex 7), there is substantial overlap between the control and treatment groups. This statistical alignment is further validated by qualitative data, which confirm that farmers across both groups are largely homogeneous.

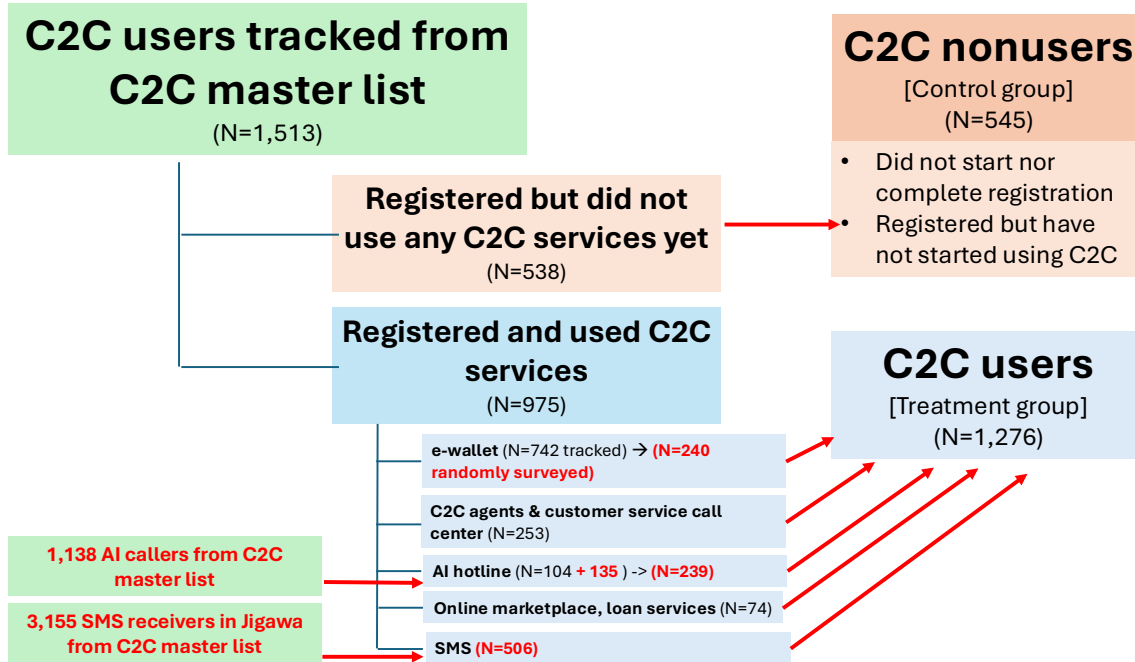
Most farmers in the former group (tracked C2C active users) are using e-wallet services. To better evaluate the effects of advisory services (AI, SMS, and human agents), we obtained a second master list from C2C of 1,138 AI-powered hotline callers and 3,155 SMS-receiver participants from a 2024 C2C project. We successfully tracked 239 AI-powered hotline callers and randomly sampled 506 SMS receivers from nearby communities. Because users of other services (e.g., e-wallets) may have received incidental advice from agents, we broadened our treatment definitions. Our treatment groups are thus defined as:

Treatment Group 1: Total C2C Users (N=1,276): Reported using any C2C service.

Treatment Group 2: C2C Advisory Service Users (N=998): Specifically reported receiving advice via AI hotline, SMS, or human agent (subset of Group 1). The remaining 278 users in Group 1 used only non-advisory services (mainly the e-wallet, and some the input marketplace or loans). Within Group 2, 239 called the AI hotline and 506 received SMS advisories; the remaining 253 received advice only from human agents or the regular customer call center.

The composition of these groups is detailed in Figure 3 (see more details in **Annex** Figure 5.1). The analysis of treatment effects by service was challenging because of sample size and limited statistical power. Nonetheless, we isolated AI hotline and SMS groups to provide indicative evidence of their relative contributions. In addition, we estimated the treatment effects by crop and farmer subgroup. We also examined farmers' self-reported benefits and identified who is more likely to report benefits. These results are presented in the mechanism and heterogeneity analysis section.

Figure 3. Composition of the treatment and control samples



Note: N=number of observations.

3.4. Covariate balance

The matching covariates are individual respondent's characteristics (age, gender, education), location-based characteristics that did not change over time (distances to road, market and town, rainfall, state), and characteristics unlikely to have changed in the one to two seasons since C2C advisory intensified (electricity access, group membership), confirmed as similar at baseline and time of survey. The treatment and control groups are generally balanced, except for a few covariates. Compared to non-users, C2C users are more likely to have a second income source, to have electricity, and to be members of a group or association (**Annex 7**). C2C users are also more likely to live closer to paved roads and experienced less rainfall. C2C user respondents are younger and more educated (84% of users have at least high school versus 68% among non-users). After weighting, standardized differences fall below 0.1 for most covariates (**Annex Figure 7.1; Annex Table 7.3**). The exceptions under inverse probability weighting and regression adjustment (IPWRA) are 2025 rainfall and the state dummies (0.11–0.14), which also enter the outcome model of the doubly robust estimator; Mahalanobis-distance kernel matching leaves a larger gender imbalance (0.22–0.44), so we use it only as a robustness check.

3.5. Econometric techniques

Outcomes of an intervention are best measured by randomizing treatment assignment or using longitudinal (before–after) data to compare similar samples, assuming a constant time trend, where the intervention is the only differentiator between treatment and control groups. In the absence of random assignment, we employed a quasi-experimental design to estimate the farm-level outcomes of C2C services. An ideal counterfactual represents a scenario where non-users are identical to users, differing only in their use of the C2C service. To approximate this counterfactual, we intentionally selected farmers from the same communities and wards as the C2C users.

To ensure internal validity and minimize selection bias, we addressed remaining covariate imbalances between the C2C user (treatment) and non-user (control) groups using matching and weighting techniques. Our primary estimation model is IPWRA, which offers a double-robust property: the estimates of the effects remain consistent if either the treatment model or the outcome model—but not both—is mis-specified. IPWRA estimators model both the outcome and the treatment to account for non-random assignment. Several studies have used this method in outcome evaluation (see Mwangi et al. 2021; Thapa et al. 2025; Wooldridge 2007 for examples). For robustness checks, we employed alternative matching and weighting techniques, including kernel weighting/matching using propensity scores and alternatively using Mahalanobis distance.² The outcome estimates are largely consistent across IPWRA and the two kernel weighting techniques (see **Annex 8** for details on these methods). Weighting and matching balance observed covariates by construction; they do not remove bias from unobserved differences. Our estimates therefore rest on the selection-on-observables assumption, which we support with the choice of registered non-users as the main comparison group and with qualitative evidence on why they had not yet used C2C (Section 3.3). Because C2C did not assign services by location and we compare farmers who actually used C2C services with comparable non-users, the estimate is the average treatment effect on the treated (ATET), not an intention-to-treat effect.

3.6. Willingness-to-pay elicitation

Willingness to pay (WTP) for C2C advisory services is elicited through a contingent valuation module using a multiple-bounded discrete choice (“bidding game”) design. Enumerators first read a short script explaining that digital platforms, extension experts, and call centers must be financed through grants, contributions, or subscriptions. Respondents were then presented with two hypothetical services in turn: (i) an expert-based advisory service, in which farmers call agricultural experts, and (ii) an AI-enabled advisory service, in which farmers’ questions are answered by an AI system. Both services were described with the

² Other matching techniques were considered, such as nearest neighbor matching (NNM), but it performed poorly because of the nature of the dataset (a smaller control group [545] than treatment group [1,276]): many treated observations without matched controls were dropped.

same content: personalized advice for the respondent's crops and location; timely alerts on planting, fertilizer application, and pest control; location-specific weather forecasts; pest and disease identification through a helpline; answers to farmers' questions; and information on improved practices. They also had the same delivery terms: toll-free calls, USSD, or SMS, with no smartphone or internet required; service in English, Hausa, and Yoruba; and unlimited contacts during the season. Payment was framed as a monthly subscription that covered all calls and messages, paid at the start of each month through mobile airtime or the C2C digital wallet, and could be cancelled at any time. Holding content and payment terms constant across the two scenarios allows the difference in WTP to be read as farmers' valuation of a human expert relative to an AI advisor.

For each scenario, respondents were first asked whether they would subscribe to the service at all. Those who answered yes or were unsure were asked whether they would pay a starting bid of NGN 4,000 per month (we randomized the starting bid). Respondents who accepted were then offered higher bids in NGN 500 increments until they declined. Those who rejected were offered lower bids in NGN 500 decrements, down to a floor of NGN 1,000, until they accepted. In both cases, the sequence continued until a switch point between acceptance and rejection was identified. The sequence was followed by an open-ended question asking for the maximum amount the respondent would be willing to pay per month, so WTP can be bounded both by the bidding sequence and by the stated maximum. Respondents were then asked which payment mode they preferred: a monthly subscription, a yearly subscription priced at half the cost of twelve monthly payments, or pay-per-use. Those who preferred pay-per-use went through a parallel bidding sequence that started at NGN 45 per minute and moved in NGN 10 increments. Respondents who declined to subscribe, or who would not pay any amount, were asked for the main reason. This allows genuine zero valuations (finding the service not useful, being unable to afford it, or already receiving similar advice for free) to be distinguished from protest responses (distrust that the service would deliver, the view that government should provide advice free of charge, or lack of access to payment channels).

Mean WTP is estimated using an interval-data regression approach (following Hanemann et al., 1991) that accounts for the interval-censored nature of the bidding-game responses, with the open-ended maximums used as a complementary estimate. Respondents who would not subscribe at any price are treated as having zero WTP, and protest responses are excluded in a robustness check. Estimates are reported separately for the expert-based and AI-enabled services, for the full sample, separately for C2C users and non-users in the comparison group, by gender, and for the other subgroups used in the heterogeneity analysis. A probit model on the binary responses to a NGN 4,000 starting bid is used as a robustness check. Because all respondents faced the same starting bid, the estimates may be affected by starting-point (anchoring) bias; comparing the bidding-game results with the open-ended maximums provides a partial check.

3.7. Limitations of the study

Notwithstanding its rigorous research design, this study has some limitations. First, while we controlled for observable characteristics, we could not account for unobservable factors; therefore, our results indicate strong statistical associations rather than strictly causal impacts. We therefore present our findings as the average treatment effects on the treated (ATET) of C2C services and of C2C advisory services. Second, we successfully tracked only about half of the registered farmers on the master list, as most of the remaining contact numbers were invalid or inactive (Section 3.3). This high attrition rate is primarily driven by farmers changing SIM cards to exploit telecommunication promotions. Although this churn appears random—and tracked and untracked users do not seem systematically different—we cannot fully verify the baseline characteristics of untracked individuals. Furthermore, dissatisfied users may have actively avoided our calls or concealed their participation, introducing potential attrition or survivorship bias. Nonetheless, because our sample includes numerous users who reported no benefits from C2C services, survivorship bias is likely minimal. Third, information spillovers within communities containing C2C users are probable and unmeasured. This spillover may also manifest as a contagion effect regarding C2C registration and usage, though the latter pathway may already be captured within our treatment definition. Ultimately, if unmeasured spillover effects are present, our estimates of the average treatment effects would represent a conservative lower bound.

4. RESULTS

4.1. Average treatment effects on crop productivity and income

We evaluate the short-term effects of three concurrent interventions launched or intensified in 2024—an AI-powered voicebot, SMS advisory services, and human agent-based advice and trainings—on crop productivity, sales, and household income. These effects are measured as recall data during the 2025 rainy season, which spans from May to December and aligns with the primary crop rotation cycle. The recall data were collected in December 2025 to January 2026. Consequently, our estimates capture the short-term effects of C2C services, spanning one to two agricultural seasons.

Compared to non-users, C2C users had generally higher total production value and production value per hectare, our measure of productivity, although not statistically significant (Table 1). C2C users had slightly higher total costs (due to slightly higher inorganic fertilizer use and agrochemical use). As a result, C2C users had slightly higher farm income (production value – costs), although the difference is not statistically significant. C2C users had significantly higher sales (share, volume, and value), while the difference in cash farm income or profits (sales value – costs) among sellers was not statistically significant. For the C2C advisory subsample, production value, farm income, sales, and profits were significantly higher than those of non-users, but productivity was not.

Table 1. Comparison of outcome indicators between control and treatment groups

Indicators	Control	All C2C users	C2C advisory users subsample
Production value (000 NGN)	1906	2015	2099*
Productivity [Production value (000 NGN/ha)]	983	1001	1002
Total cost (000 NGN)	481	496	495
Total cost per hectare (000 NGN/ha)	242	275**	259
Farm Income (Production Value - Cost) (000 NGN)	1425	1518	1603*
Sales (% of harvest)	30	37***	38***
Sales (kg)	1096	1267*	1334**
Sales value (000 NGN)	661	870**	925***
Profit (Sales - Cost) (000 NGN) among sellers	776	937	987*
#Obs	545	1276	998

Note: The Nigerian naira (NGN) to US dollar (USD) average exchange rate in 2025 is 0.0006593 [NGN 1,517 = USD1]. All NGN used are nominal 2025 NGN. The production, sales, and income indicators pertain to the 2025 rainy season (roughly May-December 2025), the main season in the study area, during which many farmers practice relay cropping. The survey was conducted from December 2025 to January 2026. Significance levels are based on t-tests between the corresponding (sub)groups and control group. Significance level: *: $p < .10$, **: $p < .05$, ***: $p < .01$.

After matching and weighting to address selection bias, most results are generally consistent with descriptive data in **Table 1**. Our results show no significant average treatment effects of C2C services on production and productivity on average (**Table 2**). The standard errors for production value are large because production values are highly dispersed across farms and crops, even after extreme outliers were removed.

We find significant effects of C2C services on sales. C2C users sold NGN 161,520 (USD 106) more in crop sales than comparable non-users ($p < 0.05$) [24% of the control mean]. The effect is even higher for the C2C advisory user subsample, where users realize additional sales of NGN 215,380 (USD 142), significant at the 1% level [33% of the control mean]. The estimated effects on profits (sales value – costs) are positive, NGN 91,740 (USD 60) for all users (12% of the control mean) and NGN 129,340 (USD 85) for advisory users (17% of the control mean), but not statistically significant (Table 2).

Table 2. Average treatment effects of C2C services (overall) and advisory services

Models	C2C service	Advisory service
Production value (000 NGN)	-2.81 (111.38)	30.92 (124.34)
Productivity [Production value (000 NGN/ha)]	-29.84 (47.94)	-27.51 (51.18)
Farm Income (Production Value - Cost) (000 NGN)	-16.32 (98.26)	0.13 (109.36)
Sales value (000 NGN)	161.52** (72.92)	215.38*** (80.38)
Sales (% of harvest)	0.06*** (0.02)	0.09*** (0.02)
Sales (kg)	145.91 (105.53)	241.65** (111.10)
Profit (Sales - Cost) (000 NGN) [among sellers]	91.74 (91.36)	129.34 (100.82)
#Obs	1736	1487

Note: Significance level: +: $p < .15$, *: $p < .10$, **: $p < .05$, ***: $p < .01$. Each outcome indicator is modeled via IPWRA, which is largely consistent with kernel techniques. The figures are the average treatment effects on the treated (ATET) of the treatment groups (C2C services, advisory services) vis-à-vis control group. The figures in parentheses are the standard errors. The number of observations (#Obs) includes both treated and control farmers used in each model.

4.2. Heterogeneous treatment effects

The outcome estimates above represent average treatment effects. To identify whether specific subgroups benefited more than others, we estimated treatment effects by subgroup, using interaction terms in the outcome regression models (IPWRA) and analyzed correlates of self-reported benefits (see **Annex 9** for details).

Crop-level effects: We modeled the outcomes of C2C advisory services separately by main crop. Examining the outcomes by crop reveals considerable heterogeneity of effects hidden behind the insignificant productivity effects on average. High productivity effects were observed across most crops: 35% for sorghum (the second most common crop), 13% for groundnut, and 153% for sesame (**Annex Table 9.1**). After weighting, productivity gains remained significant only for sorghum producers and sesame producers, while positive effects on sales volumes and values persisted for sorghum producers and groundnut producers. Market participation increased, with 15 to 16 percentage points more farmers selling sorghum, millet, and groundnut. After weighting, the positive market participation effects remained only for groundnut farmers. The lack of significance for some crops may reflect the smaller crop-level samples and limited power to detect effects. Overall, the share of harvest sold was 2 to 14 percentage points higher among treatment farmers than among control farmers for six of the eight crops (unweighted estimates). High sales volume effects were estimated for most crops (ranging from 54% more groundnuts, 73% more sesame to 99% more sorghum sold), alongside high sales revenue effects (94% for sorghum and 98% for groundnut). However, rice (most common crop) producers who are users of C2C had significantly lower

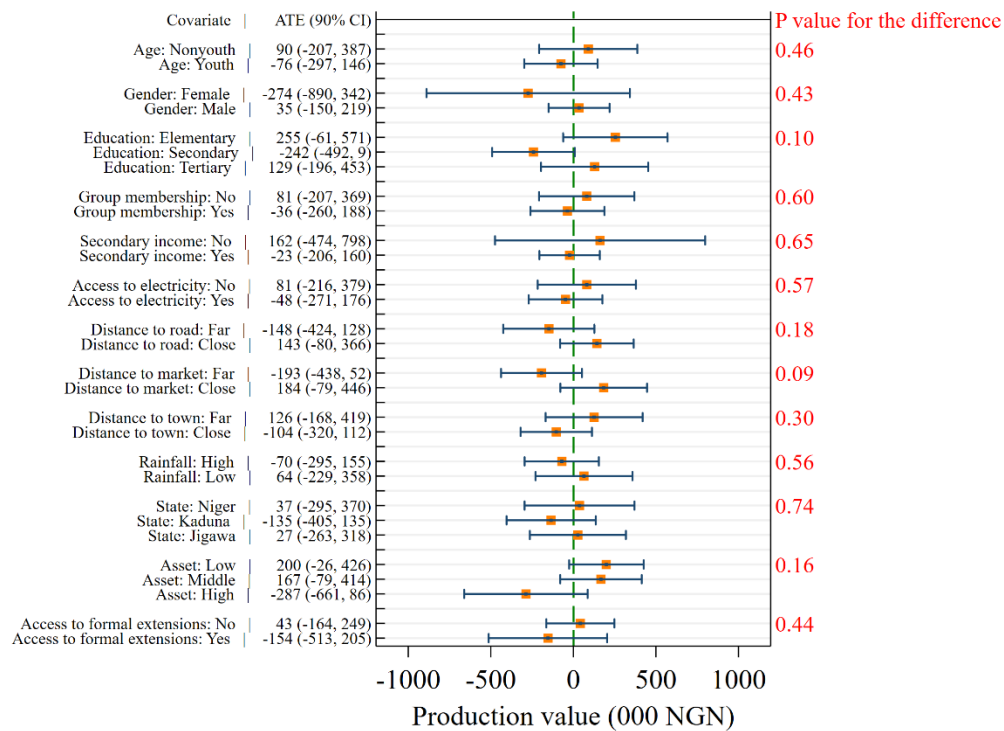
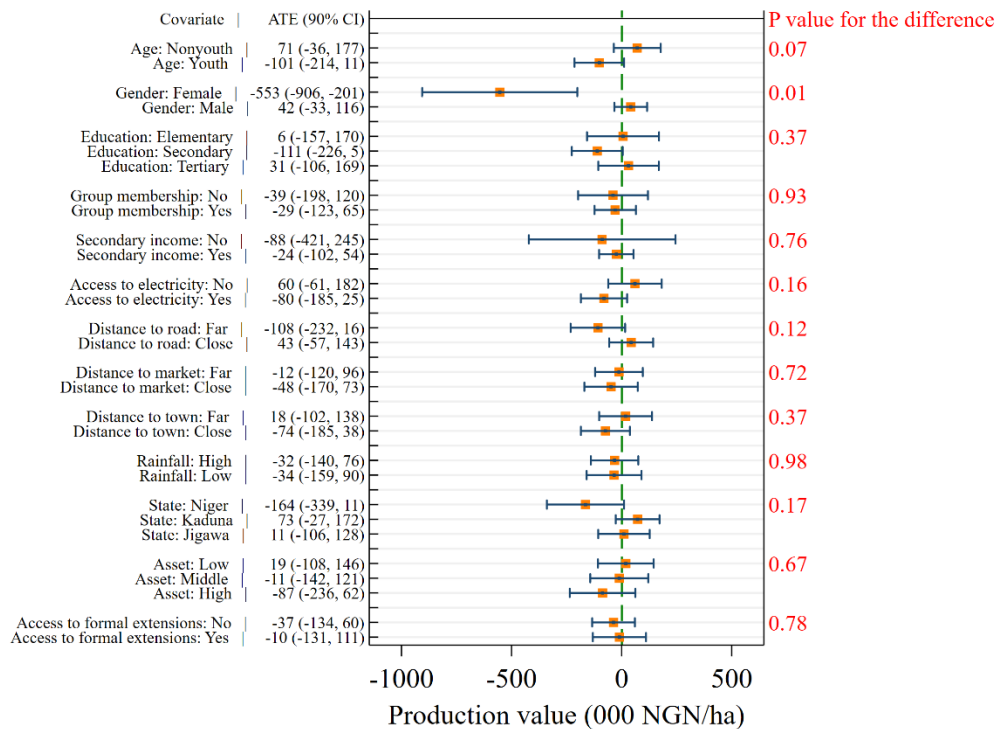
yields, before and after weighting. C2C users seem to have experienced significant negative yield effects in their rice farms, although sales share, volume, and profits were not significantly affected. Finally, home consumption levels were generally maintained across crops, except for millet and rice, though seed saving was slightly lower, consistent with increased purchase of fresh seeds.

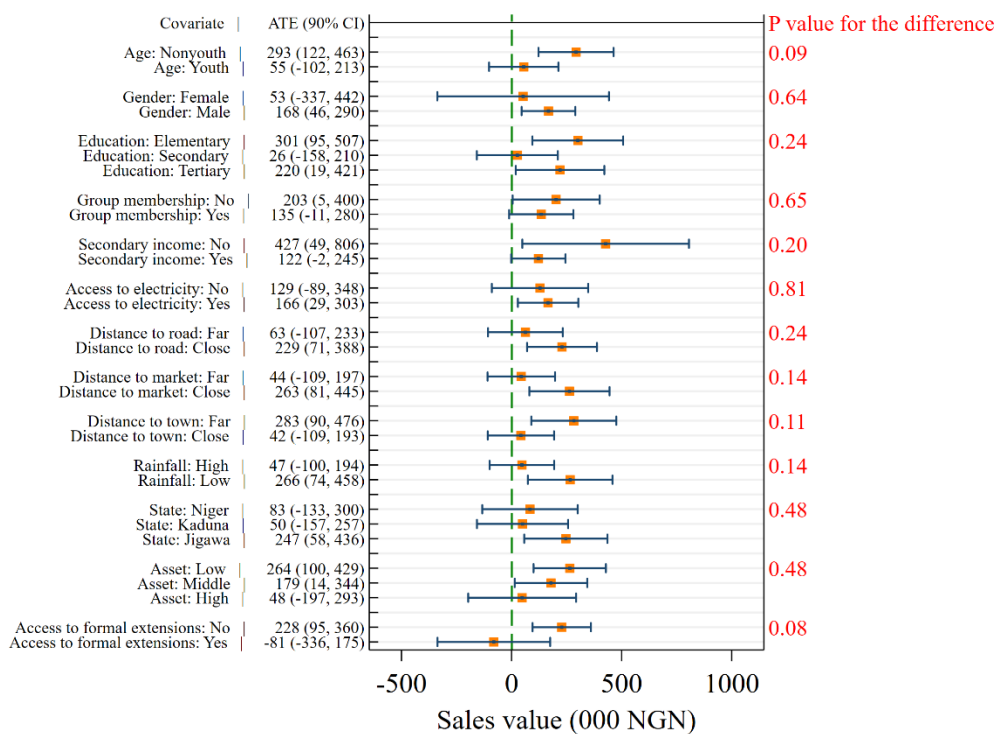
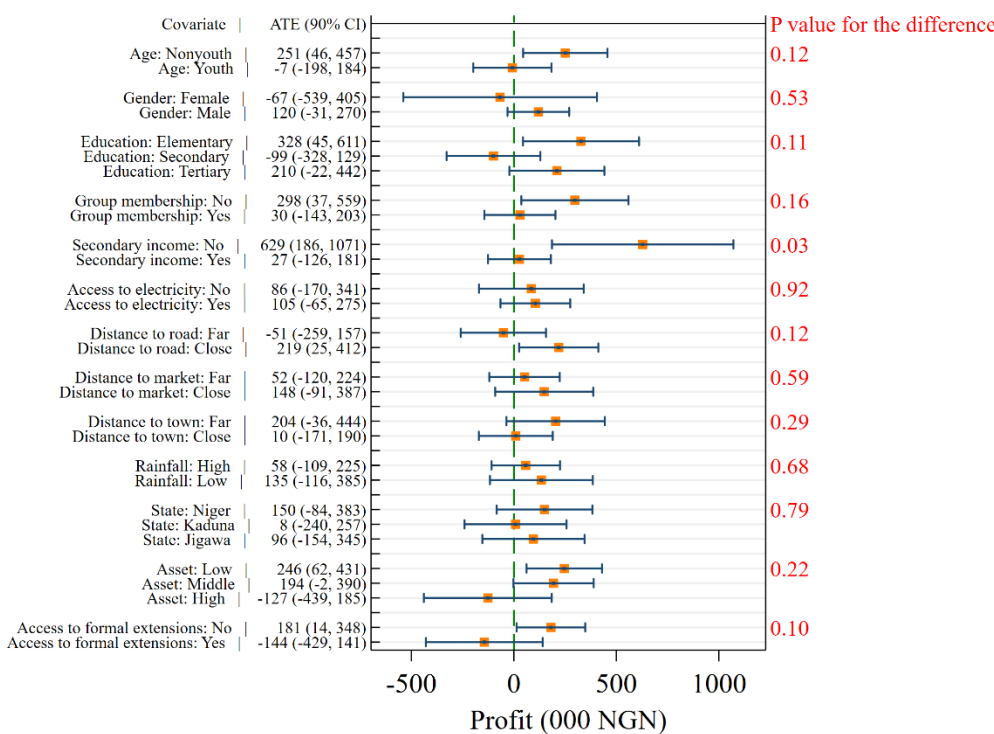
Age: Survey evidence consistently shows that non-youth farmers (>35 of age) gain significantly higher productivity, sales, and profit effects than youth. Paradoxically, youth are more likely to register for and use C2C digital services, given their higher digital literacy. However, older farmers—who tend to have more land, more established market relationships, and more savings to invest in recommended practices—appear better positioned to realize the gains from advisory (**Figure 4**). Qualitative data corroborate this from a different angle: extension agents note that youth farmers are more enthusiastic early adopters, but older farmers who have sustained C2C engagement over multiple seasons are the ones reporting dramatic yield and income improvements. The implication is that the returns to advisory accumulate over time and through sustained behavior change.

“Youth involved in farming use it more, especially those aged 25 to 30. Teenagers are fewer, and older people may be slowing down... So the youth participate more than older farmers.” — Extension agent, Miga, Jigawa

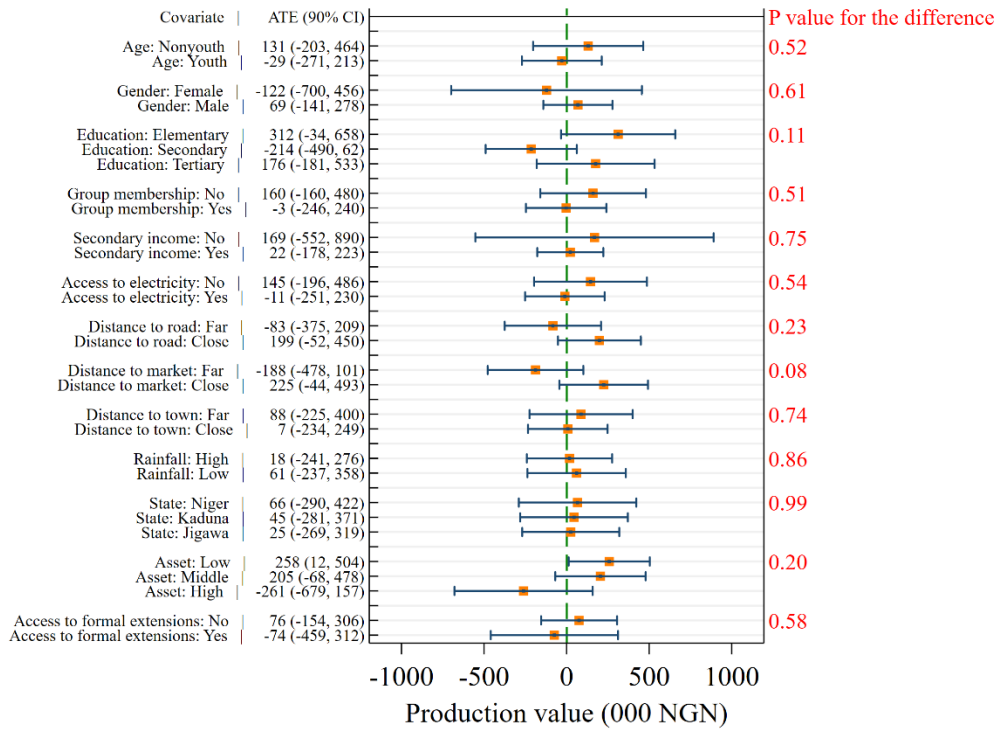
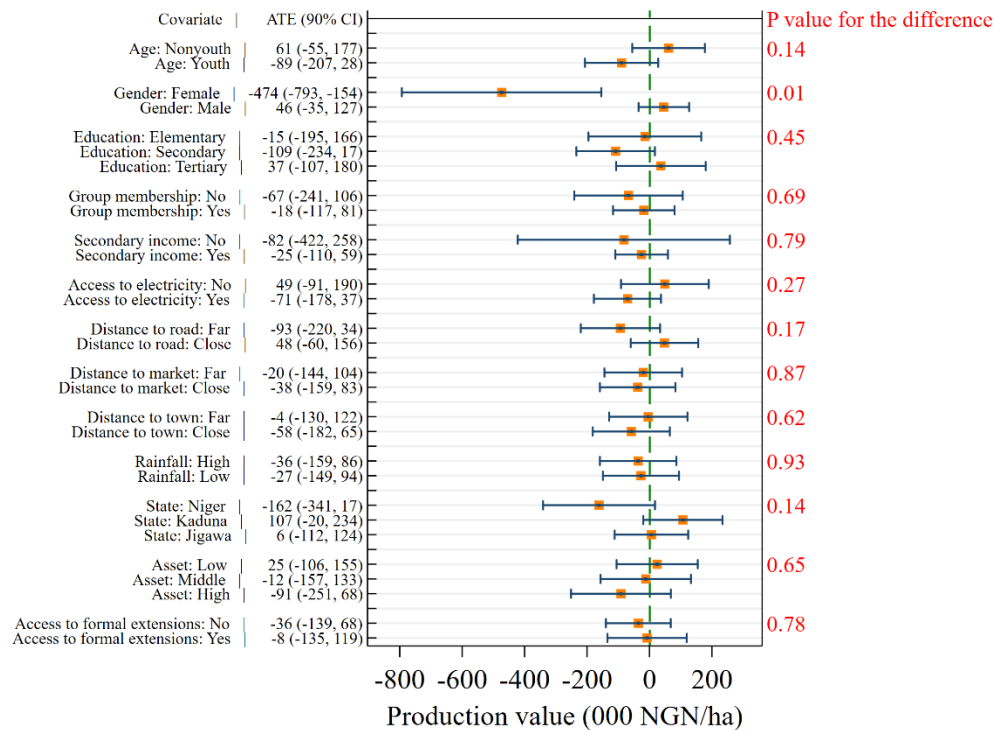
Figure 4. Heterogeneous treatment effects of C2C services and C2C advisory services

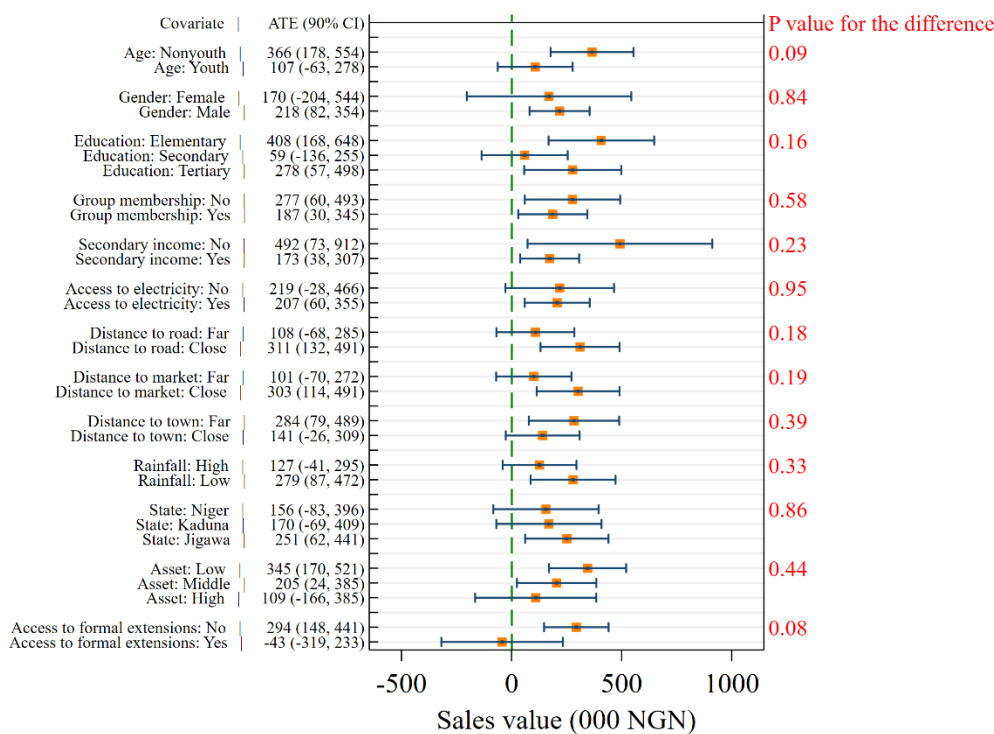
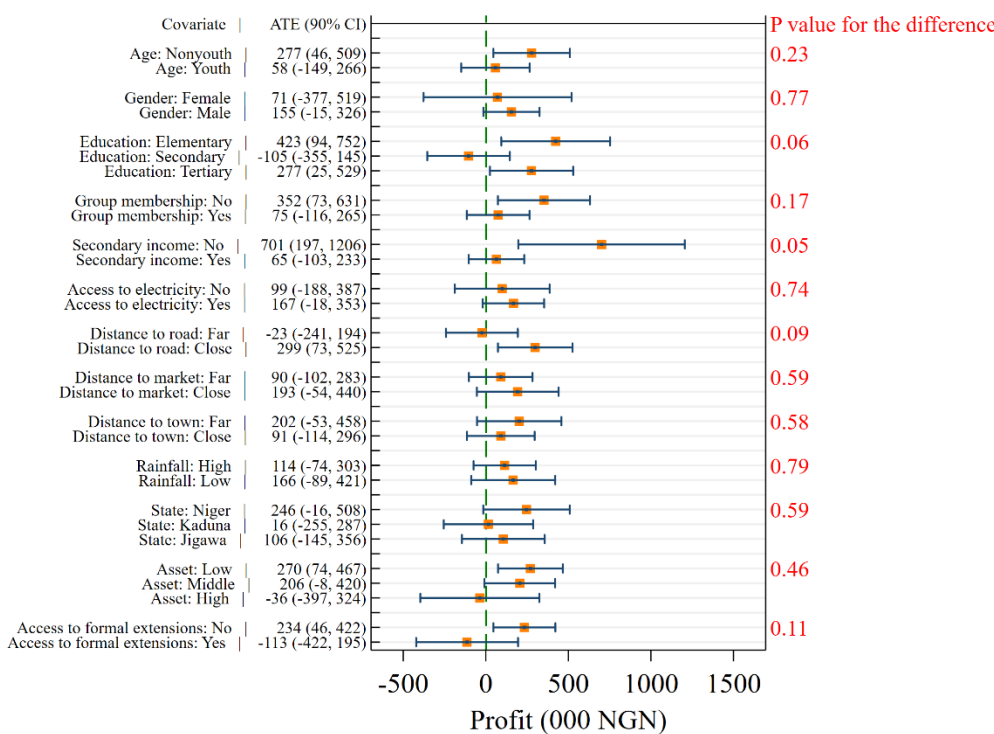
a. C2C services





b. C2C advisory services





Note: 1) Age: Youth is defined as respondents aged 35 years or younger; 2) Distance to road: Households are classified as close to roads if they are located within 150 meters of the nearest road; 3) Distance to market: Households are classified as close to market if they are located within 75 km of the nearest market; 4) Distance to town: Households are classified as close to town if

they are located within 15 km of the nearest town; 5) Rainfall: Households are classified as having received high rainfall if they had more than 866 mm of rainfall in 2025; 6) Asset terciles are constructed based on asset scores, with respondents evenly divided into three groups: low, middle, and high; 7) Access to formal extension: Defined as farmers having received information from at least one of the following sources: government programs, demonstration farms, training centers, or extension agents.

Gender: Women are consistently underrepresented across all C2C services. E-wallet adoption among women ranges from 10% (Gwaram, Jigawa) to 25–32% (Miga, Jigawa) compared to 75–90% for men, based on FGDs in 23 communities. In the survey, women are 16% of all C2C users and 17% of advisory users, and only 7% of AI hotline callers (Annex Table 7.1). Male users experienced significant sales gains (NGN 168,000; **Figure 4**), while sales gains are wide-ranging and inconclusive for women due to small sample size. What is clear is that women have lower productivity than men (**Figure 4**). The barriers are structural and cultural: as most agricultural land and financial decisions are male-controlled; women are less likely to own a mobile phone; veiling customs in some communities restrict women’s movement and communication with male agents; and awareness campaigns have not specifically targeted women. Extension agents across states confirm that women’s participation requires dedicated female agent networks:

“When a man sees his wife having an interview or discussion with another woman, he won't feel anything; he will be comfortable. Unlike when it's a man—even if there is nothing going on. So, I suggest women agents should be involved.” — FGD participant, Dutse, Jigawa

Education and group membership: The relationship between education and profit effects is not clear: point estimates are larger for those with no formal schooling up to elementary school and for those with tertiary education than for those with secondary education, but the differences are not statistically significant (Figure 4). Those not members of groups or associations also show larger point estimates, again without statistically significant differences. At the same time, farmers with tertiary education are significantly more likely to self-report benefits from C2C services, and group members are more likely to report benefits from the AI hotline (Annex Table 9.3). This highlights the role of absorptive capacity: advice is more actionable for farmers who can read SMS messages, understand technical recommendations, and draw on peer networks.

Geography: Regression analysis of self-reported benefits shows that farmers in Jigawa are significantly more likely, and farmers in Kaduna significantly less likely, to report positive outcomes than those in Niger State (Annex Table 9.3); effects on profits, sales, and productivity do not differ significantly across states (Figure 4). Qualitative data suggest several explanations for the stronger results in Jigawa in terms of sales revenue: C2C has been operating longer there; the crops there (rice, maize) align closely with C2C’s expertise and seed offerings; and digital infrastructure is stronger. In Kaduna, other enterprises have offered similar advisory content for years, which narrows C2C’s perceived advantage (Section 4.4). In Niger State,

despite transformative advisory on rice in Gbako and Lavun LGAs, the 2024–2025 flooding heavily disrupted outcomes, and is the likely reason for the slightly lower productivity gains in Niger compared to other states.

“It is only from C2C that we get information and have this improvement. We don’t do any other thinking apart from C2C. The others are not comparable to C2C.” — C2C user, Niger State

Market access: Because proximity to roads and markets did not change between the period before C2C use and the survey, we use these variables for the heterogeneity analysis. Farmers closer to roads show somewhat higher market-related effects, consistent with the marketing-channel interpretation of C2C’s sales effects. Those without road access benefit less from C2C’s market price advisory since they cannot easily act on price information.

Asset status: Baseline asset tercile is used for heterogeneity analysis. For most outcome indicators, effects do not differ significantly across asset terciles. However, for sales and profits, farmers in the lowest asset tercile (poorest) show significantly larger effects (Figure 4). Anyone with a basic-feature phone can call the AI hotline and seek for advice. C2C also provides integrated services from advisory and input marketplace to e-wallet and credit facilitation that address multiple constraints by farmers.

“Smallholder farmers have the land to cultivate but they don’t have the necessary funding. So, C2C comes to their aid with input loans to be repaid afterwards.” — Agro-processor partner, Kaduna North

Treatment effects by service: We isolated the AI users (N=239) and SMS subsamples (N=506) to estimate indicative treatment effects of these services on the outcomes. With smaller sample sizes and higher standard errors, we focus on the direction of change rather than the magnitude to provide insights into the relative contribution of these services. The effects of C2C services broadly, and of advisory services more specifically, carry through to the AI and SMS subsamples. Before weighting and matching, sales were significantly higher than among non-users (**Table 3**). After weighting and matching, the sales and profit effects of AI are positive but not statistically significant, while those of SMS are close to zero or negative and not statistically significant, likely because of widely dispersed values and a sample too small to detect the minimum effect size. Power calculations were conducted for the comparisons of all users and of advisory users with non-users, but not for the AI and SMS subsamples, which is why we treat the latter as indicative. The effect on sales share is higher for AI users. Notably, the effects of SMS on production value per hectare and on farm income are significantly negative (**Table 4**). Several explanations are possible, although this cross-sectional design cannot separate them. First, SMS receivers were drawn from a 2024 C2C project and are concentrated in Jigawa (65%, against 52% of the control group; Annex Table 7.1), so

the estimate partly reflects that state's crop mix and the 2024–2025 flooding rather than the service alone. Second, SMS messages are one-way and generic; they cannot respond to farm-specific conditions, and untimely or mismatched recommendations may lead to input or timing decisions that lower yields. The negative estimate is consistent with the broader finding that standalone digital channels do not produce the same outcomes as phygital delivery, and it warrants a review of SMS content and timing within C2C.

Table 3. Comparison of outcome indicators between control and different treatment groups

Indicators	Control	All C2C users	Advisory only	AI only	SMS only
Production value (000 NGN)	1906	2015	2099*	2086	1976
Productivity (000 NGN/ha)	983	1001	1002	1047	956
Total cost (000 NGN)	481	496	495	479	477
Total cost (000 NGN/ha)	242	275**	259	276*	241
Farm income (Production Value - Cost) (000 NGN)	1425	1518	1603*	1607	1499
Sales (% of harvest)	30	37***	38***	41***	37***
Sales (kg)	1096	1267*	1334**	1326*	1271
Sales value (000 NGN)	661	870**	925***	947***	884*
Profit (Sales - Cost) (000 NGN)	776	937	987*	999*	957
#Obs	545	1276	998	239	506

Note: The Nigerian naira (NGN) to US dollar (USD) average exchange rate in 2025 is 0.0006593 [NGN 1,517 = USD1]. Significance levels are based on t-test between the corresponding (sub)groups and control group. Significance level: *: p<.10, **: p<.05, ***: p<.01.

Table 4. Primary outcome estimates of C2C services from IPWRA models

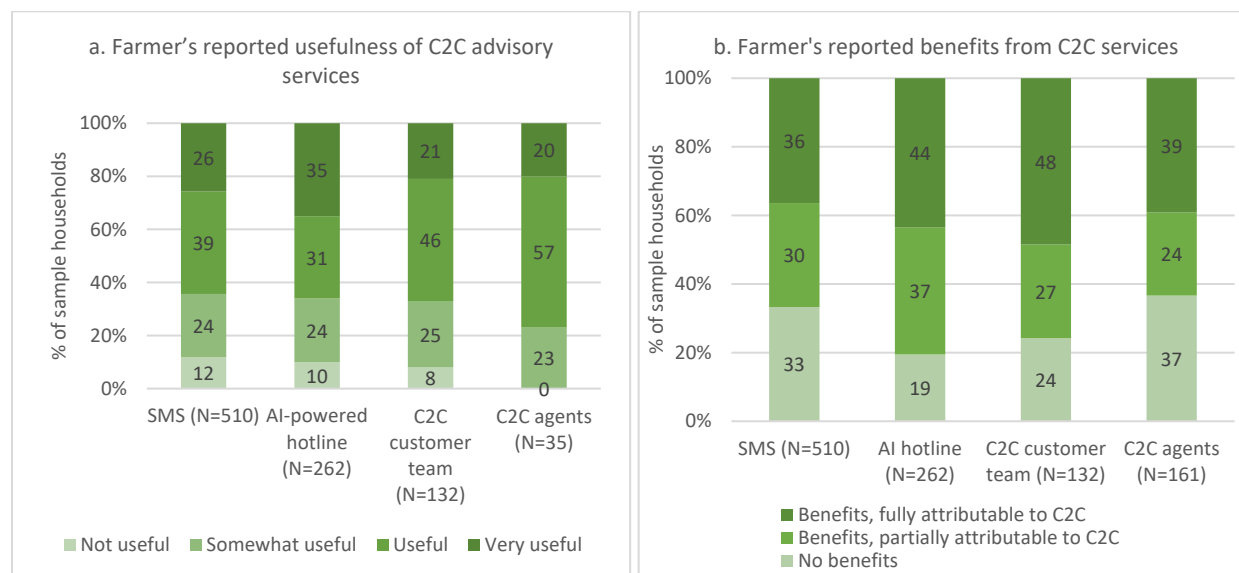
Models	C2C service	Advisory service	AI hotline	SMS
Production value (000 NGN)	-2.81 (111.38)	30.92 (124.34)	-58.08 (199.77)	-252.81+ (173.77)
Productivity (000 NGN/ha)	-29.84 (47.94)	-27.51 (51.18)	64.03 (76.05)	-203.73*** (76.47)
Farm income (Production Value - Cost) (000 NGN)	-16.32 (98.26)	0.13 (109.36)	-34.11 (176.51)	-256.60* (139.83)
Sales value (000 NGN)	161.52** (72.92)	215.38*** (80.38)	219.54+ (141.65)	24.34 (129.67)
Sales (% of harvest)	0.06*** (0.02)	0.09*** (0.02)	0.12*** (0.03)	0.07*** (0.02)
Sales (kg)	145.91 (105.53)	241.65** (111.10)	208.07 (162.46)	84.11 (151.62)
Profit (Sales - Cost) (000 NGN)	91.74 (91.36)	129.34 (100.82)	163.62 (168.91)	-77.23 (136.80)
#Obs	1736	1487	780	1022

Note: Significance level: +: p<.15, *: p<.10, **: p<.05, ***: p<.01. Each outcome indicator is modeled via IPWRA. The figures are the average treatment effects on the treated (ATET) of the treatment groups (C2C services, advisory services, AI hotline, and SMS) vis-à-vis control group. The figures in parentheses are the standard errors.

Based on stakeholder feedback, about a third of the users reported no or little usefulness and no benefits (**Figure 5**). Per service, 36% of SMS receivers, 34% of AI callers, 33% of C2C customer team

callers, and 23% of those interacting with C2C agents reported no or little usefulness of the C2C advisory service. In terms of reported benefits or improvements in outcomes, 33% of SMS receivers, 19% of AI callers, 24% of C2C customer team callers, and 37% of those interacting with C2C agents reported no benefits from C2C services.

Figure 5. Proportion of users reporting usefulness and benefits from C2C advisory services, by type



Based on the survey, queries to the AI hotline primarily focused on pest control and seed selection (including sourcing). Many callers also inquired about fertilizer application and micro-dosing, while a few sought advice on weather forecasts, planting timing, and best practices for crops like rice, sesame, potato, and soybeans. The C2C customer hotline followed a similar pattern, with the majority of inquiries centered on pest control and seeds. Additional queries covered fertilizers, C2C services, loan and grant applications, market pricing, and soil fertility strategies. Notably, engagement with human intermediaries remains low: only 161 users reported interacting with C2C agents, and just 35 received direct advisory services from them. Among those who reported getting advice from agents, the most common queries were pest control and seed selection, followed by fertilizers, C2C services, and loan and grant applications.

Who was more likely to report having benefited from C2C services? About 60% of users reported having benefited from C2C. **Annex Table 9.3** shows who were more likely to report benefits. Those who completed tertiary education were more likely to report benefits from SMS and advisory in general; and those with secondary or tertiary education were more likely to report benefits from C2C services in general.

Turning to the AI-powered hotline, male users were less likely than female users to report benefits from advisory services in general ($p < 0.05$) and, at the 15% level only, from the AI hotline. Users in Kaduna

were the least likely to report having benefited from the AI-powered hotline. Compared to users who were not part of groups or associations, group members were more likely to report having benefited from the AI-powered hotline. Those in areas receiving more annual rainfall were more likely to report having benefited from the AI-powered hotline.

4.3. Mechanisms

Further examination of the intermediate outcomes sheds light on the mechanisms and pathways behind the null productivity effects and the positive sales effects of C2C services on average. Among the C2C service users and C2C advisory user subsample, use of formal seed (from formal sources including traders, extension agents, or seed companies) and agrochemicals is significantly higher than among non-users (**Table 5**). However, there are no clear differences in the adoption of agricultural management practices promoted by C2C (**Annex 10**). The use of inorganic fertilizer was higher while the use of organic fertilizer was lower among C2C service users than non-users, although only significantly different in the simple comparisons and only marginally significant or insignificant after weighting. Intermediate production-related outcomes provide no clear and strong indications of pathways to higher production and productivity on average (**Table 5**). Survey and qualitative data from C2C users corroborate this finding. Only 36% of surveyed C2C users reported receiving benefits via improved production (**Figure 6**); and about a third of advisory service users (AI, SMS, human agents, customer call center) reported little or no usefulness or benefit (see **Figure 5**). FGD participants largely report yield gains, but some users reported lower yields, and some non-users also reported improved yields. Overall, these different data sources consistently show that positive yield effects may have been limited to some users only while the majority of users did not see yield improvements. When we disaggregated AI and SMS users, effects of AI generally mirror the effects of C2C users and of C2C advisory users. Among AI users, sourcing seed from formal sources is significantly higher; inorganic fertilizer use is higher (although not significant in some cases), while organic fertilizer use is significantly lower than among non-users (**Table 5**). For the SMS group, agrochemical use is much higher, as well as use of fresh seeds from formal sources. For all other intermediate indicators, there is no clear effect of AI and SMS services.

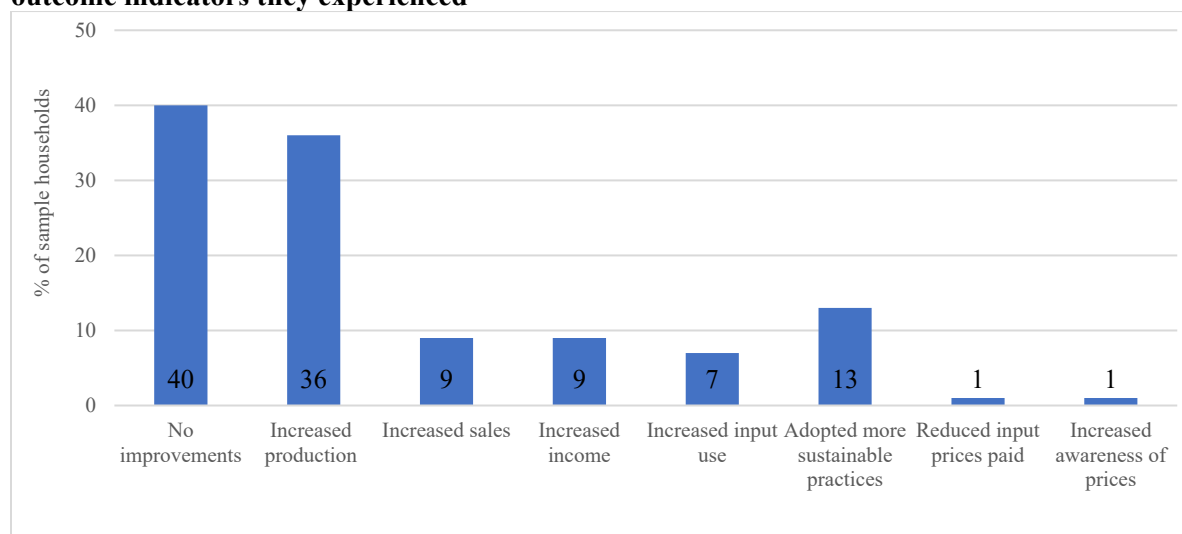
Table 5. Intermediate outcome estimates of C2C services via IPWRA models

Intermediate outcome indicators/ ¹	C2C service	Advisory service	AI hotline	SMS
Household used inorganic fertilizer (dummy)	0.018 (0.019)	0.008 (0.020)	0.019 (0.019)	0.017 (0.026)
Inorganic fertilizer quantity (kg)	-2.509 (12.550)	3.346 (12.293)	-22.869 (17.507)	7.063 (16.119)
Inorganic fertilizer quantity (kg/ha)	9.789* (5.765)	7.335 (5.755)	7.961 (8.584)	4.667 (8.012)
Household used organic fertilizer (dummy)	-0.028 (0.028)	-0.047+ (0.030)	-0.126*** (0.045)	0.015 (0.038)
Organic fertilizer quantity (kg)	-24.462* (13.037)	-23.341* (14.015)	-60.331*** (21.051)	4.351 (16.030)
Organic fertilizer quantity (kg/ha)	-6.223 (7.770)	-7.799 (8.378)	-21.527* (13.000)	4.085 (9.940)
Household used agrochemical (dummy)	0.061** (0.024)	0.058** (0.027)	0.051 (0.043)	0.081** (0.032)
Total farming costs (000 NGN)	13.511 (25.252)	30.794 (26.679)	-23.972 (41.407)	3.796 (49.913)
Total farming costs (000 NGN/ha)	27.591** (14.048)	25.443* (13.829)	38.858* (20.507)	-3.121 (25.370)
<i>Seed use</i>				
Farmer self-reportedly using improved seed variety	0.008 (0.023)	0.023 (0.024)	0.008 (0.022)	0.029 (0.027)
Seeds were newly acquired or recycled within optimal times	0.024 (0.026)	0.050* (0.029)	-0.014 (0.044)	0.089** (0.036)
Seeds were acquired from formal sources (=1)	0.059** (0.028)	0.096*** (0.030)	0.109** (0.045)	0.091** (0.036)
Quality seed composite index	-0.008 (0.016)	-0.001 (0.017)	-0.007 (0.016)	-0.003 (0.019)
Average crop price received (NGN/kg)	-9.153 (27.157)	-18.204 (28.729)	-4.238 (44.420)	-24.051 (34.112)
Adoption of sustainable practices (count, 0-19)	0.139	0.026	-0.153	0.290+

Intermediate outcome indicators/ ¹	C2C service	Advisory service	AI hotline	SMS
	(0.126)	(0.134)	(0.193)	(0.181)
#Obs	1736	1487	780	1022

Note: Significance level: +: $p < .15$, *: $p < .10$, **: $p < .05$, ***: $p < .01$. Each outcome indicator is modeled via IPWRA. The figures are the average treatment effects on the treated (ATET) of the treatment groups (C2C services, advisory services, AI hotline, and SMS) vis-à-vis control group. Variable definitions are in Annex Table 2.1; #Obs includes both treated and control farmers used in each model.

Figure 6. Proportion of users reporting benefits from C2C services and the specific improvements in outcome indicators they experienced



Note: The specific survey question is “Did you find improvements in the following [indicators] because of Crop2Cash service?”

The sales–marketing–quality pathway is the most consistently and richly documented mechanism across both quantitative and qualitative data. What is consistent among FGD participants and the survey results is the higher sales values through produce quality differentiation, access to market price information, buyer diversification, and improved postharvest storage. The crops that FGD participants most consistently mentioned as having increased sales were groundnuts, rice, and maize. Four specific sub-mechanisms are identifiable. The first is quality-based price differentiation. From FGD data, C2C’s certified seeds produce grain that is visually distinguishable at the point of sale—differences in grain uniformity, color, and moisture content allow buyers to discriminate between C2C-user and non-user produce in the same market on the same day. FGD participants in Kubau (Kaduna) described this mechanism explicitly:

“Because even if you go to the market now to buy farm produce with yours and mine displayed with a price tag of 2,000 naira — my own will be priced at 1,500 naira... because the quality of your produce is visible, which is as a result of good seed variety and other good agronomic practices.” — FGD participant

This quality premium is not a marginal effect: field notes from Dutse (Jigawa) record that C2C users’ rice commanded NGN 1,500 per unit compared with NGN 1,000 for non-users selling in the same market simultaneously—a 50% price premium which participants attributed largely to observable quality differences. Participants described how certified seed and improved agronomic practices visibly elevated produce quality.

“A quality good doesn’t necessarily need to be taken to the market; the buyers will come and seek it out themselves.” — FGD participant

Second, access to market information and buyer diversification constituted additional drivers of sales performance. C2C’s price portal enabled users to compare prevailing market prices prior to selling, directly influencing transaction behavior:

“For groundnuts, when you enter the C2C portal, you will find prices, which can help with price determination.” — FGD participant

One participant transitioned from retail to bulk wholesale selling based on C2C advisory, citing improved profitability. Another explicitly linked C2C advisory to a change in marketing strategy, moving away from dependence on a single buyer toward competitive price discovery:

“I don’t sell to just one buyer again because others can come with higher prices.” — FGD participant

“We sell more because we get informed on when to sell better.” — FGD participant

The third sub-mechanism is the corporate buyer linkage. C2C’s network of business partners includes seed companies, agro-processors, and commodity traders who buy in bulk at prices systematically above those offered by petty traders at village markets. In Bida (Niger State), where market infrastructure is thinnest and the counterfactual of informal petty trader dependence is starkest, this linkage produces the

largest price improvements, based on KII and FGD data. One rice farmer quoted prices that doubled following C2C-facilitated corporate buyer introduction. This mechanism is particularly important because it is partially independent of farm advisory: even with limited adoption of recommended farm practices and limited productivity effects, farmers can gain income from buyer linkage if their produce meets minimum quality standards.

The fourth sub-mechanism is postharvest storage and market timing. C2C's advisory on hermetic bag storage, chemical pest control (including specific fumigants against weevil infestation), and the timing of sales relative to seasonal price cycles enables users to hold produce beyond the harvest-time price trough. C2C-recommended pest management techniques, including improved postharvest loss management against insect and rodent infestation, enabled users to maintain grain quality over longer periods and sell at more favorable times and prices:

"They showed us some kind of powder that repels insects and rodents... Our stored produce remained free from insect infestation when we followed their storage advice." — FGD participant

"They were advised to store their produce in good condition and sell late at a more reasonable price. The change in storage improved their income." — FGD note

"I changed the way I store my products based on the advice I received from C2C. I implemented measures to prevent rats and pests from accessing my produce. I no longer travel far for marketing. I sell at the nearby market." — FGD participant

The most structurally significant mechanism, however, is the reorientation of farming logic from subsistence to market-oriented production. In Kubau, Kaduna, participants described a fundamental shift in their approach to agriculture:

"We used to do farming for consumption only... Now, farming is done both for personal consumption and for business purposes. This is the reason why the farming practices were expanded around this region." — FGD participant

This transition from household food consumption to commercial production may directly explain why C2C users register higher sales values even when operating within the same commodity price environment as non-users, and why farm area expansion has become a rational response to improved market access and price intelligence.

4.4. Reflections on scalability, competitiveness and sustainability of C2C services

C2C operates in communities and provides services along with other service providers and competitors. C2C is not the only provider aiming to address farmers' constraints; many other providers—government, nongovernmental organizations (NGOs), other social enterprises, traders, and private companies—do so as well. This section summarizes the experiences and feedback of diverse stakeholders on the strengths, contributions, and competitive edge of C2C services (see **Annex 11** for the summary). Returning to the ToC diagram (**Figure 1**), we mapped the issues and threats to the sustainability and expansion of C2C services, and the opportunities and areas for improvement for accelerating and sustaining their effects, from better knowledge integration and content quality of advisory services and greater use of a phygital approach to strengthening the competitive niche of its commercial services, market support, and intentionality in women's empowerment and climate resilience. The seven entry points are: (1) knowledge integration: better integration of state-of-the-art global, national and local knowledge bases; (2) content: stronger quality and content of advisory services; (3) phygital strategy: embracing a phygital approach and expanding human-based advisory; (4) competitive edge: a stronger niche in the input marketplace and digital payments; (5) loan repayment: technical and marketing support for farmers to ensure loan repayment; (6) market support: a pivot toward postharvest and marketing support; and (7) inclusion and resilience: explicit strategies for women's empowerment and climate resilience.

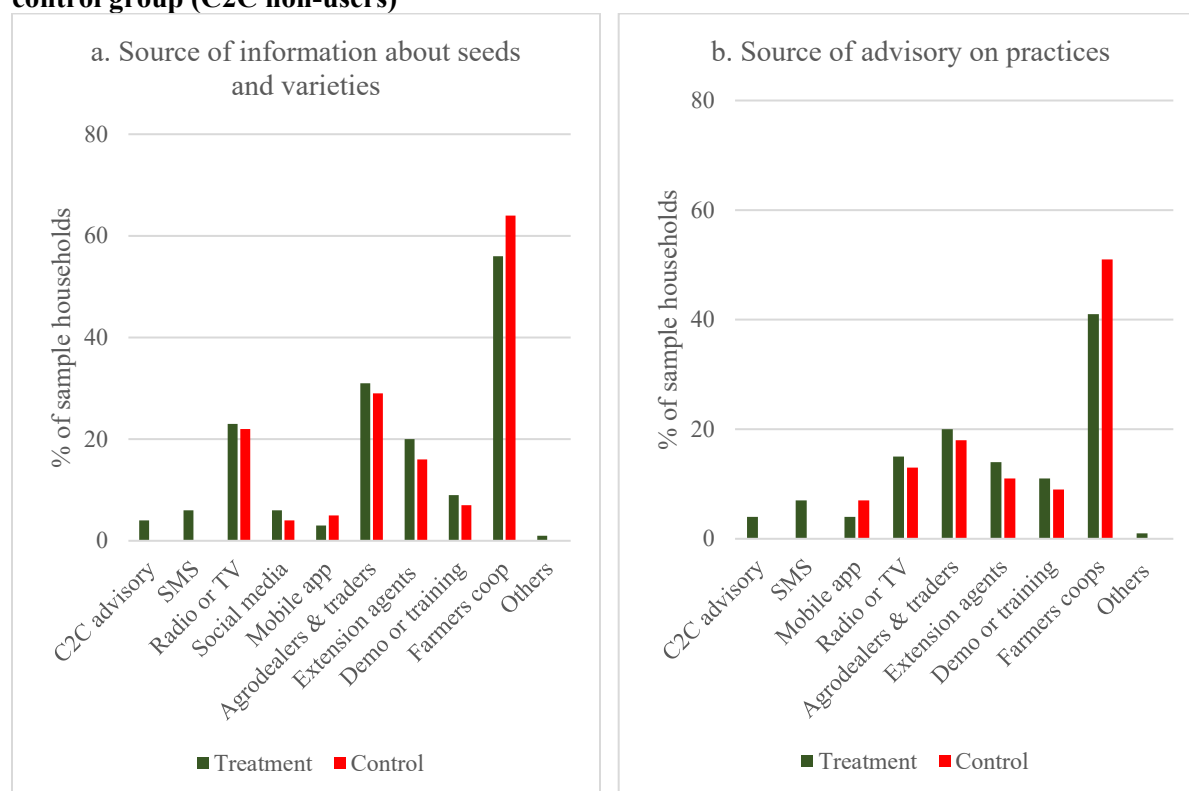
Contribution and competitive edge

There are many sources of agricultural advice in the study areas, as highlighted by the FGD and survey participants. Other providers include radio programs, government extension agents, extension agents of NGOs or private companies operating in study areas, traders, and farmers' organizations and cooperatives. As seen in **Figure 7**, there is generally no clear difference in the sources of agricultural information between C2C users and non-users. The perceived contribution of C2C services is mixed across diverse stakeholders and communities. Extension agents of other NGOs were rated higher in some communities; but C2C services were rated higher in others.

"They boosted yields. Previously, we planted with wide spacing; C2C taught 20 cm by 20 cm spacing for rice, and farmers who adopted it saw benefits. They also taught improved planting for groundnut and cassava, leading to good harvests." — FGD participant

"...very reliable advice, particularly on plant spacing and fertilizer application. We have been getting good results from this advice." — FGD participant

Figure 7. Sources of information and advisory services between treatment group (C2C users) and control group (C2C non-users)



However, users highlight that they have other sources of information. Even without C2C, they have sources of information and advice on farming. C2C non-users also confirm this. They do not see an information advantage for users, since they (non-users) have access to the same information.

“For me, I will say that they are better, but understand that we non-users also have other ways of getting advice or benefiting from farm activities, and they work, too.” — FGD participant, C2C non-user

“In terms of good seeds, we do have access to it. This from research institutes. They bring seed for us to practice with.”— FGD participant, C2C non-user

External validity and scalability of the effect estimates

We do not have sufficient data at different scales to be more conclusive on the external validity and scalability of the outcome results (see List, 2024, on the “voltage effect”, the tendency for effects to diminish as an intervention scales up), but we offer some insights. The study areas have diverse sources of information; the effects may be larger in areas with fewer sources: our heterogeneity analysis shows that in areas with limited formal extension services, the sales and profit effects were larger (Figure 4). This is also corroborated by qualitative data showing high appreciation and perceived value of C2C advisory in areas where government extension agents or NGO projects are scarce. Similarly, our heterogeneity analysis shows that those not members of groups had larger (though not statistically different) profit effects, suggesting that C2C services help fill the institutional void.

The sample households are in closer proximity to paved roads than the average rural population, and the heterogeneity analysis shows that sales effects were greater for those closer to paved roads and markets, likely because of greater access to more lucrative markets and different buyers. The effects may not be similar in areas with limited market opportunities.

The bundled services may have mattered more than any single service. None of the individual services (AI alone, SMS alone) show equally strong and consistent effects as the integrated C2C user group; and our sample is too small to separate the effects of the other services. The qualitative data indicate strong perceived value of the integrated, bundled services.

Our data also show that areas with electricity had greater uptake of C2C services, which is expected because phones need to be charged; C2C services may therefore be less accessible in areas without electricity. Lastly, while our data show that the poorest tercile within our sample had larger sales and profit effects, our sampling covered farmers who were generally better off, with a reasonable asset base, and not the ultra-poor. This needs to be tested further with expanded datasets.

In sum, external validity is supported but bounded. The study sample is drawn from LGAs where C2C already operates, limiting generalization to communities with broadly similar characteristics (crop mix, phone penetration, agro-dealer infrastructure). The documented sales effects and self-reported benefits are consistent with the 60 Decibels (2023) self-reported findings and with GSMA (2024) satisfaction data, providing triangulated external corroboration. Generalization to the ultra-poor and to more remote or infrastructure-poor settings would require additional evidence.

Commercial sustainability

Advisory differentiation is real but variable by geography. In Niger State, where pre-existing advisory infrastructure is thin, C2C’s advisory is transformative. In Kaduna, where a non-profit and a for-profit enterprise have been operating for years with similar content, C2C’s advantage narrows to frequency and the AI hotline. In Jigawa, the AI hotline is strongly adopted (~90% of farmers in Gwaram use the call

center, based on FGD), but differentiation is limited because the same extension agents deliver both C2C and government advisory. There is overall appreciation of the contribution of AI, which KII and FGD participants considered unique and a great complement to the integrated advisory services.

For sustainability, C2C must address the technical issues in its advisory services. Some survey respondents and FGD participants reported technical issues, noting that they tried to call the AI service but could not connect, mainly because of network failures. Others mentioned that while C2C provided initial sensitization and inputs, there was a lack of consistent follow-up from the team. The AI hotline requires an urgent functionality audit to address the 42% telecom infrastructure uptime rate. Language expansion to Nupe and other local languages is critical for Niger State and other areas with non-Hausa populations. KII and FGD participants valued the advisory from human agents, highlighting the need to pivot to a more phygital and integrated approach.

There is a need to examine why there is no clear evidence that advice translated into knowledge, behavior change, and actual adoption of promoted practices—and in turn, into higher production and productivity. The content of advisory services relies heavily on an in-house agronomist and information gathered online. While C2C reports ad-hoc interactions with national and global research institutes (e.g., CGIAR), these engagements are not systematic. While C2C reports conducting daily calls (with approximately 10 callers) to verify the relevance of AI advice, it remains unclear how farmers' local knowledge is incorporated into the content. To strengthen these services, C2C must be more aggressive in compiling and curating up-to-date global, national, and local knowledge and expertise.

Additionally, over the past two years across the three study states, C2C has worked closely with government extension agents to onboard farmers, organize training, and provide advisory services. C2C also collaborates with lead farmers, community promoters, and group leaders. These promoters receive an honorarium or small incentive for training sessions, farmer onboarding, or facilitating loan repayments. Moving forward, human agent networks need operational support: motorbikes for mobility, clearer incentive structures, and formal MOUs with government extension bureaus. The current informal arrangement creates vulnerability. SMS content should be reviewed for literacy appropriateness and supplemented with community-level group listening sessions where literacy is low.

The advisory services (training, SMS, and AI) are provided free of charge and currently depend on grants and cross-subsidization from C2C's commercial services (input marketplace, e-wallet, credit scoring service). Table 6 summarizes the contingent valuation results. Eighty-nine percent of respondents were willing to subscribe to the expert-based advisory service and 78% to the AI-enabled service. The mean willingness to pay was NGN 1,848 (USD 1.22) per month for expert-based advisory service and NGN 1,460 (USD 0.96) per month for the AI-enabled service. C2C users were willing to pay more than non-users; male respondents were willing to pay more than female respondents. Our contingent valuation module

shows that farmers attach a positive value to AI- and human-based advisory, but stated willingness to pay is modest relative to what would be needed to break even at the current scale of active users, and collecting small monthly fees from smallholders would itself be costly.

Table 6. Willingness to pay for C2C advisory services, by service type and group

	Expert-based advisory	AI-enabled advisory
Willing to subscribe (% of respondents)	89	78
Mean WTP, interval regression (NGN/month)	1848	1460
C2C users	2005	1590
Non-users (comparison group)	1488	1160
Men	1982	1638
Women	1467	1120
Median stated maximum WTP (NGN/month)	1000	500
Zero WTP (% of respondents)	11	22
Protest responses (% of zero bids)	14	12
Accepted NGN 4,000 starting bid (%)	14	9
#Obs	1807	1807

Source: Contingent valuation module of the household survey (December 2025–January 2026).

Note: Mean WTP is estimated by interval regression on the bidding-game responses (Hanemann et al., 1991); zero WTP includes respondents who would not subscribe at any price. USD 1 = NGN 1,517 (2025 average).

Three features of these results matter for C2C’s business model. First, stated WTP is hypothetical and tends to overstate what farmers actually pay, so these figures indicate an upper bound on revenue rather than expected revenue. Focus group participants reported a lower WTP of about NGN 200–500 (USD 0.13–0.33) per month once benefits are proven, and direct smallholder subscriptions have repeatedly struggled in Nigerian agri-fintech. Second, our preliminary assessment is that even the survey estimates would not be sufficient for the advisory layer to break even at the current scale of about 28,827 farmers active in the past 12 months, and collecting small monthly fees from smallholders would itself be costly. Third, WTP is low relative to the value created: advisory users sold on average NGN 215,000 more crops a year than comparable non-users (Section 4.1), while an AI-assisted session costs C2C about NGN 302. The sustainability of its advisory services will be heavily dependent on strengthening the niche and commercial sustainability of the commercial services that provide the cross-subsidization. There is strong competition in these services and C2C has to strengthen its competitive edge, unique offerings and address several of

its technical and operational challenges (see Annex 11 for details). Any fee is therefore better embedded in loan or marketplace transactions than charged for advice alone, and the advisory layer will continue to need grant or public co-financing.

Climate resilience, inclusion, and equity

There is a need for greater intentionality regarding gender equality and climate resilience. There is no clear evidence of improved adoption of the 19 climate-resilient and sustainable agricultural management practices. It is important to understand the bottlenecks—whether they lie in the nature and content of the advice, the economics of these practices, the delivery and learning process among farmers, or behavioral and incentive issues—and test solutions that improve adoption of these climate-resilient practices.

Furthermore, while the use of basic feature phones lowers the barrier to entry, stakeholders noted that women have less access to phones and lower digital literacy. Experts suggest a targeted focus on women for digital, technical, and marketing training.

“If an expert can sensitize women on how to use these digital platforms, it would be very useful. Many women handle cash while marketing, which is dangerous and risky.” — Extension agent

“...Elderly women, in particular, don’t use these tools at all. The younger women who have smartphones mostly use them for photography or entertainment. We need sensitization training to create awareness of how these tools can be used for business.” — Extension agent

The e-wallet service is a potentially useful tool for women traders and farmers, but current promotion of the e-wallet to women is limited. The evidence from other e-wallet providers (OPay and Moniepoint) in the same cultural context shows that accessible design can achieve substantially higher women’s participation. Both offer ATM cards, physical agent points, and higher transaction limits. There is a need to design women-specific e-wallet onboarding by engaging more female agents, offering household-level account opening, and developing a savings product alongside the transaction wallet to deepen engagement among women and men.

Women’s inclusion in all C2C services requires dedicated female agent networks, household-level sensitization visits, and targeted loan products for women-led and managed farms. C2C should set explicit gender targets (e.g., at least two women from each LGA in Jigawa, as suggested by one FGD participant). Youth farmers who are early adopters should be systematically supported to sustain engagement beyond initial registration.

Sustainability requires closing the women’s inclusion gap. Women represent 37% of crop labor in Nigeria (Palacios-Lopez et al., 2017) but only 16% of surveyed C2C users. This is not only an equity problem—it is a commercial constraint. Reaching women systematically would substantially expand the addressable user base and improve statistical power for gender-disaggregated estimates.

5. CONCLUSIONS AND POLICY IMPLICATIONS

This study provides a rigorous outcome evaluation of digital advisory services of a bundled agri-fintech platform operating at medium scale in sub-Saharan Africa. Its findings contribute to the growing literature on private sector digital agricultural advisory services (DAAS) while generating specific recommendations for C2C’s operations, investors, policymakers, and the broader digital agriculture research agenda.

Our findings show economically meaningful sales gains by small-scale farmers from C2C services broadly and C2C advisory services more specifically. C2C users sold on average NGN 161,520 (USD 106) more than comparable non-users—a 24% gain relative to the control group’s average sales of NGN 661,000, which is large partly because non-users sell only 30% of their harvest (Table 1); estimated profit effects are positive but not statistically significant. This places C2C within the range of income effects documented in comparable DAAS evaluations, where income increases range from 0 to 75% (see review by Ragasa et al., 2026). These sales effects are larger than those typically reported for stand-alone SMS or voice advisory services, which is consistent with C2C’s bundling of advice with an input marketplace, market price information and buyer linkages—the channels through which, as discussed below, most of the gains arise. Equally important is what drives these gains: not yield increases—where survey results show null effects on average—but a sales–marketing–quality pathway evident from the qualitative findings that comprises produce quality differentiation via quality seeds promoted by C2C advisory and input marketplace, improved postharvest management, corporate buyer linkages, and access to market price information. This decoupling of sales gains from productivity gains is a substantive finding for the DAAS literature, which has focused disproportionately on yield as the primary outcome. It suggests investment in postharvest and market linkage content is at least as important as agronomic advisory.

The study makes five specific contributions to knowledge.

First, the sales–marketing–quality pathway is documented via quantitative and qualitative data. Sales effects (share, volume, and value) were consistently large across econometric models. Qualitative data suggest that certified seeds promoted by the C2C advisory and input marketplace produced visually distinguishable produce that FGD participants reported commanded 30–50% price premiums; postharvest storage advice enabled holding strategies that captured higher seasonal prices; knowledge of market prices and different buyers led to higher prices and profits; and corporate buyer linkages replaced single-buyer

trader dependence. Although drawn from a limited number of qualitative interviews, these insights consistently help explain the patterns in the survey data. This pathway operates even in the absence of measurable yield gains on average, indicating that market integration is a necessary complement to—not a downstream consequence of—production advisory.

Second, the sales and profit effects are positive and statistically significant among farmers without access to formal extension services and among those in the lowest asset tercile, and their point estimates are larger than for other groups (the difference is statistically significant at the 10% level for access to extension services but not across asset terciles). While the sampled farmers are not ultra-poor, these results demonstrate that C2C can benefit those who are asset- and resource-constrained and lack access to more lucrative markets. C2C's comparative advantage is not its technology per se but its presence in an institutional void. The policy implication is direct: scaling digital advisory in well-served areas is likely to generate smaller returns than deploying it where public extension has collapsed.

Third, the null average effects on productivity and on adoption of climate-resilient and sustainable management practices require serious attention. C2C's stated mission emphasizes farm advisory, yet there is no clear evidence that this advisory translates into measurable behavioral change at scale. This places C2C at the lower bound of adoption and yield effects documented in comparable DAAS evaluations, where technology adoption improved by 10–40% and yield increases range from 0 to 86% (see the review by Ragasa et al., 2026). Identifying the specific bottlenecks—whether in content quality, delivery mechanics, economics of recommended practices, or farmer behavioral constraints—is essential before further investment in advisory content can be justified.

Fourth, a significant finding is what we term the digital inversion: C2C's most technically sophisticated service (the AI hotline) is the least known and accessible to its intended beneficiaries, even though it works on basic feature phones, while its least digital component (face-to-face human agents) generates the most durable farmer trust and the highest self-reported benefit rates. This inversion is not a statement about technology per se; it is a finding about infrastructure, language, and the gap between technical capability and operational delivery. Telecom uptime at 42% is not an advisory quality problem—it is an infrastructure problem. The absence of Nupe language is not a design choice—it is a market exclusion. For the broader DAAS literature, this finding warrants a general caution: the sophistication of the technology does not determine the quality of the last-mile connection, and it is the last-mile connection that determines whose lives the technology actually changes.

Fifth, the systematic exclusion of women from C2C's active user base is an additional structural outcome of platform design. Women are only 16% of surveyed C2C users and 7% of AI hotline callers, and focus

groups put women's share of advisory users at 5–20% in most communities. Male users experience large and significant sales gains; however, there is no statistically clear evidence of income gains among female users, though the small female sample ($N < 250$) limits the power of this comparison. This exclusion reflects the interaction of male land ownership, patriarchal norms, mobile phone and smartphone access gaps, and registration procedures designed and targeted toward male farmers. Correcting this requires deliberate design—female agent deployment, doorstep digital financial access, and gender-targeted sensitization—not incremental improvement to the existing model.

Several questions remain open. Do C2C's sales effects translate into yield gains over three to five seasons of sustained engagement? Qualitative evidence documents practice consolidation across multiple seasons, but cross-sectional data cannot confirm this trajectory. A multi-year panel tracking the same farmers would answer this with statistical confidence. Do women who gain access to C2C services benefit differently from men? The small female sample in this study prevents gender-disaggregated outcome analysis. What is the cost per beneficiary of each advisory channel, and how does it compare with the documented sales gains? This cost-effectiveness analysis is essential for optimizing the service mix. To what extent do sales effects spill over to non-users through peer information sharing? Qualitative evidence is suggestive, but the evaluation was not designed to estimate spillover effects formally.

The findings extend beyond C2C to the growing cohort of private sector digital agricultural platforms that seek to serve smallholder farmers in low-infrastructure environments. Two broad lessons follow directly from the evidence.

For platform operators and investors: A bundled, phygital approach combining farm advisory with market linkages and an input marketplace is what smallholders need, is synergistic within the platform, and is associated with large sales effects. AI-powered advisory is a useful complement to human agents, not a substitute for them; standalone digital channels do not produce the same outcomes. Timely input delivery—guaranteed before the planting window, for example, through forward supply agreements with manufacturers—is a high-leverage operational change, given that late delivery is the most consistently cited failure across all three study states. Expanding the AI hotline's telecom partnerships and language options, and restructuring agent incentives from enrollment counts toward practice adoption and loan repayment rates, are the next priorities in order of expected outcome.

For government policymakers: This study documents what happens when private platforms fill the gap left by collapsed public extension: real income gains for those the platform already reaches, alongside systematic exclusion of women and digitally disconnected communities. C2C is not a substitute for public extension; it is a complement that functions best where some baseline of digital literacy and physical

infrastructure already exists. Governments can increase the platform's reach and equity by creating conditions that give C2C agents access to government training resources, accreditation, and shared agricultural data systems—formalizing the informal collaborations already operating across the three study states. Gender inclusion targets must be mandatory in every digital extension partnership that draws on public co-financing.

The evidence assembled here points in a single direction: sales gains from a digital agricultural advisory are achievable within one to two seasons and, under the right conditions, can reach asset-poor farmers. They do not require yield increases to materialize, do not require smartphones, and do not require farmers to abandon existing market relationships. What they do require is that inputs arrive before the planting window closes, that agents be rewarded for outcomes rather than enrollment counts, and that the communities with the least access to public extension, the fewest assets, and the most constrained marketing options are reached deliberately rather than incidentally. C2C is already generating sales gains for the farmers it serves. Its most distinctive innovations—an interactive AI hotline and a machine-learning credit scoring model for unbanked farmers—have no direct equivalent among competitors in the study area. The opportunity to grow and accelerate those outcomes—by expanding language options, adding a telecom partner, realigning agent incentives, addressing the barriers to practice adoption, and implementing explicit gender inclusion targets—is substantial and fully within reach. The measure of the sector's seriousness about inclusive digital agriculture will be whether these tractable failures are corrected before the next generation of platforms repeats them.

References

- 60 Decibels. (2023). Crop2Cash customer insights [Internal report prepared for Crop2Cash].
- Abate, G. T., Abay, K. A., Chamberlin, J., Kassim, Y., Spielman, D. J., & Tabe-Ojong, M. P. J. (2023). Digital tools and agricultural market transformation in Africa: Why are they not at scale yet, and what will it take to get there? *Food Policy*, 116, 102439.
- Aker, J. C., Ghosh, I., & Burrell, J. (2016). The promise (and pitfalls) of ICT for agriculture initiatives. *Agricultural Economics*, 47(S1), 35–48.
- Ambler, K., Balana, B., Bloem, J. R., Maruyama, E., & Olanrewaju, O. (2024). Take-up of cash loans vs. agricultural input loans: A pilot study. Rethinking Food Markets Initiative Project Note, September 2024. International Food Policy Research Institute, Washington, DC.
- Ambler, K., Balana, B., Bloem, J. R., Maruyama, E., & Olanrewaju, O. (2025). Credit access, demand, and repayment among smallholder farmers in Nigeria: A follow-up analysis. IFPRI Project Note, July 2025. International Food Policy Research Institute, Washington, DC.
- Baumüller, H. (2018). The little we know: An exploratory literature review on the utility of mobile phone-enabled services for smallholder farmers. *Journal of International Development*, 30(1), 134–154.
- Birner, R., Daum, T., & Pray, C. (2021). Who drives the digital revolution in agriculture? From digital divide to digital dividend. *Food Policy*, 102, 102111.
- Fabregas, R., Kremer, M., & Schilbach, F. (2019). Realizing the potential of digital development: The case of agricultural advice. *Science*, 366(6471), eaay3038.
- Florez, M., Bourdon, I., Schirmer, J., Eber, R., & Materia, V. (2026). The role of solution business model patterns in digital agriculture: Linking business model components and sustainable outcomes from a startup business perspective. *Business Strategy and the Environment*. Advance online publication.
- GSMA. (2024). Cultivating climate resilience for farmers through digital technology: The GSMA Innovation Fund for Climate Resilience and Adaptation- Nigeria case study. GSMA, London.
- Hanemann, W. M., Loomis, J., & Kanninen, B. (1991). Statistical efficiency of double-bounded dichotomous choice contingent valuation. *American Journal of Agricultural Economics*, 73(4), 1255–1263.
- Kenney, M., & Zysman, J. (2016). The rise of the platform economy. *Issues in Science and Technology*, 32(3), 61–69.
- Knierim, A., Labarthe, P., Laurent, C., Prager, K., Kania, J., Madureira, L., & Ndah, T. H. (2017). Pluralism of agricultural advisory service providers – Facts and insights from Europe. *Journal of Rural Studies*, 55, 45–58.

- List, J. A. (2024). Optimally generate policy-based evidence before scaling. *Nature* 626, 491–499.
- Mehrabi, Z., McDowell, M. J., Ricciardi, V., Levers, C., Martinez, J. D., Mehrabi, N., Wittman, H., Ramankutty, N., & Jarvis, A. (2021). The global divide in data-driven farming. *Nature Sustainability*, 4(2), 154–160.
- Mwangi, B., Macharia, I. & Bett, E. 2021. Ex-post impact evaluation of improved sorghum varieties on poverty reduction in Kenya: A counterfactual analysis. *Social Indicators Research*, 154(2), 447–467.
- Palacios-Lopez, A., Christiaensen, L., & Kilic, T. (2017). How much of the labor in African agriculture is provided by women? *Food Policy*, 67, 52–63.
- Ragasa, C., Ma, N., Alvi, M., & Abate, G. (2026). Impact and commercial sustainability of digital agricultural extension and advisory services in LMIC: A systematic review [unpublished manuscript]. International Food Policy Research Institute, Washington, DC.
- Steinke, J., van Etten, J., Müller, A., Ortiz-Crespo, B., van de Gevel, J., Silvestri, S., & Priebe, J. (2021). Tapping the full potential of the digital revolution for agricultural extension: An emerging innovation agenda. *International Journal of Agricultural Sustainability*, 19(5–6), 549–565.
- Sutherland, L.-A., & Labarthe, P. (2022). Introducing ‘microAKIS’: A farmer-centric approach to understanding the contribution of advice to agricultural innovation. *The Journal of Agricultural Education and Extension*, 28(5), 525–547.
- Thapa, G., Choudhary, D., Pandit, N.R., & Dongol, P. (2025). Fertilizer demonstration, agricultural performance, and food security of smallholder farmers: Empirical evidence from Nepal. *World Development Sustainability* 6, 100196.
- Tsan, M., Totapally, S., Hailu, M., & Addom, B. K. (2019). *The digitalisation of African agriculture report 2018–2019*. Wageningen: CTA/Dalberg Advisers.
- Wooldridge, J. M. (2007). Inverse probability weighted estimation for general missing data problems, *Journal of Econometrics*, 141(2), 1281–1301.

Annexes

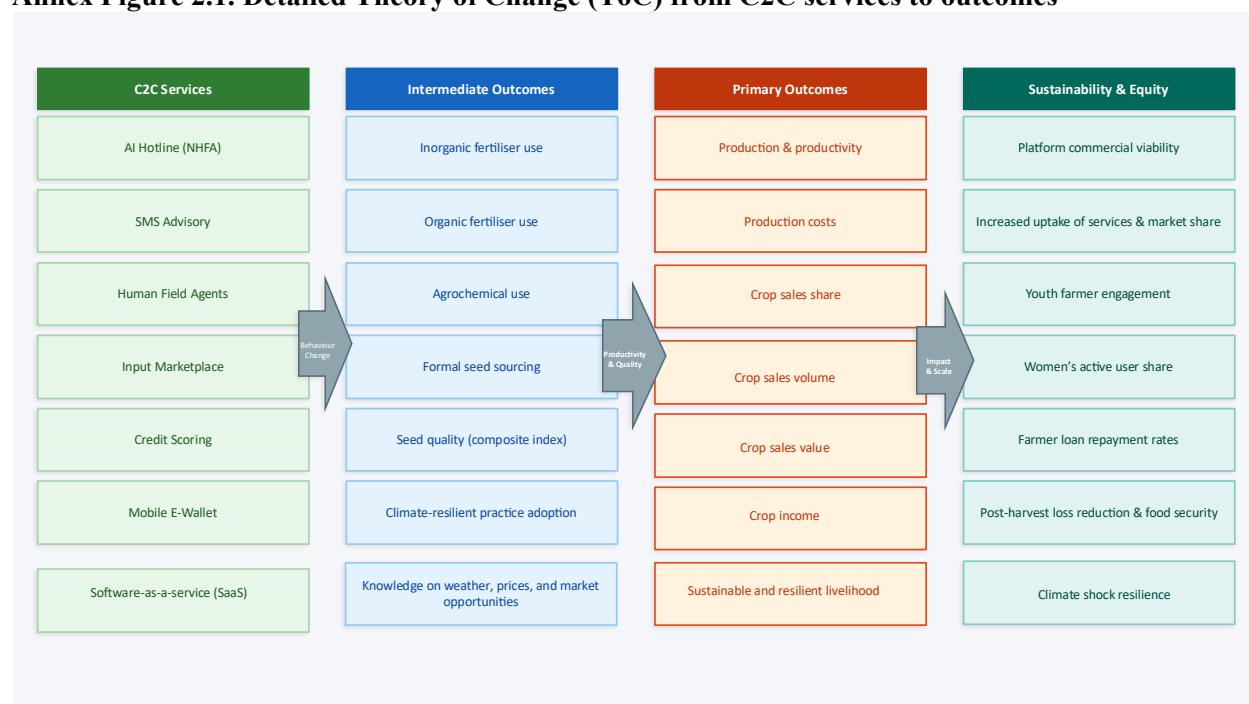
Annex section 1. C2C self-reported AI tool performance metrics

C2C reported that they have an M&E system in place and uses the following metrics:

- *Grounding & Source Fidelity* - Benchmark-based evaluation using curated question–answer pairs derived from validated source content. Model responses are scored for factual alignment, source coverage, and absence of unsupported claims (daily check; 99% performance)
- *Advisory Quality (Expert Validation)* - Periodic expert review of anonymized advisory samples against national extension guidelines (weekly)
- *Safety & Risk Mitigation* - Human review of sampled conversations combined with automated prompts for uncertainty detection and escalation to experts (10 random checks daily; 100% performance)
- *Speech Transcription Accuracy* - Human review comparing audio recordings to generated transcripts (10% of calls daily; 90% performance)
- *Perceived usefulness by users* - Post-call survey asking farmers whether the information helped them make a decision or take action ((10% of calls daily; 78% performance)
- *Contextual Relevance* - Post-call question: “Was the advice you received directly relevant to your farm, crop, or current challenge?” (10% of daily calls, 97% performance)
- *Coherence & Fluency* - Human review of sampled call recordings for clarity, pacing, and comprehension (10% of daily calls; 96% performance)
- *Task Completion* - Review of anonymized call flows and recordings to confirm successful completion of advisory tasks (10 random check daily; 99% performance)
- *Latency (End-to-End vs AI Inference)* - Disaggregated latency measurement separating telecom infrastructure delay from AI inference time [10% of calls daily; performance: ~25s (Telecom) / ~20ms (AI Model)]
- *System Uptime (Disaggregated)* - Human monitoring of telecom infrastructure uptime and Automated monitoring of AI server availability [monitoring every 3 hours; performance: 42% (Telecom Infra) / 99.9% (AI Servers)]

Annex section 2. Detailed ToC and outcome indicators

Annex Figure 2.1. Detailed Theory of Change (ToC) from C2C services to outcomes



Annex Table 2.1 presents the complete indicator framework guiding the evaluation. Intermediate outcome indicators capture changes in input use—the most proximate behavioral pathway from advisory to income—and agronomic practice adoption. Primary outcome indicators capture production value, costs, returns, sales, and profit. Heterogeneity is assessed across subgroups defined by age, wealth, gender, education, group membership, road proximity, and state. All monetary values are denominated in NGN thousands; USD equivalents use the 2025 average exchange rate of NGN 1,517 per USD 1.

Annex Table 2.1. Outcome indicator framework

Category	Indicator	Measurement
Primary Outcomes	Profit (sales – cost) (MAIN OUTCOME INDICATOR)	NGN '000
	Production, value of crop production	NGN '000
	Productivity, measured as crop production value per hectare	NGN '000/ha
	Total farming cost	NGN '000
	Returns (production value – cost)	NGN '000
	Crop sales share	Percentage of harvest sold
	Crop sales volume	Kilograms
	Crop sales value	NGN '000
Intermediate Outcomes (mechanisms)	Inorganic fertilizer use	Dummy; kg; kg/ha; cost (NGN '000)
	Organic fertilizer use	Dummy; kg; kg/ha; cost (NGN '000)
	Agrochemical use	Dummy; liter; liter/ha; cost (NGN '000)
	Seed quality composite index	Index 0–1 (germination rate, freshness, sourcing, satisfaction)
	Seeds sourced from formal seed sourcing	Dummy (seed company / extension agent / breeder / scientist / trader)
	Adoption of climate-resilient practices	Count 0–19 (e.g., conservation tillage, soil cover, soil testing, decision-making based on weather advisory, integrated pest management)
Heterogeneity Subgroups	Age group (youth ≤35 vs. non-youth >35)	Binary
	Wealth / asset tercile	Low / middle / high
	Gender	Male / female
	Education level	Elementary or below / secondary / tertiary
	Group membership	Dummy
	Proximity to road	Within 150 m of paved road (binary)
	Proximity to nearest market	Within 75 km distance (binary)
	Access to formal extension services	Dummy - received agricultural advice from government programs, demonstration farms, training centers, or extension agents.
	State	Jigawa / Kaduna / Niger State

Annex section 3. Study area

Annex Table 3.1 provides key comparable indicators of the three focus states. The three states face nearly identical threats to their agricultural output:

- **Climate Shocks:** All three suffered from excessive flooding in late 2024 and 2025, which destroyed significant hectares of farmland.
- **Security Risks:** Banditry and insecurity remain primary threats, often forcing farmers to abandon fields and disrupting the safe transport of harvests.
- **Rising Input Costs:** Farmers across all three states report significant struggles with the soaring prices of fertilizers, pesticides, and quality hybrid seeds.
- **Inadequate Infrastructure:** Common "pain points" include road inaccessibility for transporting produce and deteriorating irrigation dams that require urgent rehabilitation.

Annex Table 3.1. Agricultural and digital ecosystem of the three focus states

Indicators	Niger State	Jigawa State	Kaduna State
Population	7 m	7.7 m	9.4 – 11 m
Estimated number of farming households	400,000	500,000 (150,000 supported in the wheat program)	2 m
Average farm size (national=0.85 ha)	4.6 ha	2.4 ha	2 ha
Top National Rank	#1 in Rice (707,072 MT), #1 in Yam	Top Wheat Producer (with Kano, >70% of national total)	#1 in Maize, #1 in Ginger (76.4% of national total)
Main Crops	Rice, Yam, Soybeans, Shea nuts, Millet	Wheat, Sesame, Hibiscus, Rice, Tomatoes	Maize, Ginger, Tomatoes, Soybeans, Cotton
Vegetation Zone	Guinea Savannah	Sudan & Sahel Savannah	Guinea & Sudan Savannah
Strengths	Massive landmass (largest in Nigeria); home to major hydroelectric dams for irrigation.	Reputation for relative safety, making it the government's choice for wheat dry-season initiatives.	Strong agro-processing infrastructure (dairy, flour, ginger processing); strong private sector presence in agriculture
Weaknesses	High risk from rural banditry affecting farm access.	Prone to flooding and desertification; high dependence on seasonal river floodplains.	High farmer-to-extension agent ratio, leading to ineffective service delivery. High security risks in some areas.
Investment opportunities	Focus on large-scale grains and yam processing due to its top-tier production volumes.	High potential in sesame and hibiscus export cleaning and packaging, as well as wheat value chain development.	Opportunities in tomato processing to reduce the current post-harvest loss rate and ginger value-addition for global markets.
Active Internet Users	~3.5 million	~2.8 million	~5.5 million
Mobile Phone Access	66%–75%	~60%	66%–98%
Estimated Smartphone Usage	~22%	~22%	~22%–37.5%

Source: various sources.

Despite high mobile access (66-98% of the adult population), most use basic feature phones and about 22-37% are estimated to use smartphones. Several “digital divides” persist across these three states. Erratic internet connectivity and inconsistent network signals in rural areas often render smartphones “basic” for real-time weather or market tracking. While 96%–100% of farmers are aware of call and SMS functions, fewer than 10% use mobile devices for advanced tasks like diagnosing plant diseases or soil health monitoring. High data prices and the cost of quality smartphones are consistently the top-ranked constraints for rural farmers.

There are several state-led digital initiatives in the focus states:

- Jigawa’s Smart Agriculture Platform: In May 2025, Jigawa enrolled 100,000 farmers into a digital platform that includes digital wallets, GIS-based farm mapping, and AI-driven pest advisory systems.
- Niger Foods: As part of the state’s “agricultural revolution,” the government uses a digital farmer database to manage its 250,000 ha grain cultivation project.
- National Digital Farmers Registry (NDFR): Launched in November 2025 by the Federal Government to harmonize fragmented databases. It uses geo-tagging of farms to ensure targeted delivery of credit, insurance, and extension services.
- Nigeria Agricultural Intelligence Platform: Launched in October 2025, this platform uses Artificial Intelligence to connect researchers, policymakers, and farmers, offering AI-powered advisory services and an online marketplace.

There are numerous digital payment or e-wallet providers in northern Nigeria. Aside from e-wallet, there are other digital services providers in the areas, although none of them were mentioned by the samples. Hello Tractor, known as the Uber for tractors, manages mechanization services via a mobile app and booking agents. AFEX operates digital commodity exchange platforms and physical warehouses in Kaduna and other Northern states to provide market price transparency and storage solutions. Babban Gona provides a franchised model using digital apps for input credit, training, and marketing, with a high focus on youth empowerment in Northern hubs. ThriveAgric is an online platform that uses a proprietary "Agricultural Operating System" (AOS) to provide farmers with finance and data-driven advisory services. VetsArk is another provider of financial and credit scoring services in the area. Agromall and Foodlocker provide supply chain logistics and produce aggregation services. A comprehensive landscaping of service providers and competitors of C2C services and an analysis of their competitive advantage, strengths, weaknesses, opportunities, and threats (SWOT) are provided in Annex 11.

Annex section 4. Sampling approach for qualitative data

We adopted a sequential qualitative-quantitative-qualitative research approach. We interviewed diverse stakeholders involved in C2C to understand the context and help in drafting the survey instruments and validating the results (**Annex Table 4.1**). The survey instruments were informed by 42 pre-survey KIIs and 17 FGDs with 136 farmer-participants; in total, the study draws on 68 interviews (42 pre-survey KIIs and 26 post-survey in-depth interviews) and 23 FGDs with 172 participants. Key results were validated, and remaining queries were further investigated during a second round of in-depth interviews and FGDs.

Annex Table 4.1. Summary of interviews and focus group discussions

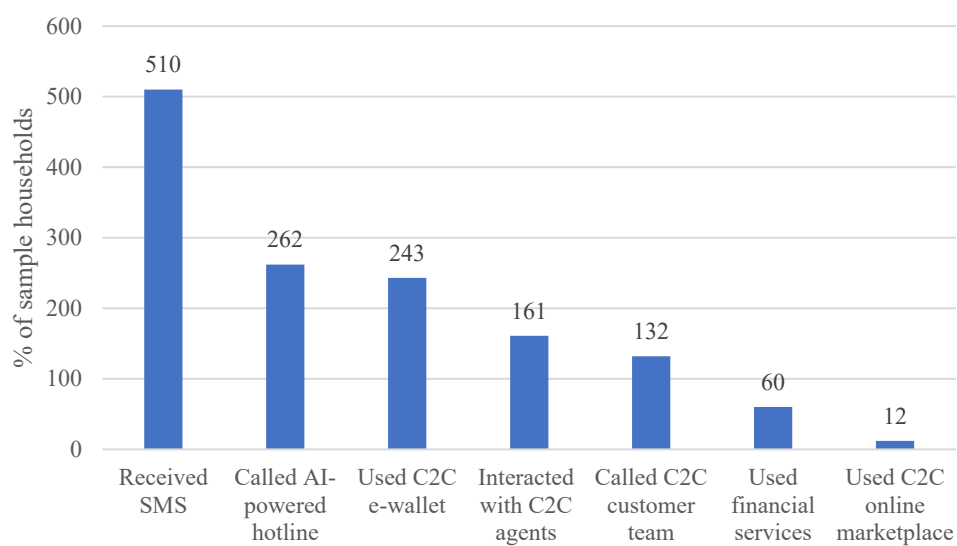
Categories of participants	Number of participants
Key informants' interviews (KII) (pre-survey)	42
Crop2Cash management	1
C2C agronomist	1
C2C agents / government extension agents working with C2C	18
Businesses partners (seed companies, banks, input suppliers)	4
Inactive users of C2C	18
In-depth interviews (post-survey)	26
C2C agents	4
C2C users	19
Business partners	3
Focus group discussions (FGDs)	23 FGDs [172 participants]
FGDs with community leaders and farmer-users of C2C - Treatment group	14 FGD [112 participants]
FGDs with C2C non-users in communities where C2C is getting popular – Control group	3 FGD [24 participants]
FGD with users and non-users (post-survey)	6 FGD [36 participants]

Annex 5. Sampling approach for the survey

Annex Table 5.1. List of C2C users who were tracked and not

Survey States	LGAs	Target Number of Active Users (provided by C2C)	Tracked C2C Users*	Tracked (but misclassified: HH did not start nor complete registration)	Not tracked (could not be reached; wrong mobile number; different LGA/state)	% of farmers that could not be tracked
Jigawa	Dutse	97	59	20	18	39
	Miga	243	196	47	0	19
	Gwaram	135	113	5	17	16
	Ringim	150	132	3	15	12
	Sub-Total	625	500	75	50	20
Kaduna	Kauru	313	157	73	83	50
	Kubau	58	35	7	16	40
	Soba	80	34	6	40	58
	Lere	235	27	89	119	89
	Zaria	596	247	1	348	59
	Sub-Total	1282	500	176	606	61
Niger	Gbako	153	86	1	66	44
	Katcha	94	36	32	26	62
	Lavun	264	192	7	65	27
	Bida	359	199	1	159	45
	Sub-Total	870	513	41	316	41
Total		2,777	1,513	292	972	46

Annex Figure 5.1. Composition of the treatment group samples



Note: 63 sample farmers applied for financial services, but only 5 sample farmers got approved for loans.

Annex 6. Comparison between registered users (treatment group) and registered non-users (control group)

Registered-but-inactive farmers are not disinterested, resistant, or fundamentally different from active users. They registered for the same reasons, face the same problems, aspire to the same services, and prefer the same channels. The gap between them and active users is almost entirely operational: timing failures, follow-up gaps, technical access barriers, language inaccessibility, and unmet promises.

Annex Table 6.1. Main reasons why registered farmers have not used C2C services yet

Reasons for not using C2C yet	Primary States / Sites	Notes
Late input/info timing	All states — esp. Kaduna, Jigawa	<i>Structural; farmer intent is strong but services missed the window</i>
No follow-up or agent support	All states	<i>Registration not followed by activation; farmers left without guidance</i>
Language barrier (English, not Hausa)	Jigawa (Miga), Niger (Nupe absent)	<i>Messages arrive in inaccessible language; farmers disengage</i>
Unmet promises / broken trust	Kaduna (Kubau), Jigawa (Gwaram)	<i>C2C promised inputs and loans; did not deliver; community withdrawal</i>
Low awareness of platform mechanics	All states — esp. Niger, Kaduna	<i>Know C2C exists but not how to access or use services</i>
Poor training outreach at scale	Jigawa (Dutse)	<i>1,500+ registered; <50 attended trainings; information not cascaded</i>
Technical barriers	Kaduna (Kubau, Kauru), Niger	<i>Location-specific: poor network; individual-specific: SIM loss, no smartphone and a respondent thinks it is better to connect with smartphone</i>

Reasons why registered farmers have not used C2C

6.1. Late Timing of Inputs and Information—Registration After the Season

The most consistently cited reason across all three states is not lack of interest, but a mismatch between when C2C enrolled farmers and when those farmers needed services. Across Kaduna and Jigawa especially, farmers registered late in the season or after the planting window had already passed, rendering any advisory or input supply immediately irrelevant.

“The reason is that when they approached us, it was not the right time to provide inputs. It was delivered to us after activities. However, we are currently waiting and hoping to start this activity.” — Non-user, FGD Kubau, Kaduna

"The reason is that the information came to us at the end of the rain, whereas now we are approaching the rainy season. We're hoping we can maximize the opportunity." — Non-user, FGD Kubau, Kaduna

It is not a reflection of distrust or lack of interest, but a supply-side failure of scheduling. These farmers remain aspirationally active and explicitly state they plan to use C2C in the coming season.

6.2. Absence of Follow-Up and Agent Support After Registration

Several farmers registered but received no subsequent guidance, follow-up, or support on how to actually use any C2C service. Registration was treated as an endpoint rather than an onboarding gateway. Without an agent to explain the platform, many farmers simply never took the next step.

"There are no agents moving around to clarify for farmers how to use C2C. As I am speaking, we can use Google or Chrome, and even at that, I haven't enjoyed the benefit yet. Users don't know how to use it, and there's no agent to teach them, so the data and card giveaway is over." — Non-user, FGD Gbako, Niger

"I registered because my neighbor told me to. He said it was good. But after registering, I didn't see any benefit. No one explained to me how to use it. So I just forgot about it." — Non-user, FGD Miga, Jigawa

"In the past, some extension agents visited our community. They were responsible for explaining how to access and utilize Crop2Cash services. We made efforts to have them work here, but unfortunately, we were unable to get them to come back." — Inactive farmer, Kauru LGA, Kaduna

This friction reflects a gap in last-mile service delivery: registration campaigns are not always followed by activation campaigns. The farmer's intent is present, but there is no structured nudge, demonstration, or handholding to convert registration into first use.

6.3. Language Barrier: Content Delivered in English, Not Hausa

In Jigawa—and reportedly in pockets across all three states—some registered farmers stopped engaging because advisory messages arrived in English rather than Hausa. For smallholder farmers with limited literacy, this is a decisive barrier.

"I registered, but the messages were coming in English. I don't read English well. So I stopped paying attention to them. If they were in Hausa, I would use them." — Non-user, FGD Miga, Jigawa

This is confirmed by the quantitative study's finding that the AI hotline is unavailable in the Nupe language, and awareness remains very low. A language gap directly converts interested, registered farmers into inactive ones.

6.4. Poor Communication and Unmet Promises by C2C

A distinct group of inactive farmers does not simply lack information — they registered, were told they would receive benefits (inputs, loans, follow-up), and then never did. This group expresses active disillusionment based on experience, not merely ignorance.

"Crop2Cash doesn't fulfil its promise and that's the problem. It is not as if it is not accepted, no. It has the acceptance, but it was the lack of keeping its promises that made people withdraw. There would have never been a company around here like it, but only if it had kept its promises." — Inactive Farmer, Kubau, Kaduna

"About 3 years ago, we were given forms to fill out, and we have not heard anything since then. Later a lady called me to register, and she asked me some questions. She said they will reach out to me again... but since then I haven't heard anything from them." — Non-registered farmer, FGD Bida, Niger

"Sometimes, after taking one's name, they never return." — Inactive Farmer, Miga LGA, Jigawa

6.5. Low Awareness of What C2C Services Actually Offer

A striking number of inactive farmers are simply unaware that the services they registered for are already live and accessible. They registered — often at community events — without understanding what they had signed up for, and no one bridged the gap.

"I was not in the village when they came. They came and registered people, but I was at my farm far away. By the time I returned, they had left." — Non-user, FGD Miga, Jigawa

"I didn't use it after I signed up... I don't know that it's online." — Inactive farmer, Miga, Jigawa

"To be sincere with you, we are not aware of [the toll-free AI advisory service] at all." — Inactive Farmer, Soba LGA, Kaduna

Lack of awareness is not just about the existence of C2C—it is about the mechanics: how to call, what USSD code to use, what questions can be asked, what the AI will say. Even farmers who have heard of C2C often have no practical understanding of how to initiate a service interaction.

6.6. Inadequate Communication and Training Outreach by C2C

Even where training events were held, the communication about those events failed to reach many registered farmers — particularly in Jigawa, where extension networks are geographically scattered and WhatsApp groups used for dissemination do not reach all members.

"I cannot say the reason why, but perhaps at the time we registered, we were almost over one thousand, and perhaps it was the training that didn't reach me." — Inactive Extension Agent, Dutse, Jigawa

"When we did the training at FUD and when we did it at the state library, a lot of people said that they were not informed. About 1500 of all of us were registered, but when we were called upon, I don't think we were up to 50 for the first and second gatherings combined. So, there is definitely inadequate conveyance of information." — Agent, Dutse, Jigawa

This represents a systemic outreach failure at scale, not just individual cases of missed communications.

6.7. Technical Barriers: Lost SIM Cards, Wrong Numbers, No Smartphone

A cluster of practical digital barriers prevents registered farmers from accessing services even when they want to. These include: losing the SIM card linked to registration, having no smartphone to use the e-wallet, poor network coverage blocking registration completion, and receiving no messages because a phone number was entered incorrectly.

"I registered, but I have not used the service because I lost the SIM card that I registered with. By the time I got a new SIM, I could not remember my login details. I tried to recover, but it was too much trouble." — Non-user, FGD Miga, Jigawa

“I registered, but I did not receive any messages. I don't know why. Maybe they did not put my number correctly. I have been waiting, but nothing has come.” — Non-user, FGD Miga, Jigawa

“I stopped using the e-wallet because I don't have a larger phone at the moment... I lost their number and stopped using it.” — Inactive Farmer, Kubau LGA, Kaduna

“Sometimes when you are trying to do the registration along the road due to bad network [it fails]. That was what stopped me from doing the registration.” — Inactive Farmer, Niger State

Key Similarities

The most analytically important finding — one confirmed by both the qualitative evidence and the quantitative design — is that inactive registrants and active users are remarkably similar in their baseline motivations, farming challenges, and stated aspirations.

6.8. Both groups registered for similar reasons — access to benefits

Neither group was coerced. Across all sites, inactive farmers explain their registration decision in terms of the same motivators as users: access to inputs, capital, and advisory services.

“The reason for registering is to get benefits.” — Non-users (collective), FGD Gbako, Niger

“Yes, money, fertilizer, agrochemicals and even animal farming — we saw them as some of the benefits.” — Non-users (collective), FGD Gbako, Niger

“What attracted me was that they came right to our village and asked me questions which I responded to. They even told me that if I am interested in farming but don't have the capital, I will be able to secure it. Since I am interested in farming, I decided to register.”
— Non-user, FGD Kubau, Kaduna

6.9. Both groups face the same structural farming challenges

Inactive farmers are not meaningfully different from active users in the challenges they face: high input costs, poor seeds, weather shocks, limited capital, and limited access to markets. These are the very problems C2C purports to address, and inactive farmers are acutely aware of them.

“We have many challenges: First, seedlings. If you don't have good seed, no matter the effort, it will not yield well. Secondly, fertilizer: if the soil is weak, you may have no fertilizer to apply.” — Non-users (collective), FGD Gbako, Niger

This is consistent with the quantitative study's design rationale, which treats inactive registrants as the closest possible counterfactual for users precisely because 'they chose to register, likely sharing the same unobservable motivations as active users.'

6.10. Both groups prefer the human agent as their primary channel

When asked which C2C service they would use first, inactive farmers overwhelmingly chose the human agent — exactly as active users report the human agent to be the most trusted and valuable channel. Neither group instinctively reaches for digital tools first; both want face-to-face or voice interaction.

“Which among them are you planning to use later? [All participants:] Human agent.” — Non-users (collective), FGD Gbako, Niger

“We want the agent because you can be able to discuss with him face to face, which is better for us. We will physically see the agent, ask him questions, and he will answer there and then.” — Non-registered farmers, FGD Bida, Niger

6.11. Both groups are interested and willing — not resistant

Crucially, inactive farmers are not opposed to C2C services. When fully briefed on what the platform offers, virtually all express a desire to use it. The C2C Business Lead confirms this dynamic: 'People do not believe in the first instance. Until they begin to test, when they begin to use and it works, it changes their perception.'

“Yes, if it will be useful to me... I'll try calling first to understand, then decide what else I'm interested in.” — Inactive farmer, Miga, Jigawa

“Now that you have sensitized us, we are ready to accept it wholly. We are ready to participate, and we are hoping to benefit from it.” — Non-user, FGD Kubau, Kaduna

“If I have the opportunity, I'd be willing to call. Sometimes the issue is simply not knowing about it or not having anyone to guide you. With guidance, I'd definitely use it.” — Inactive Farmer, Niger State

Annex section 7. Covariate balance

Annex Table 7.1. Covariate balance between control and treatment groups

Indicators	Control	All C2C users	Advisory only	AI only	SMS only
<u>Respondent and household characteristics</u>					
Respondent age	37.90	35.48***	35.30***	35.37***	35.38***
Respondent gender		***	***		***
Male	0.93	0.84	0.83	0.93	0.74
Female	0.07	0.16	0.17	0.07	0.26
Respondent is youth (<=35 years old) ¹	0.52	0.59***	0.60***	0.60**	0.59**
Respondent's education level		***	***	***	***
Completed elementary or lower	0.32	0.16	0.16	0.10	0.16
Completed secondary	0.37	0.42	0.41	0.36	0.41
Completed tertiary	0.31	0.42	0.44	0.54	0.43
<u>Baseline conditions</u>					
Household has a member of associations (=1)	0.65	0.74***	0.75***	0.81***	0.70*
Household has electricity (=1)	0.51	0.68***	0.69***	0.70***	0.72***
Distance to the nearest road (m) ²	573.31	256.16***	282.06***	236.32***	296.97***
Distance to the nearest market (km)	65.89	67.66	64.53	61.14**	61.56***
Distance to the nearest town (km)	14.96	12.94***	13.66**	13.18**	13.78*
<u>Exogenous control</u>					
2025 precipitation (mm) ³	833.90	810.76**	771.99***	753.80***	744.50***
State dummies			***	***	***
Jigawa	0.52	0.51	0.61	0.70	0.65
Kaduna	0.20	0.19	0.12	0.10	0.05
Niger	0.28	0.30	0.28	0.20	0.30
#Obs	545	1276	998	239	506

Note: Significance levels are based on comparisons between the corresponding (sub)groups and control group. Continuous indicators are compared using t-tests. Binary and categorical indicators are compared using chi-square tests. Significance level: *: p<.10, **: p<.05, ***: p<.01.

¹ The Nigeria National Youth Policy (2019-2023) defines youth as 18-35 years old.

² Distances to the nearest road, market, and town are calculated using geospatial data from OpenStreetMap. Roads are defined as major roads, including motorway/freeway; important roads, typically divided; primary roads, typically national; secondary roads, typically regional; tertiary roads, typically local. Towns include both cities (as defined by national/state/provincial government. Often over 100,000 people) and towns (as defined by national/state/provincial government. Generally smaller than a city, between 10,000 and 100,000 people). A market is defined as a place where markets are held. ³ Precipitation measures are based on CHIRPS v3 data.

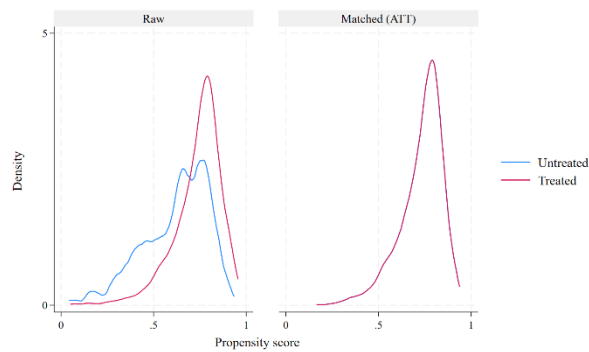
Annex Table 7.2. Regression model results of factors affecting probability of being in the treatment group

Models	C2C service	Advisory service	AI hotline	SMS
<u>Respondent and household characteristics</u>				
Respondent age	-0.003*** (0.001)	-0.004*** (0.001)	-0.003** (0.001)	-0.003** (0.001)
Respondent gender (male=1)	-0.194*** (0.036)	-0.220*** (0.039)	-0.047 (0.062)	-0.301*** (0.039)
Education level (base=completed elementary or lower)				
Completed secondary	0.121*** (0.027)	0.135*** (0.030)	0.188*** (0.047)	0.171*** (0.037)
Completed tertiary	0.137*** (0.028)	0.153*** (0.031)	0.250*** (0.044)	0.180*** (0.038)
<u>Baseline conditions</u>				
Household has a member of groups/associations (=1)	0.083*** (0.022)	0.090*** (0.024)	0.111*** (0.035)	0.049+ (0.030)
Household has electricity (=1)	0.099*** (0.023)	0.114*** (0.025)	0.103*** (0.032)	0.130*** (0.030)
Distance to the nearest road (km)	-0.072*** (0.017)	-0.068*** (0.019)	-0.105** (0.046)	-0.076*** (0.020)
Distance to the nearest market (km)	-0.000 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.002** (0.001)
Distance to the nearest town (km)	-0.003*** (0.001)	-0.004*** (0.001)	-0.005*** (0.002)	-0.005*** (0.002)
<u>Exogenous control</u>				
2025 Precipitation (mm)	-0.423*** (0.097)	-0.449*** (0.109)	-0.327** (0.131)	-0.714*** (0.140)
State (Base=Niger)				
Jigawa	-0.042 (0.036)	0.008 (0.041)	0.138*** (0.052)	-0.040 (0.050)
Kaduna	0.162*** (0.048)	0.099* (0.054)	0.102+ (0.064)	-0.020 (0.064)
Observations	1814	1537	780	1046
Pseudo-R2	0.0940	0.107	0.164	0.172

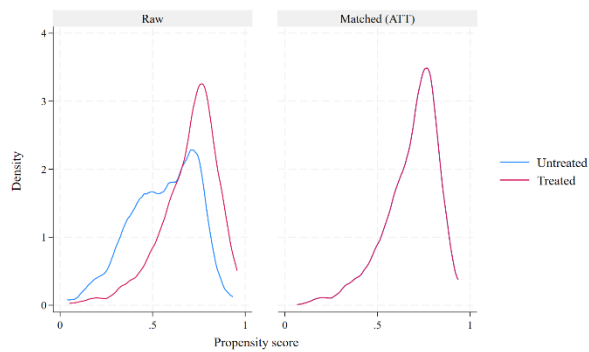
Note: Significance level: *: p<.10, **: p<.05, ***: p<.01.

Annex Figure 7.1. Density plots before and after weighting and matching

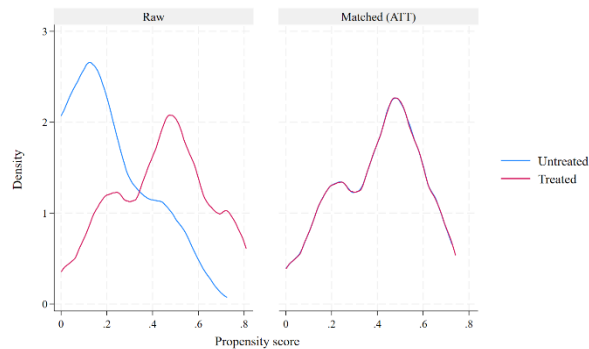
a. C2C services



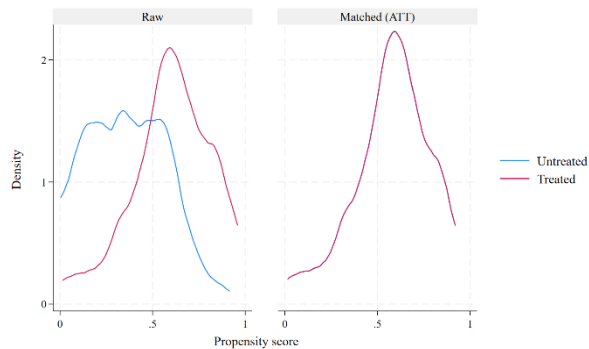
b. C2C advisory services



c. AI-powered hotline



d. SMS



Annex Table 7.3. Covariate balance before and after weighting and matching

Indicators	IPWRA		Kernel PS		Kernel MD	
	Raw	Weighted	Raw	Weighted	Raw	Weighted
<i>C2C services</i>						
Age	-0.23	0.06	-0.25	0.05	-0.25	-0.03
Male	-0.18	0.05	-0.28	0.05	-0.28	-0.22
Education (base=elementary or lower)						
High school	0.10	-0.01	0.10	-0.02	0.10	-0.01
College	0.22	0.01	0.23	0.00	0.23	0.05
Group member	0.17	0.01	0.19	0.02	0.19	-0.02
Has electricity	0.31	0.00	0.34	0.00	0.34	0.10
Distance to nearest road (m)	-0.34	-0.05	-0.34	-0.07	-0.34	-0.05
Distance to nearest market (km)	0.09	-0.07	0.07	-0.03	0.07	0.01
Distance to nearest town (km)	-0.21	0.01	-0.21	0.05	-0.21	-0.03
Annual rainfall (mm)	-0.09	-0.13	-0.11	-0.11	-0.11	-0.05
State (base=Niger)						
Jigawa	-0.04	0.14	-0.02	0.13	-0.02	0.05
Kaduna	-0.03	-0.11	-0.03	-0.08	-0.03	0.03
<i>C2C advisory services</i>						
Age	-0.24	0.05	-0.27	0.07	-0.27	-0.06
Male	-0.22	0.06	-0.30	0.13	-0.30	-0.24
Education (base=elementary or lower)						
High school	0.08	-0.02	0.08	0.05	0.08	0.00
College	0.24	0.02	0.26	-0.07	0.26	0.06
Group member	0.19	0.01	0.20	-0.01	0.20	-0.01
Has electricity	0.34	0.01	0.37	-0.02	0.37	0.12
Distance to nearest road (m)	-0.30	-0.06	-0.31	-0.07	-0.31	-0.05
Distance to nearest market (km)	-0.03	-0.05	-0.06	-0.01	-0.06	-0.03
Distance to nearest town (km)	-0.14	0.01	-0.13	-0.04	-0.13	-0.02
Annual rainfall (mm)	-0.27	-0.14	-0.29	-0.11	-0.29	-0.10
State (base=Niger)						
Jigawa	0.15	0.14	0.17	0.10	0.17	0.11
Kaduna	-0.21	-0.08	-0.23	-0.03	-0.23	0.00
<i>AI-powered hotline</i>						
Age	-0.27	0.04	-0.27	0.09	-0.27	-0.05
Male	0.03	0.03	0.03	0.03	0.03	0.00
Education (base=elementary or lower)						
High school	-0.01	-0.04	-0.01	0.03	-0.01	-0.02
College	0.47	0.05	0.47	-0.01	0.47	0.14
Group member	0.36	0.01	0.36	-0.03	0.36	0.03
Has electricity	0.40	0.07	0.40	-0.02	0.40	0.13
Distance to nearest road (m)	-0.36	-0.05	-0.36	-0.05	-0.36	-0.08
Distance to nearest market (km)	-0.19	-0.03	-0.19	0.14	-0.19	-0.04
Distance to nearest town (km)	-0.18	-0.07	-0.18	-0.01	-0.18	-0.14
Annual rainfall (mm)	-0.38	-0.13	-0.38	-0.05	-0.38	-0.13
State (base=Niger)						
Jigawa	0.37	0.07	0.37	-0.03	0.37	0.14
Kaduna	-0.28	-0.06	-0.28	-0.02	-0.28	-0.01
<i>SMS</i>						
Age	-0.22	0.09	-0.26	0.05	-0.26	-0.07
Male	-0.44	0.07	-0.51	0.13	-0.51	-0.44
Education (base=elementary or lower)						
High school	0.08	-0.03	0.09	-0.02	0.09	0.04
College	0.23	0.02	0.24	0.00	0.24	0.06

Indicators	IPWRA		Kernel PS		Kernel MD	
	Raw	Weighted	Raw	Weighted	Raw	Weighted
Group member	0.09	0.04	0.11	0.05	0.11	-0.05
Has electricity	0.42	0.07	0.44	0.09	0.44	0.19
Distance to nearest road (m)	-0.29	-0.04	-0.30	-0.04	-0.30	-0.06
Distance to nearest market (km)	-0.17	-0.05	-0.18	-0.05	-0.18	-0.07
Distance to nearest town (km)	-0.13	0.04	-0.12	0.04	-0.12	-0.04
Annual rainfall (mm)	-0.42	-0.10	-0.45	-0.07	-0.45	-0.11
State (base=Niger)						
Jigawa	0.23	0.12	0.26	0.11	0.26	0.12
Kaduna	-0.45	-0.03	-0.46	-0.02	-0.46	-0.02

Annex 8. Econometric strategy

Inverse probability weighting and regression adjustment (IPWRA)

Our primary estimation model is the inverse probability weighting and regression adjustment (IPWRA), which combines propensity score weighting with outcome regression and possesses a double-robust property: the outcome estimates remain consistent if either the treatment model or the outcome model—but not both—is mis-specified (Wooldridge, 2007). The IPWRA proceeds in two stages.

In the first stage (treatment model), the probability of being a C2C user (treatment) is modeled as a function of observable household, individual, and location characteristics:

$$\Pr(T_i = 1 \mid X_i) = F(X_i\beta)$$

where T_i is the treatment indicator (1 = C2C user, 0 = non-user), X_i is a vector of pre-treatment covariates (age, gender and education of the respondent, group membership, electricity access, distances to the nearest road, market and town, 2025 rainfall, and state indicators; see Annex Table 7.2), β is the parameter vector, and $F(\cdot)$ is the logistic function. The estimated propensity score $\hat{p}_i = \Pr(T_i = 1 \mid X_i)$ is then used to construct inverse probability weights. In the second stage (outcome model), these weights are applied in a weighted regression of the outcome variable Y on the treatment indicator and covariates:

$$Y_i = \alpha + \tau T_i + X_i\gamma + \varepsilon_i \text{ (estimated with weights } w_i)$$

The ATET is then:

$$ATET = E[Y_i(1) - Y_i(0) \mid T_i = 1] = \hat{\tau}$$

This approach has been used in comparable outcome evaluation contexts by Mwangi et al. (2021), Thapa et al. (2025), and others.

Robustness check

For robustness, we supplemented IPWRA with two kernel weighting/matching techniques: kernel propensity score matching and kernel Mahalanobis distance matching. Kernel matching uses a weighted average of control group outcomes as the counterfactual, weighting control observations by their similarity to treated observations using a kernel function $K(\cdot)$:

$$\widehat{Y(0)} = \frac{\sum_{j \in C} \left[K \left(\frac{(\hat{p}_i - \hat{p}_j)}{h} \right) \cdot Y_j \right]}{\sum_{j \in C} K \left(\frac{(\hat{p}_i - \hat{p}_j)}{h} \right)}$$

where h is the bandwidth parameter and C is the set of control observations. Outcome estimates were largely consistent across IPWRA and the two kernel techniques, enhancing confidence in the findings. Nearest neighbor matching (NNM) was considered but performed poorly due to the control group being smaller

than the treatment group (N=545 vs N=1,276), leading to large numbers of unmatched treatment observations.

Heterogeneity analysis

To investigate differential outcomes across subgroups, we introduced interaction terms in the outcome regression models. Subgroups examined include: age (youth vs. non-youth), gender (male vs. female), education level (finished elementary, secondary, or tertiary education), asset terciles (proxy for socioeconomic status), distance to roads, distance to markets (proxies for market access), group membership of family members, state (Jigawa, Kaduna, Niger), and access to formal extension services. For each subgroup variable S , the weighted outcome regression is $Y = \alpha + \beta T + \gamma S + \delta(T \times S) + X'\theta + \epsilon$, where T is the treatment indicator and X the covariates above. The subgroup effects shown in Figure 4 and Annex Table 9.2 are β (for $S = 0$) and $\beta + \delta$ (for $S = 1$), and the “P value for the difference” is the p-value of δ .

Strengths and limitations

The IPWRA approach has several notable strengths: it is double-robust, explicitly models both selection into treatment and outcomes, and allows flexible functional forms. Using registered non-users as the primary control group addresses a key source of unobservable selection bias (the decision to register with C2C). Within-community sampling further reduces geographic confounding.

However, important limitations remain. First, the design is cross-sectional, so it cannot control for unobservable time-varying confounders or establish a definitive causal chain. Second, while registration-status controls for one major unobservable (motivation to adopt digital tools), it does not control for farmer effort, managerial ability, or pre-existing relationships with agro-dealers. Third, the sample is drawn from communities where C2C already operates, limiting external validity to communities with broadly similar characteristics; most users started using C2C advisory in late 2024–2025, so the estimates reflect one to two seasons of exposure. Finally, the treatment is composite (any C2C use), making it difficult to attribute effects to specific service components except in the advisory service sub-analyses; the AI and SMS sub-analyses were not powered and are indicative.

Annex 9. Heterogeneity analysis

a. Heterogeneity analysis by crop

High productivity effects were observed across most crops: 35% for sorghum (the second most common crop), 13% for groundnut, and 153% for sesame (Annex Table 9.1). After weighting, productivity gains remained significant only for sorghum producers and sesame producers, while positive effects on sales volumes and values persisted for sorghum producers and groundnut producers. Market participation increased, with 15 to 16 percentage points more farmers selling sorghum, millet, and groundnut. After weighting, the positive market participation effects remained only for groundnut farmers. The lack of significance for some crops may reflect the smaller crop-level samples and limited power to detect effects. Overall, the share of harvest sold was 2 to 14 percentage points higher among treatment farmers than among control farmers for six of the eight crops (unweighted estimates). High sales volume effects were estimated for most crops (ranging from 54% more groundnuts, 73% more sesame to 99% more sorghum sold), alongside high sales revenue effects (94% for sorghum and 98% for groundnut). Finally, home consumption levels were generally maintained across crops, except for millet and rice, though seed saving was slightly lower, consistent with increased purchase of fresh seeds.

Annex Table 9.1. Average treatment effects of C2C services, by crop

Indicators	Rice		Maize		Sorghum		Cowpea	
	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted
Sales (=1)	0.03	0.03	-0.02	0.00	0.15***	0.08+	0.07	0.03
Sales (% of harvest)	0.03	0.02	-0.02	-0.02	0.08***	0.05*	0.06	0.04
Sales (kg)	-96.02	-259.80+	-172.24	-70.79	172.01***	158.11***	70.53	48.14
Price received for sales (NGN/kg)	20.67	8.77	10.90	-6.86	-10.36	-40.18	-58.10	-120.64**
Sales (000 NGN)	-43.39	-115.53	-57.91	-34.53	88.20***	79.83***	86.10*	55.69
Production (kg)	-368.27*	-644.00***	-349.57*	-110.56	264.13**	45.08	159.74**	80.78
Productivity (kg/ha)	-224.54*	-374.22**	-70.99	33.42	515.79***	375.90***	71.29	-45.04
Household consumption (% of harvest)	0.01	0.00	0.04	0.03	-0.07**	-0.05+	-0.07*	-0.05
Household consumption (kg)	-110.55	-215.10**	-168.53	-72.94	50.31	-103.21	67.42	32.90
Saved for seed (% of harvest)	-0.02**	-0.01	-0.00	-0.00	-0.02*	-0.01	-0.01	-0.01
Saved for seed (kg)	-55.27***	-50.80***	-4.58	-2.65	-7.61	-15.68*	4.33	1.23
#Obs	873	839	551	528	654	577	462	443

Indicators	Millet		Groundnut		Sesame		Soybean	
	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted
Sales (=1)	0.15***	0.01	0.16**	0.17**	-0.14	-0.07	0.06	0.15+
Sales (% of harvest)	0.14***	0.07**	0.14***	0.17***	-0.13	-0.05	0.02	0.14*
Sales (kg)	189.54***	33.88	170.16*	192.66*	268.37*	165.35*	-29.18	78.65
Price received for sales (NGN/kg)	-70.91*	-19.63	184.30*	14.67	0.16	-159.43	12.43	-60.48+
Sales (000 NGN)	82.70**	-4.30	334.46***	301.23**	350.37	124.66	-6.28	24.82
Production (kg)	-186.78*	-190.60	233.60*	257.40+	535.58**	178.64	-113.36	-21.50
Productivity (kg/ha)	-113.74	-77.26	122.82	118.96	444.37***	460.00***	-183.98	-246.35
Household consumption (% of harvest)	-0.13***	-0.08**	-0.12***	-0.14***	0.09	0.00	-0.03	-0.14*
Household consumption (kg)	-352.63***	-258.98**	21.19	20.26	193.76	15.24	-57.87	-147.40
Saved for seed (% of harvest)	-0.01	-0.00	-0.02	-0.02	0.02	0.02	0.00	0.00
Saved for seed (kg)	-18.72**	-26.27**	-2.35	1.55	21.11	0.48	1.33	2.61
#Obs	453	426	289	284	104	73	115	87

Note: Significance level: +: $p < .15$, *: $p < .10$, **: $p < .05$, ***: $p < .01$. Note: Unweighted differences are based on simple mean comparisons using t-tests, whereas weighted differences are estimated as coefficients from IPWRA models with sampling weights; statistical significance is reported for both.

b. Heterogeneity analysis by farmer type

Annex Table 9.2. Heterogeneous treatment effects, using interactive models

Covariate	Production value (000 NGN)	Productivity (000 NGN/ha)	Sales (000 NGN)	Profits (000 NGN)
Age: Youth	-75.56 (134.86)	-101.23+ (68.51)	55.21 (95.67)	-7.24 (116.02)
Age: Nonyouth	90.39 (180.61)	70.86 (64.72)	292.69*** (103.69)	251.24** (125.02)
Gender: Male	34.56 (112.20)	41.54 (45.27)	167.67** (74.21)	119.89 (91.51)
Gender: Female	-273.88 (374.39)	-553.46*** (214.27)	52.61 (236.94)	-66.98 (287.21)
Education level: Elementary	254.66 (192.05)	6.18 (99.47)	301.00** (125.40)	327.93* (172.19)
Education level: Secondary	-241.55+ (152.26)	-110.68+ (70.20)	26.07 (111.83)	-99.43 (139.09)
Education level: Tertiary	128.72 (197.23)	31.25 (83.49)	220.40* (122.23)	210.07+ (140.78)
Group membership: Yes	-35.96 (136.39)	-29.20 (57.13)	134.61+ (88.56)	29.95 (105.29)
Group membership: No	80.91 (175.32)	-39.00 (96.44)	202.53* (120.27)	297.94* (158.74)
Has a secondary income source: Yes	-22.61 (111.25)	-24.18 (47.61)	121.63+ (74.95)	27.45 (93.28)
Has a secondary income source: No	161.93 (386.77)	-88.23 (202.58)	427.34* (230.07)	628.64** (269.15)
Has access to electricity: Yes	-47.58 (135.78)	-79.94 (63.84)	166.01** (83.53)	104.99 (103.49)
Has access to electricity: No	81.28 (180.82)	60.49 (74.00)	129.31 (132.97)	85.56 (155.32)
Distance to the nearest road: Far	-148.30 (167.89)	-107.76 (75.46)	62.77 (103.29)	-50.96 (126.46)
Distance to the nearest road: Close	142.97 (135.38)	43.21 (60.66)	229.17** (96.43)	218.88* (117.61)
Distance to the nearest market: Far	-193.14 (148.93)	-12.11 (65.87)	44.11 (93.19)	52.14 (104.40)
Distance to the nearest market: Close	183.79 (159.46)	-48.25 (73.71)	263.05** (110.81)	148.13 (145.41)
Distance to the nearest town: Far	125.73 (178.45)	18.02 (72.96)	282.88** (117.32)	204.23 (146.02)
Distance to the nearest town: Close	-103.66 (131.40)	-73.69 (67.70)	42.17 (91.60)	9.67 (109.60)
Received rainfall: High	-70.24 (136.66)	-32.19 (65.54)	46.78 (89.20)	58.26 (101.58)

Covariate	Production value (000 NGN)	Productivity (000 NGN/ha)	Sales (000 NGN)	Profits (000 NGN)
Received rainfall: Low	64.26 (178.33)	-34.12 (75.75)	266.29** (116.78)	134.54 (152.41)
State: Kaduna	-134.96 (164.17)	72.57 (60.41)	49.96 (126.01)	8.40 (151.26)
State: Jigawa	27.39 (176.76)	10.53 (71.12)	246.62** (114.89)	95.59 (151.73)
State: Niger	37.42 (202.18)	-164.08+ (106.61)	83.45 (131.81)	149.65 (141.83)
Asset: Low	199.93+ (137.23)	19.00 (77.03)	264.45*** (99.95)	246.17** (112.06)
Asset: Middle	167.30 (149.90)	-10.68 (80.04)	179.20* (100.15)	193.73+ (119.01)
Asset: High	-287.41 (227.30)	-86.73 (90.71)	48.01 (148.90)	-126.86 (189.65)
Access to formal extensions: Yes	-153.82 (218.18)	-10.06 (73.35)	-80.59 (155.56)	-144.14 (173.10)
Access to formal extensions: No	42.56 (125.45)	-36.84 (58.91)	227.89*** (80.50)	180.99* (101.50)

Note: Significance level: +: $p < .15$, *: $p < .10$, **: $p < .05$, ***: $p < .01$. Note: Figures are the marginal effects; and figures in parentheses are the standard errors. 1) Age: Youth is defined as respondents aged 35 years or younger; 2) Asset terciles are constructed based on asset scores, with respondents evenly divided into three groups: low, middle, and high; 3) Distance to road: Households are classified as close to roads if they are located within 150 meters of the nearest road; 4) Access to formal extensions: Defined as farmers having received information from at least one of the following sources: government programs, demonstration farms, training centers, or extension agents.

c. Heterogeneity analysis of likelihood of users reporting benefits from C2C

Annex Table 9.3. Correlates of the likelihood of users reporting perceived benefits from C2C services

Perceived benefits from ...	AI service	Called C2C customer team	SMS	C2C agents	Advisory services ¹	Improvements ²
Respondent age	0.004 (0.003)	-0.007+ (0.005)	-0.001 (0.002)	-0.017+ (0.011)	-0.001 (0.002)	-0.001 (0.001)
Male respondent (=1)	-0.225+ (0.144)	-0.265* (0.158)	-0.025 (0.051)	-0.221 (0.223)	-0.090** (0.044)	0.049 (0.037)
Education (base=lower than high school)						
Completed secondary	0.020 (0.102)	0.041 (0.111)	0.035 (0.062)	-0.129 (0.236)	0.039 (0.048)	0.121*** (0.040)
Completed tertiary	0.040 (0.096)	0.185* (0.104)	0.159** (0.062)	0.354* (0.213)	0.143*** (0.048)	0.112*** (0.040)
Group member (=1)	0.155** (0.071)	0.023 (0.093)	0.057 (0.045)		0.046 (0.036)	-0.007 (0.029)
Have access to electricity	-0.078 (0.072)	0.158* (0.087)	-0.058 (0.052)	-0.343* (0.182)	-0.036 (0.038)	-0.004 (0.032)
Distance to the nearest road (m)	-0.044 (0.045)	0.284* (0.150)	0.047 (0.046)	0.525 (0.759)	0.046* (0.027)	0.063*** (0.025)
Distance to the nearest market (km)	0.002+ (0.001)	0.002 (0.004)	0.000 (0.001)	-0.002 (0.008)	0.001* (0.001)	0.001** (0.001)
Distance to the nearest town (km)	0.001 (0.003)	0.004 (0.005)	-0.002 (0.002)	-0.008 (0.010)	-0.001 (0.002)	-0.002 (0.001)
Rainfall (mm)	0.834*** (0.225)	0.095 (0.450)	0.259 (0.203)	0.252 (1.009)	0.392*** (0.148)	0.440*** (0.129)
State (base=Niger)						
Jigawa	-0.075 (0.111)	0.118 (0.187)	0.211*** (0.070)	-0.242 (0.559)	0.161*** (0.055)	0.429*** (0.044)
Kaduna	-0.420*** (0.157)	0.280 (0.197)	-0.239** (0.118)	-0.510 (0.538)	-0.077 (0.076)	-0.174*** (0.054)
Observations	236	128	508	34	869	1251
Pseudo R2	0.110	0.120	0.0524	0.299	0.0271	0.0984

Note: Significance level: *: p<.10, **: p<.05, ***: p<.01. Note: Figures are the marginal effects from probit models estimated separately for the users of each service (the samples overlap because farmers can use several services); and figures in parentheses are the standard errors. /1 Outcome of this column is a binary variable of users having perceived benefits from AI service, C2C customer team, SMS, or C2C agents, i.e. combination of four types of services. /2 Outcome of this column is a binary variable of users having found improvements in various aspects of livelihood because of C2C services.

Annex section 10. Mechanism analysis

a. Comparison of outcome indicators between treatment and control groups

Different crops and farming systems: Compared to non-users, C2C users are more likely to grow rice and practice sole cropping, but less likely to cultivate maize, cowpea, and groundnut, or use intercropping (**Annex Table 10.1**). While both groups adopt sustainable agricultural practices at similar rates overall, C2C users show significantly higher adoption of conservation tillage, soil pH management and testing, and weather-advisory supported decision-making and farming.

Better content of advisory: Nearly all surveyed households have access to agricultural information, with farmer groups being the primary source (**Figure 7**). Access to advisory services is similar between control and treatment groups. While over 1,000 C2C users utilize diverse advisory sources, only 10% (~100 farmers) specifically cited C2C as an information source. Despite no clear quantitative advantage in access, qualitative interviews reveal that C2C adds value through better content of the advisory and high-quality inputs. Furthermore, C2C human agents were highly appreciated by FGD participants.

Greater usage of inorganic fertilizer and agrochemicals: Compared to non-users, more C2C users apply inorganic fertilizers and agrochemicals and in greater volumes. Conversely, fewer C2C users utilize organic fertilizers, and those who do apply smaller amounts. This suggests that C2C users are substituting organic options with inorganic alternatives. Consequently, C2C users incur slightly higher overall production costs (**Annex Table 10.2**).

While the overall quality seed index is similar across both groups, specific indicators vary. C2C users are more likely to acquire fresh seeds for the cropping season rather than recycling from previous harvests (**Annex Table 10.2**). They also were more likely to acquire seeds from “formal sources,” such as seed companies, extension agents, or traders. Although both groups report general satisfaction with their seeds, C2C users are less likely to rate their seeds “very highly” compared to non-users. Notably, only six users purchased seeds directly through the C2C platform or its agents; therefore, these results pertaining to C2C users do not directly reflect seeds sold by C2C. However, aligned with our theory of change—which posits that C2C advisory provides critical information on where and how to source improved varieties—our results suggest that while C2C advisory shifts sourcing behavior and encourages new seed acquisition, it did not improve farmers' perceptions of their seed's quality. This requires further investigation.

Annex Table 10.1. Comparison of crops and management practices

Indicators	Control	All C2C users	Advisory only	AI only	SMS only
Total land area cultivated in 2025 (hectare)	2.60	2.34***	2.42	2.48	2.36**
Crops grown					
Maize	0.28	0.31	0.24	0.24	0.19***
Rice	0.42	0.50***	0.55***	0.52***	0.56***
Millet	0.29	0.23***	0.25*	0.23*	0.30
Sorghum	0.41	0.33***	0.36**	0.31**	0.40
Soybean	0.06	0.06	0.06	0.05	0.06
Cowpea	0.28	0.24	0.24*	0.21**	0.24
Groundnut	0.19	0.15**	0.14**	0.13*	0.17
Sesame	0.05	0.06	0.07	0.12***	0.08*
Cropping system					
Sole cropping	0.61	0.70***	0.71***	0.77***	0.68**
Intercropping	0.49	0.42***	0.41***	0.36***	0.44*
Count of different crops	2.01	1.93	1.95**	1.85***	2.04*
Crop diversification index	0.37	0.34**	0.34**	0.29***	0.36
Use of agriculture management practices promoted					
Soil and water conservation structures	0.16	0.18	0.16	0.16	0.16
Conservation tillage (no-till, reduced tillage)	0.06	0.10***	0.10***	0.15***	0.09**
Crop rotation and diversification	0.18	0.16	0.14*	0.14	0.16
Soil cover / Cover cropping	0.06	0.05	0.04*	0.03*	0.04*
Agroforestry systems (planting trees in the field)	0.02	0.02	0.02	0.05*	0.01
Weather and climate advisory monitoring – using tools to check and record weather	0.11	0.14	0.14	0.15	0.14
Automated irrigation systems (e.g., drip irrigation)	0.04	0.03	0.03	0.02	0.03
Adjusting seeding rate based on need	0.41	0.38	0.40	0.46	0.41
Adjusting fertilizer application based on need and soil conditions	0.39	0.35*	0.36	0.38	0.37
Soil pH management	0.02	0.03*	0.03	0.03	0.02
Rainwater harvesting	0.10	0.09	0.08	0.04***	0.05***
Integrated pest management (IPM)	0.11	0.12	0.12	0.11	0.15*
Use of drought-resistant or heat-tolerant crop varieties	0.16	0.16	0.17	0.15	0.20
Organic farming practices	0.43	0.41	0.44	0.48	0.50**
Manure management and composting	0.10	0.08	0.07*	0.09	0.08
Biochar application	0.04	0.03	0.03	0.03	0.02
Intercropping	0.19	0.18	0.18	0.16	0.20
Using weather forecasts and climate information for decision-making	0.09	0.12*	0.13***	0.11	0.17***
Soil testing	0.06	0.09**	0.09**	0.06	0.09**
Count of promoted agriculture management practices adopted	2.72	2.73	2.74	2.86	2.89
#Obs	545	1276	998	239	506

Note: Significance level: *: p<.10, **: p<.05, ***: p<.01.

Annex Table 10.2. Comparison of intermediate outcome indicators between control and treatment groups

Indicators	Control	All C2C users	Advisory only	AI only	SMS only
Household used inorganic fertilizer (dummy)	0.84	0.88**	0.87*	0.87	0.87
Quantity (kg)	206.28	207.68	199.80	181.81	191.03
Quantity (kg/ha)	99.83	111.89**	101.89	101.06	94.93
Cost (NGN 000)	192.88	196.14	190.80	180.05	185.08
Cost (NGN 000/ha)	98.21	111.65**	102.24	105.71	97.68
Household used organic fertilizer (dummy)	0.63	0.54***	0.53***	0.49***	0.54***
Quantity (kg)	218.94	173.72***	176.90***	164.52***	184.31**
Quantity (kg/ha)	119.39	96.52***	94.16***	89.27**	95.85**
Cost (NGN 000)	31.67	24.93**	25.24**	26.94	23.10**
Cost (NGN 000/ha)	16.40	13.12**	12.40***	13.08	10.81***
Household used agrochemical (dummy)	0.77	0.86***	0.84***	0.82	0.84***
Quantity (liter)	4.76	4.95	4.83	3.93**	4.82
Quantity (liter/ha)	2.38	2.64**	2.42	2.21	2.35
Cost (NGN 000)	25.11	25.75	24.67	22.14	24.40
Cost (NGN 000/ha)	13.21	14.56	13.17	12.63	12.27
Household used biofertilizer (dummy)	0.14	0.10**	0.10**	0.08**	0.09**
Cost (NGN 000)	1.98	1.27**	1.18**	0.84**	1.29*
Cost (NGN 000/ha)	1.20	0.70**	0.58***	0.41**	0.65**
<i>Total costs</i>					
Total farming costs (000 NGN)	481.16	496.40	495.44	479.12	477.28
Total farming costs (000 NGN/ha)	242.13	274.69**	259.40	275.83*	240.89
<i>Seed use</i>					
Farmer self-reportedly using improved seed variety	0.22	0.20	0.22	0.19	0.20
Seeds were newly acquired or recycled within optimal times	0.71	0.77***	0.78***	0.72	0.81***
Seeds were acquired from formal sources	0.60	0.68***	0.70***	0.68**	0.70***
Seeds have a high germination rate (>=80%)	0.83	0.80*	0.81	0.85	0.81
Farmer very satisfied with seed quality	0.76	0.65***	0.64***	0.59***	0.67***
Farmer very satisfied with access to seeds	0.71	0.62***	0.60***	0.52***	0.63***
Farmer very or moderately satisfied with seed quality	0.95	0.91***	0.91***	0.91**	0.93
Farmer very or moderately satisfied with access to seeds	0.94	0.93	0.92	0.91	0.94
Quality seed composite index ¹	0.09	0.08	0.09	0.05*	0.08
#Obs	545	1276	998	239	506

Note: Significance level: *: p<.10, **: p<.05, ***: p<.01.

Annex 11. Reflections on competitiveness and sustainability of C2C services

Annex Table 11.1. Summary of the uptake, competitiveness, strengths, weaknesses, scalability, and sustainability of C2C services

Services	Uptake	Competitive edge	Strength and scalability potential	Weaknesses and threats to sustainability	Areas for improvement (links to entry points 1–7 in Section 4.4)
Phygital, integrated advisory service	<p>Low uptake (compared to total farming households in 3 states)</p> <ul style="list-style-type: none"> C2C reports 335,885 registered farmers; 28,827 active users in last 12 months across 18 states 7,454 active users in 3 focus states (Kaduna, Jigawa, Niger), 2,777 of them in the 13 study LGAs; 46% could not be tracked (wrong numbers, out-of-area) Advisory users (only N=998 active users tracked) Only 10% of C2C users cite C2C as primary advisory source; farmer groups remain the dominant source 	<p>Many other service providers and competitors (NGO, private companies, traders, government extension agents, radio program, social media); Rated mostly 3-4/4 (2-3/4 rating from one FGD) in terms of competitiveness</p>	<ul style="list-style-type: none"> Integrated multi-channel bundle (AI + SMS + agents + training) is unique in study areas Phygital approach bridges digital and physical gaps Basic feature phone accessible — no smartphone required for SMS or USSD High scalability: advisory marginal cost approaches zero at scale once platform is built Proven sales effect (on average) in the study areas 	<p>Dependent on grants and cross-subsidization from C2C commercial services; no clear effect on the adoption of promoted management practices and productivity (on average); about two-thirds of survey users find advisory useful, but about a third did not find it useful or did not benefit from it.</p>	<p>1=Knowledge integration: Better integration of state-of-the-art global, national, and local knowledge bases; 2=Content: Strengthened quality and content of advisory services; 3=Phygital strategy: Embracing a 'phygital' approach and expanding human-based advisory; 7=Inclusion & resilience: Explicit implementation of strategies to contribute to women's empowerment and climate resilience.</p>
AI hotline	<p>Extremely low awareness and uptake by farmers</p> <ul style="list-style-type: none"> Launched 2024; toll-free in Hausa, Yoruba, English N=239 AI callers tracked in survey sample; ~1,138 callers from master list 	<p>AI-powered hotline is unique and no comparable AI service competitor; but many other non-AI-advisory providers in the study area</p>	<ul style="list-style-type: none"> Only interactive (non-IVR) AI advisory platform for smallholder farmers in northern Nigeria Accessible via basic feature phone; no data/internet required 	<p>Only 1 partner telecom, with only 42% uptime; not conversational Hausa; no Nupe language; No clear indication of positive productivity effects (on average); some signs of negative effects on organic fertilizer and quality seed index</p>	<p>1=Knowledge integration: Better integration of state-of-the-art global, national, and local knowledge bases; 2=Content: Strengthened quality and content of advisory services; • Need to heavily promote it to increase awareness and uptake • Partner with at least one additional telecom (MTN or Airtel) to increase uptime to >90%</p>

Services	Uptake	Competitive edge	Strength and scalability potential	Weaknesses and threats to sustainability	Areas for improvement (links to entry points 1–7 in Section 4.4)
	<ul style="list-style-type: none"> C2C reports 700 repeat callers nationwide 				<ul style="list-style-type: none"> Add Nupe language as urgent priority; audit Hausa vocabulary for conversational register
SMS	<ul style="list-style-type: none"> ~3,100 farmers received SMS in 2024 Jigawa grant program; 2–3 messages/week for ~3 months Push service — farmers do not need to initiate; accessible on any basic feature phone 	Many advisory service providers: government radio (non-interactive but higher reach); WhatsApp farmer groups; input dealer advice	<ul style="list-style-type: none"> Zero literacy or internet requirement for receiving Timely, crop-calendar-linked messaging: “They say apply fertilizer on the 15th day after planting.” — FGD, Miga Lowest cost-per-farmer of all channels at scale Can be delivered via basic feature phone to most rural farmers 	<ul style="list-style-type: none"> Dependent on grants; No indication of income effect; signs of negative productivity effects; One-way: farmers cannot respond or ask follow-up questions Generic content may not suit heterogeneous farm conditions: “The advice is general. Farming is not general. My farm is different from my neighbour's farm.” — FGD non-user, Miga 	Expand; focus on getting the content right 1= Knowledge integration : Better integration of state-of-the-art global, national, and local knowledge bases; 2= Content : Strengthened quality and content of advisory services;
Human agents; training	<ul style="list-style-type: none"> Push service — farmers do not initiate; agents identify and visit farmers in communities C2C deploys agents on payroll + government extension agents (last 2 years in 3 states) Only 161 users in survey sample reported direct agent interaction; only 33 received formal agent advisory Agent density low: only 1 agent in all of Miga and Dutse (Miga extension agent KII) 	Many advisory service providers and competitors, NGOs and private companies have denser in-person agent networks in Kaduna	<ul style="list-style-type: none"> Most highly appreciated channel in FGDs: “Nothing beats a person standing with you on your farm.” — FGD, Miga some KII say C2C advisory is more frequent than other providers Builds farmer trust — the foundation for subsequent digital service adoption Enables demonstration effect and peer learning within communities Co-deployment with government extension agents leverages existing infrastructure at low incremental cost Highest gain per interaction of all channels; most highly rated by farmers across all FGDs 	<ul style="list-style-type: none"> Dependent on grants; Too few agents relative to farmer population; single agent per LGA in some areas Agent mobility dependent on personal resources — no motorbikes provided by C2C Agent incentives (per-farmer-registered) may prioritize onboarding over quality follow-up Women's access to agents severely limited by cultural norms; male agents cannot freely advise women 	3= Phygital strategy : Expand agent corps; provide motorbike mobility; set contact frequency targets <ul style="list-style-type: none"> Formalize MOUs with state ADP programs to secure agent partnerships Incentivize quality follow-up, not just farmer onboarding (shift KPI from registrations to practice adoption) Deploy female agents in all LGAs as minimum gender inclusion measure Develop structured feedback loops: agents report practice gaps to management for AI/SMS content updates

Services	Uptake	Competitive edge	Strength and scalability potential	Weaknesses and threats to sustainability	Areas for improvement (links to entry points 1–7 in Section 4.4)
e-wallet	Low market share	<ul style="list-style-type: none"> Competitors: OPay and Moniepoint dominant in study areas; both offer ATM cards, physical agent points, higher transaction limits <p>USSD-accessible; no fee; integrated with marketplace place and advisory</p>	<p>Integrated into the C2C bundle — no separate registration required</p> <ul style="list-style-type: none"> Zero transaction fees — meaningful advantage for low-income farmers USSD-based: works on basic feature phones without internet Fast network speed reported in Jigawa vs. OPay/Moniepoint Enables loan disbursement and repayment within platform — reduces cash handling risk 	<ul style="list-style-type: none"> No ATM card: “Every farmer that has a bank account opened for him should have an ATM card because not all of them can conduct electronic transactions.” — Business partner, Kaduna North No physical branches: “Other banks have branches, but Crop2Cash does not have any branches.” — Farmer, Gwaram Very low transaction limits restrict usefulness for larger input purchases Women's exclusion: male-dominated household transaction norms; no women-specific 	<p>4=Competitive Edge: A strengthened niche and competitive edge in the input marketplace and digital payment platforms</p> <ul style="list-style-type: none"> Partner for ATM card issuance and raise transaction limits Open additional agent points in Kaduna and Niger to mirror Jigawa adoption rates Design women-specific e-wallet onboarding (female agents; household-level account opening) Develop a savings product alongside transaction wallet to deepen farmer engagement
Input marketplace	<p>Very low market share; extremely low users of the online marketplace</p> <ul style="list-style-type: none"> 989 farmers nationwide using online platform (Dec 2025); 122 in 3 focus states — very small market share ~200 farmers estimated to have purchased seeds via C2C agents in 2024 (10t maize seed sold) More buyers via human agents than online platform 	<ul style="list-style-type: none"> Many competitors from open market traders and NGO credit/subsidy schemes to agro-dealers and other private companies Price advantage documented: maize seed 40% cheaper per kg than market; NPK 2–22% cheaper; herbicides 8–21% cheaper 	<ul style="list-style-type: none"> Lowest price on key inputs: 40% savings on maize seed; 17–21% on Vanquish herbicide Quality-assured, anti-counterfeiting: verifiable chain of custody from supplier to farmer Bundled convenience: full input package (seeds + fertilizer + herbicide + pesticide) with free delivery — no market equivalent Integrated with advisory and loan: farmers receive advice on how to use what they buy Strong competitive position on seeds; rated 4/4 by multiple business partners 	<ul style="list-style-type: none"> Fertilizer quality rated inferior to some competitors Delivery timing failures: C2C delivered in June instead of April–May in some communities, making inputs unusable for that season Very low market penetration: ~200 active buyers in focus states; scale insufficient for commercial sustainability 	<p>4=Competitive Edge: Upgrade fertilizer sourcing to match closer competitor's quality ratings</p> <ul style="list-style-type: none"> Forward-contract seed supply to guarantee April delivery; this is the single highest-priority operational fix Expand agrochemical range; ensure stock of commonly requested items at agent level Develop agro-dealer franchise model to extend reach without proportional capital investment

Services	Uptake	Competitive edge	Strength and scalability potential	Weaknesses and threats to sustainability	Areas for improvement (links to entry points 1–7 in Section 4.4)
		<ul style="list-style-type: none"> Seed quality advantage: “C2C does not mix their seeds and fertilizers and sell like other companies.” — Input buyer, Bida, Niger 			
Credit scoring and farmer facilitation and monitoring	<p>Low uptake</p> <ul style="list-style-type: none"> 2023: 700 farmers in Kaduna received input financing via C2C 2024–2025: 150 farmers in Southwest Nigeria via Agric Fast Cash (AFC); no northern loans due to market volatility and cheap crop imports C2C reported USD 2.8M in credit enabled to smallholder farmers via FCMB bank partnerships to date Only 63 sample farmers applied for financial services; only 5 were approved — very low loan penetration in the study areas 	<p>Several providers of in-kind credit schemes in the study areas</p> <p>Credit-scoring service + farmer mobilization and monitoring are unique; C2C partners with banks; Machine-learning credit scoring creates financial identities for unbanked farmers — long-term financial inclusion benefit</p>	<ul style="list-style-type: none"> Only interest-free input loan with cash repayment in study areas — strongly preferred over crop repayment competitors USD 2.8M in bank credit facilitated via FCMB partnerships (C2C-reported, not independently verified) — B2B value proposition Repayment flexibility (installments allowed) reduces farmer stress vs. competitors Scalability: credit scoring revenue (B2B fees to banks) is the most commercially scalable C2C revenue stream; requires sustained farmer data accumulation 	<ul style="list-style-type: none"> Extremely low farmer awareness of credit scoring function; most experience it only as FCMB loan access Community-level default suspension penalizes non-defaulting farmers — damages trust and undermines sustainability No loans issued in northern Nigeria 2024–2025 due to market volatility — service gap at a critical time Timing failures (June disbursement vs. April need) make loans effectively useless for that season Cash-only repayment disadvantages farmers with crop surplus but cash constraints: “C2C could introduce repayment with a crop of equivalent market value.” — Business partner, Soba Low repayment rates a systemic threat; Ambler et al. (2024, 2025) document structural challenges in Nigeria agri-lending 	<p>5=Loan repayment: Technical and marketing support for farmers to ensure loan repayment;</p> <ul style="list-style-type: none"> Integrate weather-indexed loan deferral triggered by rainfall data; restructure rather than penalize after climate shocks Introduce individual liability option alongside group model to prevent default contagion Allow crop repayment at market value as an option — increases flexibility without undermining cash model <p>6=Market support: Pivot toward post-harvest and marketing support to ensure loan repayment capacity</p>

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