60__decibels

DFS Population Research Handbook

Methodology for Collecting Population-Level insights in Kenya and Nigeria: Testing, Pilots, Key Learnings, and Overall Approach

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1. Background and Key Concepts

Digital solutions have the potential to transform agriculture for the world's 600 million smallholder farmers. With over 1000 digital agriculture solutions launched globally, this market is estimated to be worth a staggering $10.7 billion. Initially, the focus was on supply-side metrics like 'providers' and 'app downloads', but now the ecosystem recognizes the critical need for demand-side data from farmers to effectively understand scale, growth, and impact.

However, currently, there is a lack of demand-side data for this work, and there isn't a recommended methodology for collecting this data directly from farmers. This challenge is compounded by the fact that farmers are often unaware of whether they are using or have previously used digital agricultural services to support their farming activities.

To address this gap, The Bill & Melinda Gates Foundation, Busara Center for Behavioral Economics, and 60 Decibels have collaborated to develop a Farmer-Centric Measurement Approach. This methodology is designed to estimate the adoption of Digital Farmer Services (DFS) within specific farming populations. We have experimented with various approaches to asking questions, the frequency of data collection, sampling methods, and more. The objective is to create a replicable framework that can be adopted by others in the future as this initiative aims to facilitate the ongoing monitoring of the adoption and impact of digital agricultural services, recognizing their significance within the sector.

Between 2022 and 2024, 60 Decibels developed and refined a methodology for generating population-level insights on DFS. By testing the approach in Nigeria, Kenya, and a state in India, we collected to study access, usage, and meaningful use of digital agricultural services. The partnership seeks to provide valuable insights into how digital innovators can better tailor their services to meet the needs of smallholder farmers. This effort highlights the importance of understanding farmers' perspectives as they are the key users and end beneficiaries of such solutions, for sustainable impact and growth in the sector.

1.1 Key definitions

1.1.1 Objectives Digital Farmer Services

A Digital Farmer Service (DFS) is an agricultural solution that is:

- Offered by either an organization or an individual associated with an organization, known as the 'DFS Provider.
- Designed with the primary objective of addressing farming challenges and/or enhancing farmers' crop productivity and incomes.
- Delivered in part or in full through a mobile phone (feature phone or smartphone) to farming households or facilitated in part or in full by an agent using digital tools. These digital tools are restricted to devices observable by the farmer, such as mobile phones,

tablets, laptops, or computers, and may include mediums like video advisories played through laptops or on computers.

For our purposes, the definition of DFS does not cover farmers' direct use of agricultural services delivered through mediums other than a mobile phone. This exclusion includes mediums such as radio or television, as well as other internet-enabled devices like tablets or laptops. This definition also excludes services where agents digitally engage, but farmers are not aware of or directly involved in the digitization process. For instance, this could involve agents placing aggregated orders on an app that farmers have no knowledge of.

1.1.2 DFS Provider

A DFS Provider is an organization, or an individual associated with an organization (such as an agri-preneur, extension worker, or sales agent) that facilitates farmers' access to a DFS. Providers generally fall into the following categories:

Provider type	Examples of Providers
Government programs and extension services, and agents delivering these services	Krishi Vigyan Kendra
Corporations	OCP Africa providing fertilizer recommendations to Nigerian farmers using IITA / TAMASA app
Small and medium businesses / companies and agents working on their behalf	DigiCow
NGOs and Technical Assistance providers	Aga Khan Foundation

1.1.3 Clusters

A cluster categorizes types of DFS based on the core agricultural product or service provided to farmers.

1. **Information and advice.** This cluster covers the delivery of information that is directly related to improving farm and livestock output and returns from their sale, including:

Information Type	Examples of Providers
Good agricultural practices (farm, livestock)	Digital Green, DigiCow
Information on market prices	RATIN
Information on soil health (with or without a device)	CultYvate, Fasal
Climate and weather advisory	Ignitia
Information on market location	iShamba

It does not cover access to a broader set of content such as finance or business training, product validation, counterfeit detection services, and record-keeping services.

2. **Financial services.** This involves a digital financial product designed specifically for farmers, with digitization aimed at facilitating access to the product, conducting financial transactions, or staying informed about the status of an agricultural financial service.

Type of Financial Services	Examples of Providers
Agricultural loans and credit	EquiFarm

Credit for farm/livestock inputs and equipment	Apollo Agriculture, SunCulture
Crop or livestock Insurance	ACRE Africa
Agriculture wallet and savings	mPesa, Phone Pe, Alluvial digital wallet

3. **Farm and livestock inputs.** This category involves models where the selection, payment, and/or delivery of agricultural inputs are facilitated through digital channels. It includes both the purchase and rental of inputs, as well as accessing information about available inputs.

Input Type	Examples of Providers
Farm / livestock inputs	Krishify
Farm equipment (tools and machinery)	SunCulture

4. **Market access.** Digital solutions that assist farmers in making informed decisions regarding the sale of their produce based on market information, connect farmers with potential buyers, facilitate storage and transportation of produce for sale, and enable farmers to receive payments from the sale.

Solution type	Examples of Providers
Arranging / coordinating a sale	Elements, Agrorite, CoAmana
Information on market prices	RATIN
Information on market location	iShamb

1.1.4 Delivery Channels

In addition to categorizing DFS based on the agricultural products/services being delivered and digitized, we also defined the delivery mechanisms for each type of DFS. This includes:

- SMS
- IVR
- USSD
- Phone Calls
- Provider's mobile application (with and without the presence of a physical device like a soil sensor)
- Existing mobile application for communication e.g. WhatsApp / Facebook
- Existing mobile payment application e.g. Phone Pe / Google Pay / Paytm / mPesa
- Internet browsing on mobile phone by self
- Digitally enabled extension agent

1.1.5 Types of Users

We categorize users to determine the primary user of DFS and assess their reliance on another individual to access and use the digital service. We have identified two distinct user types:

- **Direct Use:** Farmer is using the DFS directly on a mobile phone
- **Facilitated Use:** User accesses DFS through an agent associated with a DFS provider

1.1.6 Informal Use of Mobile Phone for Agriculture

Our definition of DFS assumes the involvement of an organized provider, as outlined in the definitions above. We rely on farmers' self-reports to gauge this involvement. However, this approach may not capture instances where farmers use mobile phones for agricultural purposes without a provider, or in cases where a provider exists but the farmer is unaware of it.

To address this, we track farmers' informal use of mobile phones for agriculture. This includes scenarios where farmers leverage the existing capabilities and applications of their mobile phones, such as phone calls, messaging, WhatsApp, Facebook, to access agricultural products or services, and to coordinate agricultural activities with shopkeepers, friends, or family, even when a DFS provider is not involved.

1.1.7 Bundled Use

Bundled use is when the farmer uses multiple services from the same providers. For instance, an input DFS provider could also offer credit to buy inputs. This would be considered bundled use.

1.2 About the Handbook

The 60 Decibels team experimented with different approaches to measuring access and usage of Digital Farmer Services (DFS) over the past year. These trials taught us valuable lessons that implementers, investors, foundations, and researchers could use to measure important DFS metrics through phone interviews. By sharing insights gained from these trials, we hope to give practical advice to those navigating the world of DFS. Key sections in the handbook are summarized below:

1.2.1 Methodology

This section examines the various experiments conducted in different regions to develop a methodology for measuring usage of DFS and gain other relevant insights. It has the following sub sections:

- **Survey Design**: Provides a detailed breakdown of survey modules used to capture metrics related to DFS adoption and impact.
- **Sampling**: Outlines the sampling approach needed for collecting representative data. The handbook discusses different sampling techniques and provides guidance on selecting the most appropriate approach based on resources, research objectives, and constraints.

1.2.2 Analysis

This section outlines an analysis plan to help researchers make sense of the collected data. It includes methodologies for analyzing survey responses, identifying trends, drawing meaningful conclusions, and presenting findings.

1.2.3 Lessons and recommendations

This section of handbook presents final lessons learned from various sampling and data collection approaches. By evaluating the strengths and limitations of different approaches, stakeholders can choose the most suitable parts of the methodology for their research needs.

The handbook aims to equip readers with practical guidance and tools for conducting population research on DFS effectively. By exploring the outlined material and recommendations readers can gather insights into the usage patterns and impact of digital services in agriculture through phone interviews.

2. Methodology

2.1 Introduction

Before delving into the specifics of the experiments conducted and the lessons learned from them to develop a DFS population research methodology, it is essential to review the overarching design and primary objectives guiding studies conducted across the three different geographies. The design of each study was customized to address unique challenges and uncover various lessons. Ultimately, these findings would contribute to recommendations for a study design capable of generating actionable insights to inform policy decisions or strategic interventions. With each geography posing its own set of opportunities and obstacles, custom approaches were necessary to ensure successful research execution. Below is an overview of the population level pilots:

2.1.1. Indian state

The India pilot attempted to collect insights on DFS with a single round of data collection where farmers were asked to reflect on the entire 2022-23 kharif agricultural season. Data was collected when farmers had sold most of their produce. The sample frame was sourced from the a local governmental database, which comprised 45,388 farmer phone numbers. These numbers represented women from 12 million rural households. A total of 2,740 farmers were screened and surveyed. The sample aimed to represent mobile phone owners, ensuring a 50% gender split by randomly including knowledgeable male household members.

The survey included five DFS clusters: information and advisory, input and equipment, insurance, credit, and market access services. Additionally, a subsidies module was integrated to gather data on government schemes. To manage the question load effectively, farmers were randomly assigned to one of three groups, each covering different combinations of clusters.

The key learning objectives were:

- Understanding utility of the data/insights for government and policymakers
- Learning trade-offs of a single post-selling data collection round instead of multiple rounds
- Recommending insights to collect through a single round
- Assessing feasibility of using an existing government database for the sample frame

2.1.2 Kenya

The Kenya study focused on the 2023-24 Masika (long rains) season. Data collection was done in three rounds, spanning the entire Masika season.

We partnered with Dalberg Research to create a nationally representative panel of 3,771 farming households that was recruited in-person. These came from 39 counties. We tried to achieve a 50% female split and ended up with contacts of 2878 female farmers. These 3771 households formed the sample frame for the Kenya study.

No listing exercise was conducted to document all eligible households in a village. We opted for a more efficient method—systematic random sampling starting from a random location. It's worth noting that this approach might miss some distant sections of the village. Although conducting a listing exercise is thorough, it's resource-intensive, and would require four times the amount of time. The number of households in the panel for each county is proportional to the total number of farming households in each county.

2,563 were interviewed in round 1 with assumed 20% attrition in later rounds. We collaborated with KALRO (Kenya Agricultural Livestock Research Org) to determine the timing of data collection. The final sample sizes are noted below.

Months	Survey rounds	Sample size
Jun-Aug 2023	Round 1: Post-Planting period (after most farmers finished planting for the season)	2563
Oct-Dec 2023	Round 2: Post-Harvest period (after most farmers completed harvesting for the season)	1931
Feb-Mar 2024	Round 3: Post Selling period (after most farmers sold their produce from the season)	1484

The key learning objectives here were:

- Exploring feasibility of shorter, higher-frequency surveys
- Assessing feasibility of in-person sample recruitment
- Understanding the trade-offs between deep dive and basic-use modules

2.1.3 Nigeria

The Nigeria study centered on the 2023-24 agricultural season. The data collection process comprised four rounds—a pilot phase focused on farmer profiles, along with post-planting, post-harvest, and post-selling rounds. This exercise was conducted in collaboration with LSMS, as a part of their broader national household survey, which included a dedicated DFS study module in each round. NBS led the implementation of the study. The sample was drawn from the sample of households for from the Nigeria National Longitudinal Phone Survey (NLPS).

The learning objectives were:

- Learning about the trade-offs associated with conducting shorter add-on rounds of data collection instead of longer stand-alone rounds of data collection throughout the agricultural season.
- Understanding the experience of working with existing firms and integrating our survey tool with existing surveys.
- Understanding the feasibility of working with an existing database to build a sample frame. We will reflect on this as a potential pathway for the sustainability of this work in the future.

2.2 Survey Design

In developing and refining this methodology, a primary focus was on identifying the data to collect. The development of the DFS surveys began with the development of the population-level research survey tool for the Indian state in April 2022 and progressed through three phases, with updates made at the end of each phase based on lessons learned.

Phase 1 involved three sub-phases:

1. DFS Provider Interviews: Interviews were conducted with DFS stakeholders, including DeHaat, Plantix, Sistema.bio, and Digital Green, as well as investors and research experts such as CGAP, Mathematica, IDH, IFPRI, and IDinsight. The goal was to define the data landscape in which DFS stakeholders operate, identify priority metrics for data collection, and understand how different stakeholders define and measure "active use" of DFS. While there is no standardized metric for active use across diverse DFS offerings, stakeholders generally aim to create positive behavior change among farmers to enhance productivity, yields, incomes, and farming sustainability. This led to the development of an impact and value-based proxy for active use measurement termed "Meaningful Use."
2. DFS Landscape Analysis Report: Prepared by the Busara Center for Behavioral Studies, this report underscored the importance of capturing farmers' social associations, such as group memberships.
3. In-person Farmer Perspective Studies in India: Qualitative surveys were conducted through six focus group discussions. These discussions aimed to understand farmers' interactions with DFS and distinguish between formal DFS use and informal mobile phone use for farming tasks. Insights included the role of agricultural agents in facilitating DFS use, prompting the inclusion of questions to capture agent-facilitated DFS utilization in the survey.

Phase 2 involved piloting the survey tool:

- In-person field pilot: Conducted initially with 16 farmers in a state in India.
- Phone survey pilot: Implemented with customers of six DFS providers including Plantix, DeHaat, and Aga Khan Foundation in India.

Phase 3 focused on stakeholder engagement and validation:

Three learning workshops were held in November and December 2022, involving DFS investors and providers to validate the survey approach and gather feedback. Workshops were conducted in-person in Nairobi with donors and funders, virtually with Program Officers from the Foundation's DFS team, and with donors, funders, and researchers. The methodology was also shared with the Foundation's India team via email.

Ultimately, the survey tool and implementation guide were finalized in December 2022, encompassing survey modules, corresponding metrics, and guidance documents for survey execution. Throughout the design process, consultations were conducted with various stakeholders, including government officials, investors, DFS providers, and potential users of the survey data, ensuring comprehensive input and alignment with stakeholder needs.

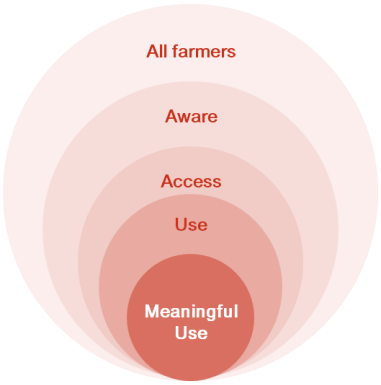
These focus groups and pilots were instrumental in identifying essential questions to include for understanding DFS usage and impact. They also helped us determine which insights could be effectively gathered from farmers through phone interviews. Drawing from insights gained from these experiences, we developed surveys for Kenya and Nigeria. We categorized the population research survey modules into three tiers based on the depth of insights they provide:

1. Essential Metrics: This tier comprises 7 questions focusing on access and usage across all five DFS clusters.
2. Core Metrics: Building on the essential metrics, this tier includes an additional 26 questions for each DFS cluster. These questions delve deeper into whether access is direct via a mobile phone or facilitated through a digitized agent, explore if services are 'bundled' with other clusters of DFS, examine the channels of DFS delivery, evaluate the value created from using a DFS, and gather non-user insights, such as whether they access services through non-digital channels.
3. Extended Metrics: This tier includes the core metrics module plus an additional set of 10 questions for each DFS cluster. These questions focus on the farming experience and outcomes of both DFS users and non-users.

2.2.1 Essential metrics

Using the essential metrics, we developed the “Engagement Funnel," a framework comprising questions to gauge DFS awareness, access, and usage. This funnel enables us to estimate drop-offs at each stage, diagnose the underlying reasons, and pinpoint actionable steps to enhance engagement.

The engagement funnel operates at two levels: cluster and overall. Cluster level data is aggregated to establish the overall DFS engagement funnel. Below, we outline the metrics at the cluster level, using the Information and Advisory cluster as an illustrative example for clarity. For each metric, “information and advisory” could be replaced with any of the other clusters.



1. Awareness:
Indicator: % of farmers with mobile phones that know of at least one digital service that provides information and advisory on farming.
Question: Do you know of any providers (e.g. companies or organisations) that share farm-related information with farmers on a mobile phone or through an agent with a digital device?

2. Access:
Indicator: % of farmers with mobile phones that have access to any provider that shares farm-related information digitally.
Question: Did you have access to any of these providers the current farming season (i.e. between March and May 2023) season? i.e. would you have been able to receive farm-related information from any of these provider(s) the current farming season (i.e. between March and May 2023)?

3. Use:
Indicator: % of farmers with mobile phones that self-report use of DFS
Use is measured using two different approaches:

a. Deep-dive module: This approach uses 3 questions to decipher whether a farmer is a user or not. This is detailed and captures multiple aspects of usage to ensure we do not over-estimate DFS usage.

Question 1:

Did your household seek or receive information or advice for your farm during [X period]?	Yes	No

Question 2:

Did your household seek or receive this information or advice in any of the following ways:	On a mobile phone — yours or a household member's/friend's/neighbour's
	From an agent with a phone/tablet/computer/video
	Both on a mobile phone and from an agent with a mobile phone/tablet/computer/video
	No

Question 3:

Can you tell us more about the organization(s) or community groups who shared information on your mobile phone? Were they: Select all that apply.	A Private Company
	A Farmer Producer Organization or Farmer Cooperative
	A Government Program or Institution or Agency
	A Financial Institution- Bank or microfinance
	An NGO
	Don't know (but is a company, organization, community group, NGO, or government agency)

	Someone else / Other (i.e. not a company, organization or community group)

To be categorized as a DFS user, a farmer must answer:

- "Yes" to Question 1
- "From an agent with a phone/tablet/computer/video" or "Both on a mobile phone and from an agent with a mobile phone/tablet/computer/video" to Question 2.

OR

- "Yes" to Question 1
- "On a mobile phone — yours or a household member's/friend's/neighbour's" to Question 2 AND Anything other than or in addition to "Someone else" to Question 3.

To be categorized as an informal user, a farmer must answer:

- "Yes" to Question 1
- "On a mobile phone — yours or a household member's/friend's/neighbour's" to Question 2 AND "Someone else" to Question 3.

To be categorized as a non-digital user, a farmer must answer:

- "Yes" to Question 1
- "No" to Question 2

To be categorized as a non-user, a farmer must answer:

- "No" to Question 1

b. Short-form: We also explored a single-question approach to assess usage, prompted by space limitations within the survey tool. This was specifically included for clusters that were not the primary focus of a data collection round.

Did you household seek or receive information or advice for your farm during this farming season from a provider (e.g. organization or company) that shares information on farming using a mobile phone or through an agent with a digital device?	Yes	No

2.2.2 Core metrics

User insights

Metric	Indicator
Usage channel: Direct (using DFS only through a mobile phone) or Facilitated (using DFS with the help of an agent, where farmers have some exposure to the digitization)	% of direct users or farmers using DFS by themselves % of facilitated users or farmers using a DFS with the support of an agent
DFS channel	self-reported digital channel used to access DFS
DFS agent organization[1]	self-reported digital agent organization used to access DFS
Bundling: Users using multiple services from the same DFS provider	% of users using bundled services
Number of DFS providers	Number of providers who provide DFS services to the user

Non-User insights

Metric	Indicator
Reason for non-use or informal use	Reasons why the farmer is not using DFS despite having access
Informal use	Who was contacted using a mobile phone?

[1] Farmers were unable to identify the names of the providers they worked with, which rendered the data unreliable.

	Specific activities conducted using a mobile phone How exactly was the mobile phone used?

Challenges in survey design

1. Awareness and Access are hard to distinguish: We found that farmers often struggle to differentiate between awareness of a service and having access to it. Rather than asking about access directly, it's more effective to gauge awareness and then deduce access through understanding why a farmer might not use a service.
2. Differentiating between facilitated and direct use: It's crucial to differentiate between direct and facilitated use of digital services. Many farmers access these services both directly on their mobile phones and through digitized agents. Capturing this distinction in survey design provides a more accurate picture of digital access and prevents underestimation.
3. Differentiating between stacked use and bundling is challenging: We attempted to distinguish between 'stacked' use (multiple providers for various services) and 'bundled' use (multiple services from one provider). However, farmers found this differentiation challenging, suggesting a need for clearer, more farmer-friendly ways to explore these concepts.
4. Farmers struggle to identify sources of DFS: Farmers often found it hard to differentiate between various types of DFS providers (government, private companies, NGOs, FPOs) or to name them specifically. This difficulty highlights the need for more nuanced approaches to understanding farmers' interactions with service providers and the blurred lines between formal and informal service use.
5. Conceptual Understanding: We observed some overlap in how farmers from different clusters perceived digital services. This insight underscores the importance of developing clear, consistent definitions of digital services that resonate with farmers' understanding and experiences.

2.3 Survey administration

As we implemented the national pilots, we experimented with various question-asking approaches to identify the leanest and most accurate methods that would be well-understood by farmers. Continuously learning from our experiences, we iteratively refined the questions based on ongoing lessons learned.

Initially, in India, we provided detailed descriptions of each DFS cluster to help farmers better understand the questions and accurately classify themselves as 'users' or 'non-users'. However, despite the additional context, this approach often confused farmers. Additionally, it was excessively lengthy and time-consuming, leading to uncertainty about the accuracy of farmers' self-classifications as DFS users or non-users.

Learning from this experience in India and noting that other organizations like KNBS also avoid extensive explanations, we decided to revise our method. In Kenya and Nigeria, we adopted a deep dive approach to identify DFS users among farmers. Instead of having farmers self-identify, we administered a set of core questions. The responses to these questions allowed us to classify farmers into categories: DFS users, informal users, non-digital users, and non-users. This classification was completed during the analysis phase, after data collection.

While the deep dive approach provided valuable information for categorizing farmers, it increased the survey length. To address this, we introduced a short-form use question: a direct question asked to farmers to determine if they were DFS users. Despite streamlining the survey, we were concerned that farmers might not have a complete understanding of DFS usage and could potentially misclassify themselves. This was because they needed a clear understanding of what qualifies as a DFS. Consequently, during analysis, we relied primarily on the more detailed deep dive questions rather than the short-form question.

Additionally, we found that providing training to enumerators on DFS was beneficial, enabling them to offer specific examples to guide respondents.

Across the various pilots conducted, different combinations of survey modules were employed. It became evident that a substantial amount of time, explanation, and understanding from both respondents and enumerators was necessary even for determining access and use (essential metrics). Therefore, when information on all five DFS clusters was required in a single round, the deepest feasible measurement was limited to essential metrics.

In summary, the key lessons learned were as follows:

1. Lengthy explanations hindered survey repeatability and caused confusion for respondents.
2. Capturing essential metrics of access and use was feasible, but more in-depth questions were challenging to incorporate within a single survey round.
3. Enumerator training on examples of DFS proved to be valuable.
   Answering questions that require farmers to identify themselves as users or non-users of digital agricultural solutions demands a strong understanding of these solutions, which many farmers lack.

2.4 Data collection

We tested 2 different cadences for data collection:

1. One round: For the Indian state, we experimented with a single round of data collection to gather all metrics applicable for a period of 12 months. Through this process, we learned that farmer recall poses a challenge due to the extended reference period. Specifically, for clusters such as Information and Advisory, Market Access, and Inputs and Equipment, where usage does not occur during defined stages of the season, it is possible that usage is underestimated if data is collected only at a single point in time.

2. Three rounds: In Kenya, we experimented with a seasonal approach involving three surveys conducted at different points in the season. This approach resulted in relatively shorter surveys, lasting between 30-35 minutes, which aided recall and increased the quality of insights. Additionally, higher-frequency surveys allowed for adaptation. For instance, in response to low insurance usage during the planting season, we adjusted questions in later surveys to avoid investing time and resources in areas that would not generate meaningful insights.

We learned that conducting multiple rounds of surveys is effective. This approach allows us to adjust the survey content based on usage trends. For example, when Insurance DFS usage dipped below the 10% mark, we adapted the subsequent survey round to investigate other popular DFS, like Information services. This strategy not only enables us to detect emerging trends early but also facilitates deeper exploration in subsequent rounds. It offers flexibility, which is crucial in the constantly changing landscape of digital services. Therefore, conducting multiple rounds and tailoring surveys based on research priorities can yield valuable insights.

2.5 Sampling

2.5.1 Sample frame

Across the three geographies, we tested three different methodologies for identifying and constructing a sampling frame.

2.5.1.1 Using an existing panel

In In Nigeria, we leveraged an established sample frame in collaboration with LSMS, using their National Longitudinal Phone Survey (NLPS) sample frame derived from the General Household Survey Panel (GHS-Panel). This nationally representative panel covers households from all six geopolitical zones in Nigeria. Out of the 5,000 households in the GHS-Panel, 4,400 provided contact information. We contacted these households for the NLPS Phase 2 surveys, successfully interviewing farmers from 2,922 households during Round 1 of Phase 2 in November 2021. By Round 5 of Phase 2 in July 2022, after some attrition, we surveyed 2,605 households. We used this base sample to select households for 60 Decibels' DFS population research, identifying eligible participants through a farmer screening module.

Household Selection
We selected ‘farming households’ with mobile phones based on these criteria:

- The household engaged in crop cultivation or livestock rearing in the last 12 months.
- The household derived at least 25% of their income or food consumption from their crop and livestock produce in the last 12 months.

Following this screening, we deemed 1,904 out of 2,605 households (73% of the Round 5 sample) eligible for the DFS population-level surveys, forming the Nigeria DFS sample frame.

Weighting
Our aim was to produce national or county-level estimates that accurately reflected the entire population of farmers in Nigeria with mobile phones. We designed weighting procedures to ensure the weighted distribution of the sample aligned with the relative distribution of the sampling frame. We calculated weights for each sampling unit based on the inverse of the overall probability of selection, considering probabilities at all three sampling stages. At the household level, we adjusted the DFS weight for non-contact and non-response, calibrated based on characteristic profiles of all farming households in the GHS-Panel. To maintain accuracy and prevent excessive standard error inflation, we trimmed extreme weights, ensuring precise representation of the target population in survey estimates.

For individual farmer-level estimates, we accounted for:

- Not all farmers were eligible for the survey, as they may not have been the most knowledgeable farmer regarding the household's farming activities.
- Unequal probability of selecting a male or female farmer to achieve balanced gender representation.

These adjustments yielded the individual-level DFS weight, ensuring precise estimates at the farmer level. We used the household-level DFS weight as the default for most profile questions and individual-level weights for specific metrics like age, gender, education level, and digital profile.

Limitations
Since we relied on phone interviews, farmers without access to these devices were not included in our study. Our sample does not represent farm households without mobile phones, though this subgroup is small, minimizing bias. We focused on solutions where farmers directly experienced digitization, excluding B2B DFS solutions or models where digitization occurs upstream. To streamline our analyses, we limited our scope to the five essential agricultural services, focusing deeply on farm advisory and inputs during the planting period. We will explore the remaining services in upcoming study rounds. We also focused solely on mobile phone use, excluding other digital devices.

2.5.1.2 Building a panel from an existing database

In the Indian state, we partnered with a government program to build the sample frame for this research. Under this initiative, women from rural poor households have been organized into Self Help Groups (SHGs) to enable peer interaction and capacity building for income generation and saving. Because this initiative had easy entry requirements and covered the entire state, we believe it provided a solid basis for our sample.

They maintains a comprehensive participant list. From this database, phone numbers of farmers were extracted, and 45,388 members were randomly selected across all 38 districts in A state in India. 60 Decibels received this contact list in April 2023, and we used it for selecting our sample.

We used a two-step screening process to select our sample. First, we identified 'farming households' from the database. Out of 3,066 households screened through phone surveys, 2,740 were eligible for our research. Following this, we identified one target respondent from each household to participate in our survey.

Household Selection

We selected 'farming households' that met both criteria:

- The household engaged in either crop cultivation or livestock rearing or both in the last 12 months, and,
- The household derived at least 25% of their income or food consumption from their crop and livestock produce in the last 12 months.

Respondent Identification

We prioritized interviewing the most knowledgeable household member about farming practices, aiming to include knowledgeable female farmers for gender-segmented analysis. If either the male or female farmer was the sole knowledgeable individual, we interviewed that farmer. In households with knowledgeable male and female farmers, we prioritized interviewing the female farmer. As a result, 28% of our sample was female.

Limitations of the Sample Frame

Our assumption was that the sample frame derived from the database represents the population of farmers in A state in India with mobile phone access. However, the frame has the following limitations:

- Despite being one of the largest efforts to assist the rural poor in the initiative we partnered with could not provide detailed beneficiary data such as distribution by district, age, and other demographics. Additionally, the contact information in the database includes only female SHG members, excluding farming households without female members. This limited data prevents a quantitative assessment of representativeness and may introduce bias if the excluded households are systematically different.

- The criteria the initiative uses to designate an SHG member as a 'farming household' are unknown and may not align with the eligibility criteria for this study. Although we use screening questions to identify eligible respondents, the potential non-random exclusion of eligible farmers from the database could introduce bias into the sample frame.

- The list of phone numbers received from the database covers only 154 out of 534 Blocks in the Indian state, and one district is underrepresented with only 17 unique farmer contacts. This limited geographical coverage might introduce bias if the excluded blocks differ systematically from those included. Additionally, a data collection error resulted in missing input and equipment usage data for one group, which we addressed by imputing data from post-selling to examine digital input and equipment usage.

Weighting

We aimed to produce state-level estimates that accurately reflected the entire population of

farmers in the Indian state with mobile phones, asking farmers to reflect on the kharif season 2022-23 in their responses. We adjusted sample and sub-sample averages using weights developed.

We designed weighting procedures to align the weighted distribution of the sample with the relative distribution of the sampling frame, adjusting for over- or under-sampling relative to gender and district quotas. We calculated weights based on the inverse of the overall probability of selection. Assuming farmers in the database were generally representative, we used 2011 India Census data to allocate the sample to districts in proportion to their total number of farmers and calculated gender-based weights by comparing the proportion of female and male respondents with the 2011 Census distribution.

Limitations
As our research relied on phone interviews, we excluded farmers without access to these devices. This subgroup is small, minimizing bias. We focused on solutions where farmers directly experienced digitization, excluding B2B DFS solutions or models where digitization occurs upstream. To streamline our analyses, we limited our scope to the five essential agricultural services, focusing on mobile phone use and excluding other digital devices like laptops or tablets.

2.5.1.3 Building a panel from scratch

In Kenya, we took a completely different approach. We constructed a national panel which was recruited from 38 Kenyan counties. We evaluated several options for creating this panel, including partnering with marketing firms to acquire phone numbers of farmers, and utilizing flyers and IVR technology to recruit farmers. However, obtaining a representative sample of farmers through these methods would be difficult. As a result, we decided to conduct in-person recruitment. Using a 3-stage sampling design, we managed to recruit about ~3,800 eligible farming households with the help of a partner organization specialized in conducting such in-person recruitment exercises.

The sample frame was stratified by county, with sampling conducted in 38 out of the 47 counties in Kenya. Nairobi, being predominantly urban, was excluded, along with eight other counties that Dalberg Research's enumerators were unable to visit.

Our sample frame development followed a multistage approach:

Stage 1: In every county, wards were designated as primary sampling units and systematically selected based on population size. This approach guaranteed that wards with larger populations had a greater chance of being chosen. To minimize sampling weight variability, the number of sample wards selected in each county was proportionate to the county's farming population.

Stage 2: Within each ward, two villages were selected as secondary sampling units. Dalberg Research obtained a complete list of villages in the chosen wards. From this list, two villages were randomly chosen per ward. Each village had an equal chance of selection.

Stage 3: With assistance from village leaders, each village was divided into four sections. In each section, researchers visited every 'xth' household (determined by dividing the total number of households in the village by 16) until they identified four eligible farming households (refer to Household Selection below). They repeated this systematic approach in the next sections.

Household Selection:
We selected 'farming households' with access to a mobile phone that met both of these criteria:

- The household engaged in either crop cultivation or livestock rearing or both in the last 12 months, and,
- The household derived at least 25% of their income or food consumption from their crop and livestock produce in the last 12 months.

Respondent Identification
Within eligible households, Dalberg Research identified all the household members who have the most knowledge about their household's farming practices, including both field- and market-related activities. We initially aimed to achieve a balanced representation of male and female farmers. However, due to the significant female farming population in Kenya, this balance occurred organically. 50% of farmers in our sample frame were female.

Limitations on Sample Frame
Our sample frame has the following limitations:

- Our sample frame represents 39 out of the 47 counties in Kenya. While excluding Nairobi was justified, if the remaining counties differ systematically from the sampled ones, our sample frame could be biased. Ideally, sampling these excluded counties in the future would allow us to supplement and enhance the representativeness of our data.

- Because we did not have population data for villages, we employed simple random sampling to select villages in our sample. This method ensured equal chances for all villages to be chosen. However, considering the varying sizes of villages, a more optimal approach would have been sampling based on population size (probability proportional to size).

- Relying on in-field researchers for accurate sampling and surveys always carries a risk. However, we ensured strict supervision and conducted spot checks, verifying maps and GPS data meticulously. These steps improved the process's accuracy and reliability.

- No listing exercise was conducted to document all eligible households in a village. We opted for a more efficient method—systematic random sampling starting from a random location. It's worth noting that this approach might miss some distant sections of the village. Although conducting a listing exercise is thorough, it's resource-intensive, requiring four times the amount of time.

- Due to large scale flooding in the North-Eastern region during April 2023, we were only able to reach 63 unique farmers, leading to their underrepresentation in the sample frame. Our ability to draw meaningful conclusions about the region is limited.

Weighting
The analysis aims to produce national (or county-level) estimates of household and individual outcomes that reflect as accurately as possible the entire population of farmers in Kenya with access to a mobile phone. Farmers were asked to reflect on the planting phase of the main peak season – long rains or masika season 2023-24 – in their responses.

The purpose of the weighting procedures is to ensure that the weighted distribution of the sample aligns with the relative distribution of the sampling frame. We calculate weights for each sampling unit based on the inverse of the overall probability of selection, considering probabilities at all three sampling stages.

While the sampling frame does not include all farmers in Kenya, it is tailored to be representative of farmers across the 39 counties. To accurately reflect the actual distribution of farmers in Kenya by county, we used the 2019 Kenya Population and Census data. This data was used to allocate the number of wards in proportion to the total number of farmers in each of the 39 counties, ensuring a more accurate representation in our study.

Limitations
Since our research relied on phone interviews, farmers without access to these devices were not included in our study. This means our sample does not represent farm households without access to mobile phones, although this subgroup is small, so any bias from excluding them should be minimal.

In addition, our study focuses on solutions where farmers directly experience the digitization. Therefore, we are unable to capture the penetration of B2B DFS solutions or models where digitization happens upstream (e.g., blockchain-enabled service delivery models).

Finally, to maintain manageable survey lengths and streamline our analyses, we limited our scope to the five essential agricultural services; of these, we did a deep dive into the two most relevant services during the planting period – farm advisory and inputs. The remaining three services will be explored in detail in upcoming rounds of the study.

Similarly, we only focused on farmers' use of mobile phones, excluding other digital devices such as laptops or tablets.

2.5.1.4 Recommended approach

Based on our experience, building a custom sample frame has several key advantages. It is a more efficient method that operates independently of external partners, enabling faster implementation. Finding a suitable sample frame can be challenging; while government institutions often have access to this data, creating a contact base from scratch allows for better control over its representativeness. Accessing government data is often difficult, as it can take

years to build the relationships and trust needed to access sensitive information. If a representative panel from a reputable market source is available, using it can save budget resources that would otherwise go into building a new panel. Ultimately, it's essential to balance rigor with the effort and budget invested to choose the most effective approach for creating a sample frame.

2.5.2 Sample size

Sample Sizes Across Geographies

- Indian state: 2313 households
- Kenya: 1484 households that were interviewed in all three rounds.
- Nigeria: TBD

Approach
India: We aimed to measure DFS usage across all clusters at a single point in time. To avoid impractically lengthy surveys, we increased the sample size and divided it into three sub-groups. Each sub-group underwent detailed surveys on the five types of DFS metrics. While this method ensured representative results through proper weighting, it complicated the analysis and reduced statistical power due to the divided sample.

Kenya: In Kenya, we opted to conduct detailed surveys for all clusters across different rounds. Data collection occurred in three rounds, allowing us to gather comprehensive data on all farmers in each cluster. This approach simplified the analysis compared to the method we used in the Indian state and increased statistical power. However, attrition across rounds reduced the final sample size from 2500 to 1600 households.

Nigeria: In Nigeria, we utilized the NLPS sample frame drawn from the GHS-Panel to create a representative sample for Phase 2. We contacted 4400 households from this frame and successfully surveyed 2605 by the fifth round.

In all geographies, survey results were weighted to ensure estimates were representative of the state/national population.

Key Considerations
Ultimately, to determine the appropriate sample size for a population-based study, you must define the population and the desired level of confidence, estimate attrition, and do the calculations.

Low usage levels of certain types of DFS reduces the power of estimates for respective core and extended metrics. This limitation arises because the sample size was calculated with the primary focus on estimating DFS usage. To obtain accurate usage estimates, the sample must include a representative mix of users and non-users from the target population of mobile-owning farmers. However, to achieve good statistical power for estimating core and extended metrics, the sample size would need to be optimized specifically for those metrics, i.e, focus on having more users in the sample. Doing so could result in significantly higher costs and effort.

This issue was particularly worse in the Indian state, where clustering was used which further reduced the already limited sample dedicated to each DFS. Our recommendation is to avoid clustering altogether. We also suggest conducting multiple rounds of data collection, which would allow for strategically selecting the DFS that warrants in-depth assessment through core and extended metrics. This approach could be more efficient in terms of resource allocation while still providing robust insights into DFS usage patterns.

3. Analysis

The aim of the analyses for all three geographies was to produce national or state-level estimates of household and individual outcomes that accurately reflect the entire population of farmers in Kenya, Nigeria and an Indian state with access to a mobile phone.

To ensure the findings are representative of the broader population, the data presented in this report are based on sample and sub-sample averages, adjusted using calculated weights. The weighted data is used to present means and, where appropriate, medians at both group and sub-group and cluster levels. This method helps in illustrating trends and patterns within the data. Only those group level differences that are statistically significant at the 95% confidence level or higher are highlighted. This ensures the robustness and reliability of the findings.

The analysis for all three geographies was conducted using the Stata software.

4. Lessons and Recommendations

Through a series of extensive experiments conducted across three distinct geographies, we have gained valuable insights that can help readers understand the optimal approach to design and implement population studies to measure access and usage of digital financial services (DFS). The following summarizes a few of the most significant lessons learned:

a. **Building a panel from scratch is efficient**: Building a panel from scratch offers many advantages in terms of efficiency, control, and timeliness. This approach allows for relatively faster implementation as there is no dependency on external partners, and it provides greater control over data usage and handling. Also, constructing a panel immediately before data collection ensures that the database is up-to-date and ready for immediate use. However, it is important to note that creating a panel entirely from scratch may not necessarily achieve comprehensive representation across all counties or regions, as there could be gaps or biases in the sampling and recruitment processes.

b. **Setting minimum usage thresholds is critical**. Establishing minimum usage thresholds is a critical consideration, particularly when dealing with DFS that have low adoption rates. Before delving into core and extended metrics, it is essential to define a minimum usage threshold. This approach helps optimize resource allocation by focusing efforts on collecting meaningful data that is statistically representative and avoids wasting resources on DFS with negligible usage. Additionally, setting usage thresholds can help minimize respondent fatigue, as participants are not burdened with extensive questioning on services they do not actively use, thereby improving the overall quality of responses.

c. **Achieving national representation requires existing national data.** Achieving national representation often requires access to existing national-level data sources. In the case of our study, there was no publicly available, up-to-date reference database on the farmer population in Kenya that could serve as a reliable sample frame. This limitation constrained the precision of our sample design and weighting methodology. To mitigate this challenge, we relied on the 2019 Kenya Population and Housing Census, which provided high-level distribution estimates of the farming population but lacked granular-level data. While this was not an ideal solution, it was the best available option given the circumstances.

d. **DFS inherently has a broad scope, so prioritization is key.** Digital financial services (DFS) encompass a broad range of products and services, making it imperative to prioritize the insights to be collected. Attempting to cover every aspect of DFS can result in excessively long and unwieldy surveys, which can adversely impact data quality and participant engagement. To address this challenge, we had to carefully prioritize the key areas of interest and focus our efforts on collecting the most relevant and valuable insights, while still maintaining a balanced and comprehensive approach.

e. **The DFS landscape is complex and is not well-suited for rapid surveys.** One of the unique selling points of lean data and studies is the ability to measure easily and regularly. However, given the diverse range of DFS products available in the market, rapid surveys can only be conducted effectively if one can prioritize a specific DFS and focus on the same. Population-

level research for DFS is a complex undertaking and can be expensive, so it may be more feasible to conduct such comprehensive studies on a less regular basis.