FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

# Participant-Based Survey Sampling Guide for Feed the Future Annual Monitoring Indicators

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# Abbreviations and Acronyms

| | |
|---|---|
| BFS | Bureau for Food Security (USAID) |
| DHS | Demographic and Health Surveys |
| EA | enumeration area |
| FANTA | Food and Nutrition Technical Assistance Project |
| FFP | Office of Food for Peace (USAID) |
| FFPMIS | Food for Peace Management Information System |
| FFS | farmer field school |
| FTFMS | Feed the Future Monitoring System |
| GFSS | Global Food Security Strategy |
| GPS | global positioning system |
| IFPRI | International Food Policy Research Institute |
| IM | implementing mechanism |
| IP | implementing partner |
| IPTT | indicator performance tracking table |
| LQAS | Lot Quality Assurance Sampling |
| LSMS | Living Standards Measurement Studies |
| M&E | monitoring and evaluation |
| MCHN | maternal and child health and nutrition |
| MICS | Multiple Indicator Cluster Surveys |
| MOE | margin of error |
| PaBS | participant-based survey |
| PBS | population-based survey |
| PDA | personal digital assistant |
| PG | producer group |
| PIRS | Performance Indicator Reference Sheet |
| PPS | probability-proportional-to-size |
| SOW | scope of work |
| SRS | simple random sampling |
| USAID | U.S. Agency for International Development |
| USG | U.S. Government |
| WASH | water, sanitation, and hygiene |
| WDDS | Women's Dietary Diversity Score |

# PART 1

# INTRODUCTION

## CHAPTERS

CHAPTER

# 1. Purpose and Background

## 1.1 Purpose of the Sampling Guide on Participant-Based Surveys

This guide provides technical guidance on the design and use of participant-based surveys[1] (PaBSs) to support the collection of data for annual monitoring indicators. The guide is intended for use mainly by U.S. Agency for International Development (USAID) Feed the Future implementing partners (IPs), including USAID Office of Food for Peace (FFP) development food security activity awardees.

PaBSs are conducted among a sample of the population that participates in a project's interventions.[2] This is in contrast to population-based surveys (PBSs), which are conducted among a sample of the entire population living within a project's area of coverage. Typically, PBSs are used in the Feed the Future context for performance evaluations using baseline, interim, and end-line surveys, and to monitor progress and see if there has been change over time at the population level in key outcomes and impact indicators. In contrast, PaBSs are typically used in the context of project monitoring to ensure that project implementation is rolling out as expected and that project interventions are on track for achieving their intended outcomes and targets in the participant population. The results of such monitoring exercises can be used to inform decisions about project strategies and to make corrections to project components if monitoring data show that they are not on track.

Data in support of annual monitoring indicators can be collected either through a project's routine monitoring systems or through specialized periodic PaBSs. All Feed the Future IPs have routine monitoring systems in place to collect basic process, output, and outcome data relating to their projects, to support the tabulation of output[3] and outcome[4] indicators on (ideally) all participants of the

[1] Such surveys were formerly called "beneficiary-based surveys." According to the *Feed the Future Indicator Handbook*, "We changed from using the term project 'direct beneficiaries' to using the term project 'participants' to describe the universe captured by [implementing mechanism]-level indicators to better align with market system-based approaches. The revised terminology also more clearly communicates that those with whom we work are active participants in their country's development journey, to their own and others' benefit."

[2] This guide uses the term "project" to refer to FFP-funded development food security activities and to non-FFP-funded activities under broader Feed the Future projects. See the USAID Automated Directives System glossary for the definitions of project and activity (https://www.usaid.gov/sites/default/files/documents/1868/ADS_glossary.pdf).

[3] Output indicators are those that reflect direct products of the activity (e.g., number of trainees, number of meetings held) that result from the combination of inputs and processes. Inputs are the sets of resources (e.g., staff, financial resources, space, project participants) brought together to accomplish the project's objectives. Processes are the sets of activities (e.g., training, delivering services) by which resources are used in pursuit of the desired results.

[4] Outcome indicators are those that reflect the set of participant-level results (such as changes in practices, skills, or knowledge) that are expected to change from the activity's interventions. Note that, for example, lower-level outcomes might reflect changes in knowledge, whereas higher-level outcomes might reflect changes in practices.

projects.[5] Often data collection through routine monitoring occurs simultaneously with project implementation; such data are collected by community members, government workers, and/or project monitoring and evaluation (M&E) staff.

Because of the complexities involved in conducting PaBSs, Feed the Future IPs should, when possible, collect data in support of annual monitoring indicators through routine monitoring systems. Nevertheless, there are various scenarios (discussed in detail in Chapter 4 of this guide) that may necessitate conducting periodic PaBSs to collect these data. This guide aims to provide a technical roadmap for IPs wanting to design and plan for PaBSs to collect data in support of annual monitoring indicators under such scenarios. The guide predominantly focuses on four Feed the Future agriculture indicators that are considered more challenging in terms of the associated data collection; Indicators relating to other sectors are discussed in Annex 4.

## 1.2 Background

Feed the Future, a U.S. Government (USG) initiative led by USAID, is the USG's global hunger and food security initiative. Phase one of the initiative was launched in 2010. Phase two, which was launched in 2017, is guided by the USG Global Food Security Strategy (GFSS) 2017–2021,[6] which presents an integrated, whole-of-government strategy and agency-specific implementation plan, as required by the Global Food Security Act of 2016. Feed the Future phase one indicators were revised in phase two; these included the set of implementing mechanism (IM) indicators (a subset of all Feed the Future indicators) used for annual monitoring purposes. Each IM indicator has an associated Performance Indicator Reference Sheet (PIRS) that provides the information needed to gather data and report on the indicator.[7] FFP, which is part of Feed the Future,[8] has adopted many of these IM indicators (referred to as "annual monitoring indicators" by FFP and more generally) to track performance of development food security activities and to allow USAID to more comprehensively capture Feed the Future results.[9] The revised set of Feed the Future IM indicators cover the following sectors: agriculture and livelihoods;

[5] Note that it is not always feasible to collect data on all of a project's participants, e.g., when the number of participants is very large.

[6] The vision of the strategy is "a world free from hunger, malnutrition, and extreme poverty**,** where thriving local economies generate increased income for all people; where people consume balanced and nutritious diets, and children grow up healthy and reach their full potential; and where resilient households and communities face fewer and less severe shocks, have less vulnerability to the shocks they do face, and are helping to accelerate inclusive, sustainable economic growth." For more information, see https://www.usaid.gov/what-we-do/agriculture-and-food-security/us-government-global-food-security-strategy.

[7] The complete set of phase two Feed the Future IM indicators and their PIRSs can be found in the publication *Feed the Future Indicator Handbook*, which is located at https://www.agrilinks.org/sites/default/files/ftf-indicator-handbook-march-2018-508.pdf.

[8] The remainder of this guide will make reference to the FFP and non-FFP parts of the Feed the Future Initiative as separate entities when relevant.

[9] Note that FFP has a number of annual monitoring indicators that are specific to FFP that are not typically used by non-FFP IPs. The full set of FFP annual monitoring indicators can be found at https://www.usaid.gov/documents/1866/ffp-indicators-handbook-part-ii-annual-monitoring-indicators.

maternal and child health and nutrition (MCHN); water, sanitation, and hygiene (WASH); resilience; and gender.

Feed the Future requires all IPs to report annually on all indicators that relate to the various sectors for which their projects have relevant components or interventions. Most Feed the Future IPs have interventions in more than one of the sectors listed above. Because data collection mechanisms are often determined by project delivery systems, which vary according to the various sectors,[10] the data collection mechanisms may vary by indicator.

Although many Feed the Future IM indicators (which are henceforth referred to as "Feed the Future annual monitoring indicators") can be collected through projects' routine monitoring systems, there are some indicators that (under certain circumstances) might warrant using PaBSs for collection of the associated data. Consultations with USAID FFP and Bureau for Food Security (BFS) staff, as well as Feed the Future IP staff, suggested that collecting data for four particular Feed the Future annual monitoring indicators relating to agriculture present challenges that might be overcome by using PaBSs. A discussion of a few of these challenges is provided in Chapter 2.

The four indicators are:

1. Yield of targeted agricultural commodities among program participants with USG assistance (henceforth referred to as "Yield of Agricultural Commodities")
2. Value of annual sales of farms and firms receiving USG assistance (henceforth referred to as "Value of Sales")
3. Number of hectares under improved management practices or technologies with USG assistance (henceforth referred to as "Number of Hectares under Improved Management Practices")
4. Number of individuals who have applied improved management practices or technologies with USG assistance (henceforth referred to as "Number of Individuals Using Improved Management Practices")

The *Feed the Future Agricultural Indicators Guide*[11] focuses on earlier versions of these four indicators.[12] The guide discusses conceptual, definitional, and measurement aspects of the indicators, but does not address data collection systems that might be required to gather the associated data. Furthermore,

[10] Data collection mechanisms could also vary within sector. For example, some annual indicators are outputs and some are outcomes. The data for output indicators are easily gathered through routine data collection, but the data for some of the more complex outcome indicators may require a different approach.

[11] The *Feed the Future Agricultural Indicators Guide* can be found at http://agrilinks.org/library/feed-the-future-ag-indicators-guide.

[12] Under phase one of the Feed the Future initiative, the four associated indicators were: i) Gross margin per unit of land, kilogram, or animal of selected products; ii) Value of incremental sales (collected at the farm level) attributed to USG implementation; iii) Number of hectares under improved technologies or management practices as a result of USG assistance; and iv) Number of farmers and others who have applied improved technologies or management practices as a result of USG assistance.

while PIRSs (which provide information on definitions, units of measurement, rationale, limitations, expected levels of disaggregation, and basic measurement notes, among other things) are available for all four of these annual monitoring indicators, they include suggestions but no detailed technical guidance on appropriate data collection mechanisms and methods.

Both USAID FFP and BFS have indicated that Feed the Future IPs could benefit from further specific guidance on survey data collection methods in support of these four agriculture-related annual monitoring indicators (as well as other annual monitoring indicators, discussed in Annex 4). This guide aims to respond to this need by providing detailed guidance on how to plan and design PaBSs to support data collection for the four selected indicators, with particular attention given to the circumstances in which a PaBS is indicated.[13] Although the main focus of this guide is on PaBSs in the context of agriculture indicators, additional focus is given to PaBSs in support of other sectoral areas (such as MCHN and WASH).

[13] Note that prior to drafting this guide, the USAID-funded Food and Nutrition Technical Assistance Project (FANTA) undertook exploratory work to obtain information on how project delivery systems and routine monitoring systems typically work across the various Feed the Future agricultural projects, and how and when awardees conduct PaBSs.

CHAPTER

# 2. The Four Selected Feed the Future Agriculture-Related Annual Monitoring Indicators

The four selected agriculture-related annual monitoring indicators are all classified by Feed the Future as "Required if Applicable" for Feed the Future projects. This means that data need to be collected on these indicators if the projects have relevant agriculture-related interventions. This is the case for most Feed the Future non-FFP projects and for many Feed the Future FFP projects.

The types of participants covered for each of the four indicators differ. For instance, smallholder producers,[14] non-smallholder producers, people in government, people in private sector firms, people in civil society organizations, and other value chain actors should be reported under the "Number of Individuals Using Improved Management Practices" indicator, whereas sales of smallholder and non-smallholder producers, private sector firms, and for-profit civil society organizations should be reported under the "Value of Sales" indicator. Reporting for the "Number of Hectares under Improved Management Practices" indicator should include area in hectares for all producers and people in civil society organizations working on both "intensive" interventions (i.e., crop lands, cultivated pastures, aquaculture), as well as "extensive" interventions (i.e., rangelands, conservation/protected areas, freshwater or marine ecosystems). Finally, the "Yield of Agricultural Commodities" indicator should be reported for all producers working within crop, livestock, or aquaculture production systems. Therefore, the participants covered by the "Yield of Agricultural Commodities" indicator are a subset of the participants covered by the "Number of Hectares under Improved Management Practices" indicator, who in turn are a subset of the participants covered by the "Value of Sales" indicator, who in turn are a subset of the participants covered by the "Number of Individuals Using Improved Management Practices" indicator. Table 1a provides a representation of the participants covered by the four indicators.

Note that although the "Number of Individuals Using Improved Management Practices," "Value of Sales," and "Number of Hectares under Improved Management Practices" indicators include more than just producers and extend to others in the value chain, **this guide focuses only on participant producers**. This is because Feed the Future projects are likely to have different mechanisms to collect data on the other actors (e.g., people in private sector firms) in the value chain. Furthermore, for practical reasons, this guide focuses on participant producers who reside in a fixed location where they can be found. **Table 1b** provides a summary of how the four indicators relate to each other, as well as a summary of the participants who are the focus of this guide for these four indicators.

[14] **Producers** include farmers, ranchers, and other primary sector producers of food and nonfood crops; livestock and livestock products; fish and other fisheries or aquaculture products; agro-forestry products; and natural resource-based products, including non-timber forest products, such as fruits, seed, and resins. A **farmer** is a type of producer that focuses on cultivating crops or raising livestock.

### Table 1a. How the Four Indicators Overlap

| Indicator | Producers | Civil society organizations | Private sector firms | Government, extension services, research organizations, and other value chain actors |
|---|---|---|---|---|
| Yield of Agricultural Commodities | ✓ | | | |
| Number of Hectares under Improved Management Practices | ✓ | ✓ | | |
| Value of Sales | ✓ | ✓ | ✓ | |
| Number of Individuals Using Improved Management Practices | ✓ | ✓ | ✓ | ✓ |

### Table 1b. Indicators and Their Associated Participants

| Indicator | Types of participants included as part of indicator definition | Subset of participants who are the focus of this guide* |
|---|---|---|
| Number of Individuals Using Improved Management Practices | Smallholder and non-smallholder producers, people in government, people in private sector firms, people in civil society organizations, and other value chain actors | Smallholder and non-smallholder producers in crop, livestock, and aquaculture production systems |
| Value of Sales | Smallholder and non-smallholder producers, private sector firms, and for-profit civil society organizations | Smallholder and non-smallholder producers in crop, livestock, and aquaculture production systems |
| Number of Hectares under Improved Management Practices | Smallholder and non-smallholder producers and people in civil society organizations managing area intensively or extensively | Smallholder and non-smallholder producers in crop, livestock, and aquaculture production systems |
| Yield of Agricultural Commodities | Smallholder and non-smallholder producers in crop, livestock, and aquaculture production systems | Smallholder and non-smallholder producers in crop, livestock, and aquaculture production systems |

* Even though the subset of participants who are the focus of this guide is the same for all four indicators, for Feed the Future FFP IPs, many participants may report a zero value for sales because they are subsistence farmers who consume most or all of what they produce; regardless, all participant values should be reported.

Additional detail on the four indicators is provided in the following sections.

## 2.1 The "Yield of Agricultural Commodities" Indicator

The "Yield of Agricultural Commodities" indicator has two component parts that are combined to form the overall indicator. The indicator estimate is calculated using the following formula:

$$Yield = \frac{TP}{UP}$$

where:

*TP* = quantity (volume) of total production in kilograms, metric tons, numbers, or other units
*UP* = number of hectares planted (for crops), number of animals (for milk or eggs), number of hectares (for aquaculture in ponds), or number of crates (for aquaculture in crates)

It is important to note that this indicator is **not** reported at the overall level; rather, the highest level of reporting for this indicator is by commodity type. This is an important aspect of the indicator that must be taken into account in the strategy for computing the overall sample size for a PaBS; this is described in more detail in Section 9.2.5. Note that in the *Feed the Future Indicator Handbook*, the PIRS for this indicator lists commodity type as the first level of disaggregate, although in effect commodity type is the highest level at which the indicator is reported and so is not really a disaggregate. In addition to commodity type, the "Yield of Agricultural Commodities" indicator must also be reported at nested lower levels of disaggregation. For instance, for producers of crops, the second level of disaggregation is by farm size (smallholder and non-smallholder), and the third level of disaggregation is by sex (male and female) and by age (15–29 and 29+).

Each of the equation's two component parts is an important data point in its own right, as it provides important information that can be used to monitor project progress with respect to outcomes. Once estimates of the two components of "Yield of Agricultural Commodities" are produced by Feed the Future IPs, they should be entered into the Food for Peace Management Information System (FFPMIS) or the Feed the Future Monitoring System (FTFMS). These systems then automatically produce estimates for the "Yield of Agricultural Commodities" indicator.[15,16]

The collection of data supporting the two component parts of the "Yield of Agricultural Commodities" indicator has its own set of challenges and complexities, which are discussed in detail (in relation to the associated archived Feed the Future annual monitoring indicator "Gross Margins") in the *Feed the Future Agricultural Indicators Guide*.

One of the challenges of this indicator is obtaining an accurate measurement for the "number of hectares planted" component, when referring to crops. While historically farmer estimates of surface

[15] While there are two component parts (i.e., data points) to this indicator, an additional data point on the number of participant producers of each commodity is also required by FFPMIS and FTFMS. These data can be obtained directly from the sample frame of participants if the sample frame contains information on the commodities cultivated/raised by each participant. If that information is not available, the total number of participant producers of each commodity can be estimated by applying the percent of participant producers of each commodity in the sample to the total number of project participant producers.

[16] Estimates of the two components are entered in these systems at the lowest level of nested disaggregates, and the systems then automatically aggregate to higher levels. Please see the PIRS in the *Feed the Future Indicator Handbook* for more details.

area have not been considered very accurate, more-recent evidence shows that farmer estimates are sometimes quite accurate, although "inaccuracies" might arise in the following ways:

- Smallholder farmers tend to overestimate area while larger farmers tend to underestimate area.
- The accuracy of farmer estimates is reported to decrease with increasing plot size.
- The accuracy of farmer estimates of area increases with the farmers' level of familiarity with area measurement units.

Thus, in cases where farmer estimates may not render accurate results (e.g., for non-smallholder farmers or farmers with limited familiarity with area measurement units), survey implementers should consider taking direct measurements of farmer plots.

## 2.2 The "Number of Hectares under Improved Management Practices" Indicator

The "Number of Hectares under Improved Management Practices" indicator has the same measurement issues as the "number of hectares planted" component (for crops) of the "Yield of Agricultural Commodities" indicator discussed above (e.g., farmer estimates that lead to potential inaccuracy). Although there would appear to be an added measurement complexity due to the necessity to restrict the estimate to only the land mass under improved management practices or technologies, once a farmer has identified that an improved technology (say) is used on a particular crop, the PIRS guidance suggests that projects should assume that 100% of the hectares planted with that crop have the technology applied to it.

## 2.3 The "Value of Sales" and "Number of Individuals Using Improved Management Practices" Indicators

The measurement challenges related to the "Value of Sales" and "Number of Individuals Using Improved Management Practices" indicators are discussed in the *Feed the Future Agricultural Indicators Guide*, although the guide references earlier versions of these indicators.

# PART 2

# ROUTINE MONITORING VERSUS PARTICIPANT-BASED SURVEYS

## CHAPTERS

CHAPTER

# 3. Comparison of Routine Monitoring and Participant-Based Surveys

## 3.1 Overview

This chapter provides a brief description of routine monitoring and PaBSs, as well as the salient features and advantages of each approach. A comparison of the two approaches gives Feed the Future IPs a sense of what is entailed in terms of resources, time, systems, and skills so that they can make informed decisions about which approach is most appropriate given programmatic circumstances and constraints.

In general, performance monitoring systems collect, transmit, process, and analyze data for project performance tracking, planning, and decision making. The components are part of a management information system that includes: data collection and aggregation tools, databases, reporting tools, and standardized indicator definitions. They may also include data quality assurance tools or checklists. Data collected in performance monitoring systems help determine if project implementation is running on schedule and meeting interim targets during the life of the project. Mid-course corrections can be made if it appears that, based on an analysis of the collected data, a project or a component of a project is not on track. Data are typically collected in support of such systems through either **routine monitoring** or **PaBSs**.

## 3.2 Description and Features of the Approaches

### 3.2.1 Routine Monitoring

Agriculture data collected through **routine monitoring** is usually undertaken by specialized project staff (such as M&E personnel or agricultural extension workers), either concurrently with the implementation of project interventions (such as during producer group [PG] meetings or agricultural extension worker/ technical staff field visits to farmers' individual plots) or through regularly scheduled visits that are not undertaken concurrently with implementation of interventions but that coincide with key points in the production cycle. However, data are typically aggregated monthly or quarterly (or even more frequently given the advent of cloud technology) to provide timely information for project tracking, planning, and management.

The data collected during routine monitoring typically support indicators at the output and lower-level outcome levels, and all relevant data relating to indicators are ideally collected from **all** direct project participants. As such, routine monitoring requires a sufficient number of field staff (e.g., agricultural extension and M&E staff, community development workers, volunteers, and promoters) to ensure sufficiently frequent contact with all participants throughout the year to collect all necessary data. This may be particularly difficult for projects with a large number of participants, where a large number of staff might be necessary to fulfill all the data collection needs.

In the case where there is a visit to the participant farmers' plots as part of routine monitoring, direct measurement of various data points, such as hectares, can easily be taken. This may be an advantage, as, in many cases, it results in improved accuracy of such data. In contrast, data collected when PGs convene typically rely on farmer estimation/recall, which can result in data that are less accurate, as noted earlier (although it usually is of acceptable accuracy for performance monitoring purposes).

### 3.2.2 Participant-Based Surveys

**PaBSs** refer to specialized periodic surveys conducted among the project participant population. In the case of agricultural projects or agricultural components of projects, data are collected on a random sample or subset of project participant producers during a visit to their households and/or farming plots—although it is also possible to take a random sample of PGs from among all those convened for those projects that use PGs as a project delivery mechanism, e.g., farmer field schools (FFSs). The collection of data is typically not linked to project implementation as it usually is for routine monitoring, except in the instance of sampling PGs mentioned above.

The surveys are usually implemented a fixed number of times per year (usually 1–4 times) and conducted at periods during the year that are often related to the agricultural cycle (e.g., planting, harvesting, sale) and the reporting cycle. In order to appropriately collect information on participants who are part of different project interventions (for example, agriculture production strengthening versus livelihood strengthening), separate surveys may be required if the participant registries are different for these interventions. However, for both routine monitoring and PaBSs, care is needed to aggregate the data across different time points in the year to ensure that no double counting of data from individual participants occurs.

## 3.3 Advantages of Each Approach

### 3.3.1 Advantages of Routine Monitoring

Some key advantages to using routine monitoring as a means of collecting annual monitoring data are listed below:

- In project designs where routine monitoring and project interventions are integrated into one process (such as in projects that collect data from individual farmers at the same time that PG meetings are held), **there is no need for a separate mechanism for data collection**.
- All projects have routine monitoring systems in place, regardless of whether or not they conduct PaBSs. In this sense, the use of routine monitoring for data collection on annual monitoring indicators may be **less resource intensive** than the use of PaBSs because, in the latter case, a separate, additional (and substantial) resource investment is required that would otherwise not be necessary.[17] However, when all annual monitoring data are collected through routine monitoring, there may also be a substantial cost to engaging an increased number of M&E staff year round.

[17] The exception to this is when projects opt to send M&E specialists to collect data from all participants at their plots several times a year as a separate and additional routine monitoring exercise, as noted earlier in the guide.

- The collection of data through routine monitoring **does not require specialized skills in survey design and implementation** (although it does require skills in questionnaire development and design), and, therefore, there is less of a need to hire an external contractor.[18]
- Using routine monitoring, data are usually collected on all participants (i.e., a "census" of the participant population is taken), and, therefore, there is no need to produce sampling weights, confidence intervals, or standard errors of the estimates, as there is with PaBSs.[19] In this sense, **data analysis of data collected through routine monitoring is much simpler than data analysis of data collected through PaBSs**, the latter of which typically requires the analysis of complex survey data.
- Because data collection using routine monitoring often occurs on an ongoing basis, data can more easily be collected at multiple points in the production cycle, at multiple harvests for a particular crop, or at different harvest times for a variety of crops. This will likely result in more-accurate data. Multiple PaBSs would need to be conducted to capture analogous data on multiple points, harvests, or crops—or, at a minimum, annually administered PaBSs would need to include the scope for data recall at multiple time points throughout the year. As a result, **routine monitoring data can be fed back to project staff more frequently than data collected with PaBSs can**.

### 3.3.2 Advantages of Participant-Based Surveys

The following is a list of advantages to using PaBSs as a means of collecting data in support of annual monitoring indicators:

- PaBSs allow for direct measurements to be taken on key data points (such as "Number of Hectares under Improved Management Practices") through a visit to the farmers' plots, and this **may result in higher-quality data**. In contrast, for projects where routine monitoring data are collected during PG meetings only and where farmer recall is used to obtain data on area, if direct measurements were desired, visits to the participant farmers' plots by an agriculture extension worker would be required. While in principle project staff should visit at least a significant proportion of participant plots during the year, this may not always happen in practice.[20]
- **The number of participants from whom data are collected is much smaller for PaBSs than for routine monitoring** because data are collected on only a random sample (or subset) of participants for the former, while data are ideally collected on all participants for the latter. Note, however, that it can be logistically difficult to collect, aggregate, and analyze data on all participants through routine monitoring for projects with a very large number of participants.

[18] It is important to note, however, that data collection through routine monitoring requires staff with a substantial understanding of the data points to be collected and of the basic principles of questionnaire development and design, and the interviewers must have the requisite skills to record and analyze the data accurately. Therefore, even with routine monitoring, appropriate training is necessary.

[19] It should be noted that although confidence intervals and standard errors of the estimates are not required in the reporting of annual monitoring indicators for Feed the Future projects, it is a good practice to calculate them to provide a sense of the quality of the data estimates produced when using PaBSs.

[20] However, in the case where field visits to farmer plots are undertaken, better-quality estimates of area may result because the project staff who collect data have a much better understanding of the farmers' plots and crops relative to interviewers from external contractors.

CHAPTER

# 4. When Are Participant-Based Surveys Appropriate?

There are certain situations in which it is preferable to use PaBSs over routine monitoring. There are other situations in which a combination of routine monitoring and PaBSs is the most effective way to collect the appropriate data. This chapter outlines three scenarios for which PaBSs may be warranted, either in isolation or in combination with routine monitoring.

## 4.1 Scenario #1: Large Project Size/Inadequate Number of Data Collection Staff

There are many Feed the Future projects that have tens of thousands—even hundreds of thousands—of participants. Although projects of this size frequently have large numbers of agricultural extension workers and M&E staff, it can still be difficult from both a resource and a logistical perspective to collect all relevant agriculture-related data on all participants. A survey with a representative sample of the participant population can be an appropriate alternative in this case.

In these cases, annual monitoring data for Feed the Future projects can be collected through a combination of routine monitoring and PaBSs. For example, one Feed the Future IP implementing projects with a large number of participants in a variety of countries deemed it infeasible to collect all data points on all participants through routine monitoring, despite having a large number of staff engaged in M&E activities. Therefore, this IP collects basic "count" data (such as data supporting "Number of individuals participating in USG food security programs") on all participants through routine monitoring, but also conducts PaBSs several times a year on a sample of participants to collect some of the more complex data on production and sales in relation to the "Yield of Agricultural Commodities," "Value of Sales," and other indicators. The survey data are sample weighted to represent the entire participant population (more details on sample weighting is discussed in Chapter 11), and the data collected through the two mechanisms are combined and stored in a large, comprehensive, proprietary database.

It is important to note that data for Feed the Future annual monitoring indicators relating to other, non-agriculture sectors (e.g., MCHN and WASH) also need to be collected and reported in the annual monitoring process. Even if a PaBS is used by a project to collect data for some of the indicators related to the agricultural component, data related to other sectors may be collected either through routine monitoring or through separate PaBSs, depending on the circumstances. Thus, using a PaBS to collect data in relation to agricultural data may not entirely solve the issue of the data collection burden for large projects, because the number of participants under other non-agricultural components might also be very large, necessitating separate PaBSs using different sample frames in those instances as well. Therefore, the development and maintenance of multiple data collection systems is a necessary reality for most annual monitoring systems. The issue of conducting PaBSs in support of annual monitoring indicators for the MCHN and WASH sectors is discussed in more detail in Annex 4.

## 4.2 Scenario #2: Farmer Estimates of Area Considered Unreliable and Direct Measurement of Plots Preferred

Projects that integrate routine monitoring with project implementation by collecting data through PGs generally use farmer estimates to obtain information on several relevant data points. As noted earlier, in some instances (e.g., for non-smallholder farmers or farmers with limited familiarity with area measurement units), recall can be unreliable for the collection of information, specifically on hectares in support of both the "Yield of Agricultural Commodities" and "Number of Hectares under Improved Management Practices" indicators. Direct measurement via a PaBS conducted at the farmers' private plots may be preferable in such instances.

It is important to keep in mind that all Feed the Future IPs must collect data for a diverse range of annual monitoring indicators, above and beyond the four agricultural indicators that are the focus of this guide. While a PaBS might be the best option for collecting high-quality data for some of the more complex indicators (such as those that involve information on hectares), routine monitoring might be the preferable option of data collection for those other indicators. Each project should determine whether it would be preferable to live with less-accurate data for a few of the more complex indicators and to use routine monitoring for the collection of data on all indicators.

## 4.3 Scenario #3: Lack of Direct Contact between a Project and Its Participants

Some projects do not have a direct link with their participants by design, for example, project implementation that focuses on engagement with agricultural businesses, where the businesses are trained by the project using a value chain facilitation approach, and the expectation is that these businesses will in turn provide technical advice to participants. In these cases, using routine monitoring to collect annual monitoring data would be difficult, as the project has no direct contact with its participants at any point during implementation.

To address this issue, it might be possible to ask the agricultural businesses to collect the requisite annual monitoring data on behalf of the project. However, this approach may lead to low-quality data, as there is little incentive for businesses to invest in such data collection unless a business case can be made for how the information is useful to them. Therefore, in this circumstance, project implementers could carry out a PaBS to collect all relevant agriculture-related annual monitoring data, provided that a comprehensive, accurate, and up-to-date list of participants exists or can be created to serve as a sampling frame.[21]

[21] Alternatively, the project could define the catchment area served by the value chain actors that they are facilitating, consider all the producers within that catchment area as participants, and conduct a PaBS within that catchment area. See the introduction section of the *Feed the Future Indicator Handbook*, and the "Application of Improved Practices and Technologies" webinar (https://www.agrilinks.org/event/new-indicators-application-improved-practices-and-technologies-feed-future-mel-webinar-series) for more detail on this approach.

PART 3

# PARTICIPANT-BASED SURVEYS: IMPLEMENTATION ISSUES

## CHAPTERS

CHAPTER

# 5. Timing and Frequency of Participant-Based Survey Data Collection

The timing and frequency of PaBSs are important considerations when planning for annual monitoring activities. If a project chooses a PaBS as a chief vehicle for collecting data in support of annual monitoring, then the survey should be conducted at least once per year, given that Feed the Future requires annual reporting.

In the case of an annual PaBS, 12-month recall may be used to collect all the required agricultural data. However, it may be advantageous to implement surveys more frequently in order to shorten the recall period to improve the accuracy of the data collected. For instance, a project could collect data on certain inputs and hectares at the time of planting, and could collect information on other inputs, production, and sales at or shortly following the harvest. Furthermore, if a project promotes multiple value chains corresponding to multiple crops that are harvested at different times of the year, it may improve accuracy to conduct separate surveys during the planting and/or harvesting periods. Finally, it might also be advantageous to collect data (and hence to conduct PaBSs) several times per year for a single crop, in the event that the crop has several plantings and/or harvests in a single year.

If a Feed the Future IP decides to collect data more frequently than once a year, one approach used to decide the timing of data collection is to obtain—or map out with project participants—a seasonal calendar of agriculture-related interventions. A seasonal calendar helps highlight the critical moments of the year during which agricultural interventions occur related to the various crops in question. With the calendar in hand, the next logical step is to analyze the available resources (budget, staff, etc.) and time constraints to determine how frequently data collection can occur.

It is also useful to have an accurate sense of the time required to conduct a survey from beginning to end, particularly if a project needs to decide whether to plan one or multiple surveys in a year to correspond with specific seasonal events. A survey timeline is usually drafted in the form of a Gantt chart and provides a projection of the expected number of weeks that a survey needs from start to finish, as well as the number of days or weeks that each particular activity needs. Such a chart can help avoid common problems with planning for the survey work, such as insufficient time allocated for activities and neglecting to take into account the interrelationships between activities.

The illustrative timeline in **Figure 1** provides some guidance on the minimum amount of time that should be allocated for some of the activities that are essential to carrying out a PaBS. The timeline assumes that, if an external contractor is used, additional time is required at the front end to draft and advertise a scope of work (SOW), to interview and select an external firm, and to draft and sign a contract between the parties. These additional activities are not included in the timeline below, but could entail several months of work and need to be finalized before the survey can start.

## Figure 1. Illustrative Timeline for a Participant-Based Survey

| Task # | Task description | Estimated number of days | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Develop and finalize survey design (sample size calculation, development of sampling frame, survey design) | 10 days | | | | | | | | | | | | | | | | | |
| 2 | Develop and translate draft survey instrument(s) (in English and in relevant local languages) | 10 days | | | | | | | | | | | | | | | | | |
| 3 | Develop, translate, and finalize survey training agenda and materials (in English and in relevant local languages) | 10 days | | | | | | | | | | | | | | | | | |
| 4 | Recruit interviewers | 30 days | | | | | | | | | | | | | | | | | |
| 5 | Train interviewers, and pre-test and finalize survey instrument(s) | 10 days | | | | | | | | | | | | | | | | | |
| 6 | Collect data | 20 days | | | | | | | | | | | | | | | | | |
| 7 | Enter, clean, and analyze collected survey data | 10 days | | | | | | | | | | | | | | | | | |
| 8 | Draft survey report and integrate comments | 10 days | | | | | | | | | | | | | | | | | |
| 9 | Prepare dataset for submission | 5 days | | | | | | | | | | | | | | | | | |

Discussions about the timing and frequency of data collection activities should begin during the project design phase, as decisions have an impact on budgets and potentially on staffing. It is important that these decisions take into consideration time availability and resource constraints to ensure that data collection and analysis activities can be effectively and efficiently implemented.

CHAPTER

# 6. Issues to Consider When Outsourcing Work to an External Contractor

Depending on the circumstances, a project can elect to implement the survey internally or to hire an external contractor to implement the survey. There are distinct advantages to using an external contractor to conduct a PaBS. For instance, a contractor can provide highly specialized expertise in survey methodology and data analysis techniques—skills that project staff often do not possess. An external contractor can also relieve the time pressures of implementing a survey from the IP, thereby freeing the project staff to focus on project implementation.

There are also disadvantages to using an external contractor. First and foremost, it will almost certainly be more expensive to use a contractor to implement a survey than it will be to engage in-house staff. In addition, identifying and selecting a qualified external contractor can be time consuming, and it is often difficult for project staff with limited survey experience to make informed judgments regarding the quality of proposed candidates for the work. Furthermore, the internal project staff member overseeing the activity needs to have an appropriate level of survey-related knowledge to develop the SOW for the contractor, to properly manage the work of the contractor, and to adequately review survey deliverables.

Conducting a PaBS entails a number of important activities, including:

1. Designing the sampling plan
2. Drafting the survey questionnaire instruments to elicit data on the relevant indicators
3. Developing training materials and field procedure manuals
4. Recruiting and training interviewers
5. Managing the logistical and administrative aspects of the fieldwork
6. Implementing data collection
7. Managing data entry, and cleaning and analyzing the survey data
8. Writing the survey report and presenting the survey results

An external contractor can be hired and tasked with any or all of the required activities.[22] Any combination of splitting the responsibilities for these activities between an external contractor and internal staff members from the project is also possible. Regardless of the assigned responsibilities, it is always necessary to clearly designate an internal staff member from the project to oversee the work of the external contractor. This authority should be explicitly detailed in the SOW for the contractor, as should the process by which survey deliverables are to be reviewed and approved.

The decision to engage an external contractor to conduct a PaBS is usually based on one or more of the following factors: budget, internal staff time, and internal staff expertise. Once the decision has been

[22] Note that project staff can be involved in the actual collection of data (as can external interviewers), but, in this case, they require special training on administering survey questionnaires and on the appropriate survey protocols in the field.

made to engage an external contractor, there are several other issues that must be given due consideration. These are outlined in the following sections.

## 6.1 Time and Effort Required to Procure and Manage an External Contractor

An IP must invest considerable time and effort in various elements related to the procurement of the external contractor, including:

1. Drafting and internally vetting a SOW for the external contractor
2. Advertising the SOW
3. Interviewing and selecting the external contractor
4. Drafting, reviewing, and approving the contract

It is critical that an IP consider the time needed for these essential activities (which can be several months) when deciding whether or not to use an external contractor, as the survey cannot start before they have been completed. The IP should also take into account the considerable time required for adequate management of an external contractor throughout the survey process.

## 6.2 Importance of a Good Scope of Work to Guide the Process

A clear and comprehensive SOW is a key element in the successful oversight of an external contractor. A good SOW helps set expectations, facilitates the management of the contractor, and provides quality control measures on survey deliverables. A shortened version of the SOW can be used to advertise for an external contractor.

The SOW should clearly delineate the responsibilities of both the contractor and the Feed the Future IP engaging the contractor. It should provide information on key survey design features and details on the expected survey activities, deliverables, and timeline. It should also clearly outline the indicator(s) for which data should be collected, as well as required disaggregates that must be reported.

A template for a SOW to advertise for or to manage a contractor conducting a PaBS can be found in Annex 1. Feed the Future IPs can use this template as a starting point and add specificity to serve their particular needs.

Feed the Future IPs can request that external firms respond to a wide variety of elements in the proposals that they submit in reply to an advertised SOW. These elements help IPs make a determination regarding which firm is most appropriately suited to undertake the work. The elements in the proposal should include, at a minimum, a technical write-up outlining how the firm intends to undertake the work, a budget, a detailed timeline, a proposed survey team with accompanying individual CVs, and evidence of past relevant experience.

Note that the survey team proposed by the external firm should consist of key personnel with a mix of defined technical and subject matter expertise. At a minimum, the key personnel should include a survey team leader, a senior survey specialist, and a field operations manager. Annex 2 contains a set of illustrative job descriptions for each of these key personnel. Sometimes members of survey teams take on the responsibilities of multiple roles within the team, but what is important is that all of the different required competencies are present within the team.

Application materials from contractors should always include examples of reports from past complex household and/or participant-based surveys that candidate contractors have designed and implemented.

## 6.3 Judging the Expertise of Potential External Contractors

Priority should be placed on recruiting a contractor that has adequate internal specialization in survey methodology and questionnaire development, as well as in managing data collection in the field. A contractor needs survey expertise relating to sample size calculations, stratification, clustering, sample selection using multiple stages and unequal probabilities of selection, and sample weight creation. In addition, the contractor should have experience in implementing household and/or participant-based surveys (i.e., the implementation of survey protocols, field logistics, data collection, and the oversight of interviewers) in developing countries, where ground realities for data collection can be considerably different, and often more difficult, than in developed countries.

It is often difficult for IP project staff with limited survey experience to make informed judgments regarding the quality of potential candidate firms that respond to an advertised SOW. To assist projects in assessing the appropriateness of such firms, Annex 3 of this guide contains a "Checklist for Engaging External Contractors." The checklist outlines a set of factors that projects should consider when choosing contractors from among the firms that have submitted proposals for the work.

## PART 4

# PARTICIPANT-BASED SURVEYS: SAMPLING FRAMES AND SURVEY APPROACHES

### CHAPTERS

CHAPTER

# 7. Sampling Frame Guidance for Participant-Based Surveys

This chapter discusses the sampling frame and its critical importance in the survey-taking process. A sampling frame is the backbone of all PaBSs. It comprises one or more complete lists of all project implementation "clusters" and/or all project participants—from which a representative sample can be randomly drawn for the survey. In this case, "cluster" refers either to the lowest level of geographic area covered by the project (typically village or community) or to PGs. Without such frame(s), it is impossible to conduct a representative survey.

A high-quality survey frame should be comprehensive, complete, and up to date. "Comprehensiveness" refers to the *type* of information that is included on the frame, while "completeness" refers to the *extent* to which information on all entities (i.e., villages/communities or PGs and/or participants) is reflected on the frame. It is important that the frame be actively maintained so that it will always be as current (i.e., up to date) as possible. This means that the list of villages/communities or PGs in which the project operates must be kept current; if new villages/communities or PGs are integrated into the project over time, they must be added to the survey frame. This also means that participant registration systems should keep close track of participants who are new entrants to the project and, if project implementers are interested in doing so, participants who are graduates from the project[23]—and the former of these should be reflected on the frame, whereas the latter should be reflected if possible. Participants who drop out from the project interventions for whatever reason (e.g., unavailability, migration, disinterest, death) should be dropped from the frame.

## 7.1 Information to Include on a Sampling Frame

Three survey design options for conducting PaBSs are introduced below and are discussed in detail in Chapter 9.

The first survey design option uses two-stage cluster sampling, for which two separate sampling frames are required. In this case, the "first stage cluster frame" consists of the list of villages/communities[24] (or any other geographic entity, more generally called "clusters") served by the project, from which villages/communities are randomly selected at the first stage of sampling. The "second stage participant frame"

[23] The *Feed the Future Agricultural Indicators Guide* states, "Farmers and others that have graduated from an activity remain direct [participants] for the duration of the activity. If IPs have the required resources to continue tracking [participants] after they graduate, they can be counted as long as they continue to apply technologies or practices promoted through your activity." https://www.agrilinks.org/sites/default/files/resource/files/FTF_Agriculture_Indicators_Guide_Mar_2015.pdf, p. 70.

[24] In contrast to PaBSs, PBSs often use enumeration areas (EAs) defined by the national census (rather than villages/communities) as the basis for the first stage cluster frame, because the population and/or household counts that are needed for sampling are readily available for each EA from the census. One of the difficulties in using EAs is that the correspondence between EAs and the villages/communities in which IPs work is not always straightforward. Fortunately, PaBSs (unlike PBSs) need not use EAs as a basis for the first stage cluster frame given that population and/or household counts are not required for sampling. Instead, counts of participants from project records are required. Therefore, for PaBSs, the villages and/or communities in which IPs work are better suited than EAs for inclusion on the first stage cluster frame.

consists of the list of participants served by the project, from which participants are randomly selected from the sampled clusters at the second stage of sampling.

The second survey design option, which also uses two-stage sampling, requires only the first stage cluster frame prior to fieldwork, because the second stage participant frame is created in the field through a listing operation.

The third survey design option employs a "one-stage sampling design," for which only the second stage participant frame is required, from which participants are directly sampled.

A fourth survey design option is introduced in Chapter 10. This design uses two-stage sampling, where clusters are PGs that are selected at the first stage of sampling, and where all participants in the selected PGs are selected at the second stage. For this survey design option, both a first stage cluster frame consisting of PGs and a second stage participant frame are required.

In general, for the **first stage cluster frame** (consisting of the set of implementation villages/ communities or PGs) to be considered "comprehensive," it should include, at a minimum, the following information:

- Unique ID number for the cluster (e.g., village/community or PG)
- Name of the cluster (e.g., village/community or PG)
- Location of the cluster (e.g., census geographic code or global positioning system [GPS] coordinates)
- Information on all appropriate higher-level geographic areas (e.g., province or district)
- Number of project participants in the cluster

For the **second stage participant frame** (consisting of the population of participants served by the project) to be considered "comprehensive," it should include, at a minimum, the following information for each project participant[25]:

- Unique participant and/or household ID number (if assigned by the project)
- Participant's complete name
- Participant's age and sex
- Participant's household location (e.g., address or relative location, GPS coordinates)
- Village name/community name or PG ID to which the participant belongs
- The location of the village/community or PG (e.g., census geographic code or GPS coordinates, if available)
- Any higher geographic levels (e.g., province or district) in which the household is located

[25] Technically speaking, a comprehensive list of all participants is needed only in the case of one-stage sampling (third survey design option) because participants are sampled directly from this frame. For all three of the other survey design options, which entail two-stage sampling, a comprehensive list of participants is needed only for each of the sampled clusters.

There is additional information that should be included on the second stage participant frame if feasible and affordable:

- Cellular telephone number, if applicable (to help locate and contact the participant)
- Spouse's name, if applicable (to help contact the participant)
- Date at which individual became a project participant and/or graduated from the project (useful if participants enter and exit the project on a rolling basis)
- Project interventions in which the participant is active (for cases where the project implements a variety of interventions for different sets of participants), including which of the project's targeted commodities the participant produces
- Whether the participant is a smallholder producer or a non-smallholder producer

For the second stage participant frame to be considered "complete" and "up to date," all current (and graduated, if feasible) project participants should be included on the frame, and, for each participant, the above information should be accurate and recent.

There should be no duplicate listings of the same participant on the frame, and, for any duplicate listings that are identified, one of the listings should be eliminated.[26] Similarly, care should be taken to ensure that unique participants with similar or identical names are distinguished and that each unique occurrence is kept on the second stage participant frame. The use of participant information on age, sex, and name of spouse can be used effectively to help distinguish participants with similar or identical names.

Finally, projects might serve multiple participants from within the same household. Care should be taken to ensure that **all** participants in a given household, along with their relevant information, are included on the second stage participant frame.

## 7.2 Participant Registration Systems as a Source of Establishing Sampling Frames

Many Feed the Future IPs have systems that register all project participants for both programmatic and reporting purposes.[27] Such systems are also essential as a foundation for routine monitoring data collection. Furthermore, they are used to develop both first and second stage sampling frames for a PaBS. Therefore, it is critical that projects invest in establishing and maintaining such systems if they wish to develop representative sampling frames as a basis for conducting PaBSs.

Participant registration systems can vary in the type of information that they store on project participants. However, many participant registration systems are not comprehensive or up to date, and contain either less information than is necessary to establish a sampling frame (i.e., the information

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[26] It is possible that one participant producer cultivates/raises multiple commodities that are targeted by the project. Regardless, there should be one unique record for each producer, with an indication of all commodities cultivated/raised by that producer.

[27] One reason for having such a register is that Feed the Future FFP IPs and non-FFP IPs need to report on the indicator "Number of individuals participating in USG food security programs." An exhaustive list of participants would facilitate reporting on this indicator, which requires a count of unique individuals in such programs.

itemized in the last section) or incomplete information on all project participants. While not ideal, there are survey design options that can accommodate this shortcoming. For instance, one of the survey design options described in this guide integrates in-the-field creation of a second stage frame of participants through a "listing" process of each of the sampled villages/communities. This approach assumes that there is an accurate first stage cluster frame available from which to sample. It is important to note that there are substantial additional resources required to list in the field. Therefore, projects that use this design to conduct PaBSs in a particular year should aim to improve their participant registration systems so that more-optimal designs can be used in subsequent years.

## 7.3 Frames for Multiple Participant-Based Surveys Conducted in the Same Year

Because Feed the Future IPs may introduce new participants over a project's life span while graduating others, participant registration systems (and other project lists that serve as a basis for sampling frames) should be continually updated.[28] The dynamic nature of participant registration systems can present challenges for PaBSs that are conducted several times a year (as described in Chapter 5).

Combining the estimates from distinct surveys conducted at various points in a given year using different versions of a sampling frame and drawing a different set of sampled participants can be misleading. For instance, if a project elects to conduct two surveys in a particular year, one after planting (to collect data on inputs used and hectares planted) and another after harvest (to collect data on any additional inputs used later in the year, as well as production and sales), adding together the input estimates from the two time points is not meaningful if different participants are sampled in each survey.

To minimize any potential problems that can arise from this issue, survey implementers should use the same set of sampled participants who are drawn from the sample frame used for the first survey for all surveys conducted in the same year, even if the number of project participants has changed between survey occasions. This effectively means conducting a set of longitudinal surveys on the same set of sampled participants within a given year. Because the same set of sampled participants is interviewed for each survey, the sample weights (see Chapter 11) will be the same for each survey occasion,[29] and therefore estimates from the various surveys in the same year can be readily combined.

Once all PaBSs have been completed in a particular year, the sampling frame can be updated (adding new entrants to the project while, if desired, maintaining graduated project participants) so that it may be used in PaBSs conducted in the year that follows.

[28] The frequency of such updates needs to be determined in accordance with what is appropriate for each individual Feed the Future project and depends on how static or dynamic the set of participants is. At a minimum, IPs should update registries annually, but more frequently is highly recommended if feasible.

[29] It is important to note that there will usually be some attrition over time when using the same set of sampled participants in a series of PaBSs. Non-response at each survey occasion needs to be accounted for through a non-response adjustment (see Section 11.2 for more details), so, strictly speaking, sample weights over time using the same participants will not be identical.

CHAPTER

# 8. Overview of Various Approaches for Collecting Annual Monitoring Data Using Participant-Based Surveys

This chapter outlines two different PaBS approaches. Each approach has different time, resource, and data-quality implications. The determination of which approach is most appropriate depends on the service delivery mechanisms used by the project, as well as the circumstances surrounding the need to conduct a PaBS (see Chapter 4). The two survey approaches are:

1. Household survey approach
2. PGs approach

## 8.1 Approach 1: Household Survey Approach

The "household survey approach" consists of a PaBS as a distinct and separate exercise from project implementation and routine project monitoring. A random sample of participants is selected using a one-stage or two-stage design (more details on these designs are provided in Chapter 9), and interviews are held with project participants at their households and/or individual farmer plots (for crop-focused producers). The data from the survey are sample weighted so that the estimates are representative of all project participants. All agricultural data related to the project's set of annual monitoring indicators that are suitable to collect through a PaBS[30] may be collected through this mechanism. Data can be collected solely by interviewing the participant or through a combination of direct measurement, observation, and participant interview. The combination approach is usually fairly time- and resource-intensive, but can yield (under certain circumstances) more accurate results for certain data points where direct measurement is used (such as for hectares).

A special application of this approach can also be used to improve estimates based on farmers' recall of hectares (for crop-focused producers), by taking a direct measurement of farmers' plots for a representative sample of participant farmers.[31] Regression analysis can then be conducted and a correlation coefficient between the two measurements used to build the regression model (i.e., farmer estimates and physical measurements of area) can be computed. A correction factor based on the correlation coefficient can then be applied to farmer estimates of area for the rest of the participant farmer population for which direct measurements were not taken. Past uses of this approach by Feed

[30] One important criterion to determine suitability of indicators for which data are to be collected is if the indicators track the activities of the same set of participants for which data are collected on the four agricultural indicators.

[31] Note that a physical measurement on land areas needs to be taken only once, unless there is reason to believe that access to land or land ownership by farmers changes substantially over the life of the project.

the Future IPs have shown that correlations between farmer estimates and direct measurement have ranged from 0.70 to 0.95.[32,33]

Approach 1 is appropriate if the project has a large number of participants coupled with an inadequate number of data collection staff so that it is considered infeasible to collect all agricultural data through routine monitoring (whether or not it is deemed essential to obtain a direct measurement on some indicators, such as those relating to hectares), as outlined in Scenario 1 of Chapter 4.

Even if the project is not large, if visits to farmer plots are **not** a routine part of project implementation, the household survey approach is also appropriate if it is deemed essential to obtain a direct measurement on some indicators, such as those relating to hectares when dealing with non-smallholder farmers or farmers with poor familiarity with area measurement units, as outlined in Scenario 2 of Chapter 4.

This approach can also be used when the project has no direct contact with project participants for the agricultural component, as outlined in Scenario 3 of Chapter 4. The use of a PaBS under the scenario of no direct contact still presents the challenge that a comprehensive, complete, and up-to-date sampling frame of participants must be available from which to draw the sample. This highlights the need for those organizations that do have direct contact with project participants (e.g., input suppliers) to develop and maintain high-quality "customer lists" from which participant registration systems and sampling frames can be developed.[34] Therefore, there is likely a need for such projects to engage the businesses that they train (who in turn have direct contact with participants) to provide substantial inputs to the participant registration systems.

For more details on Approach 1, see Chapter 9.

## 8.2 Approach 2: Producer Groups Approach

The "producer groups approach" uses surveys of PGs to collect the data in support of annual monitoring. In this case, one or more surveys of participant farmers take place during the periodic meeting of a PG, e.g., at a FFS.

To implement this approach, a sample of PGs is selected from among all active PGs, and **all** of the participant producers (rather than a sample of them) within the selected PGs are interviewed at the next meeting of a PG.[35] From this sampled group of participant producers, data relating to the four agricultural indicators or any other agricultural outcome indicators that are relevant to the same set of

[32] For more details on how to improve estimates of hectares using regression analysis, see: Fermont, A. and Benson, T. 2011. *Estimating yield of food crops grown by smallholder farmers: a review in the Uganda context*. International Food Policy Research Institute (IFPRI) Discussion Paper 01097.

[33] For this particular method, a sample size of at least 30 farmers (on which direct measurements of their plots are taken) is necessary for statistical inference.

[34] See the *Feed the Future Agricultural Indicators Guide,* http://agrilinks.org/library/feed-the-future-ag-indicators-guide, p. 7, for related guidance.

[35] In the Feed the Future context, there are typically 15–30 producers in a PG and therefore it is feasible to interview all producers within a sampled PG. In the rare cases where a PG is larger, a subsample of producers can be interviewed. However, this will introduce an additional stage of sampling.

participants can be collected. The data from the survey are sample weighted so that the estimates are representative of all project participants.

Data on producers' attributes are collected using producer recall and estimates. Because direct measurements (e.g., on hectares) are not taken, there is no need to visit individual participant households and/or plots for the survey component. For this reason, it is logistically efficient to use the PG as a first stage cluster in lieu of the village or community, the latter of which is traditionally used in household surveys. Thus, the main advantage to this approach is that the survey component is less time- and resource-intensive than the household survey approach, as it is not necessary to locate and travel to the households or plots. However, a disadvantage is the potential loss of accuracy due to the use of producer recall and estimates.

This approach is suitable only for those projects that use the PG approach as the agriculture service delivery mechanism for the interventions that the four agricultural indicators track. This approach addresses the challenge that projects using the PG service delivery mechanism encounter if they have a large number of participants coupled with an inadequate number of data collection staff, so that it is considered infeasible to collect all agricultural data through routine monitoring, and, at the same time, it is **not** deemed necessary to procure a direct measurement for data, such as hectares, because farmer estimates are considered reasonably accurate (as in the case of smallholder farmers or farmers with good familiarity with area measurement units).

For more details on Approach 2, see Chapter 10.

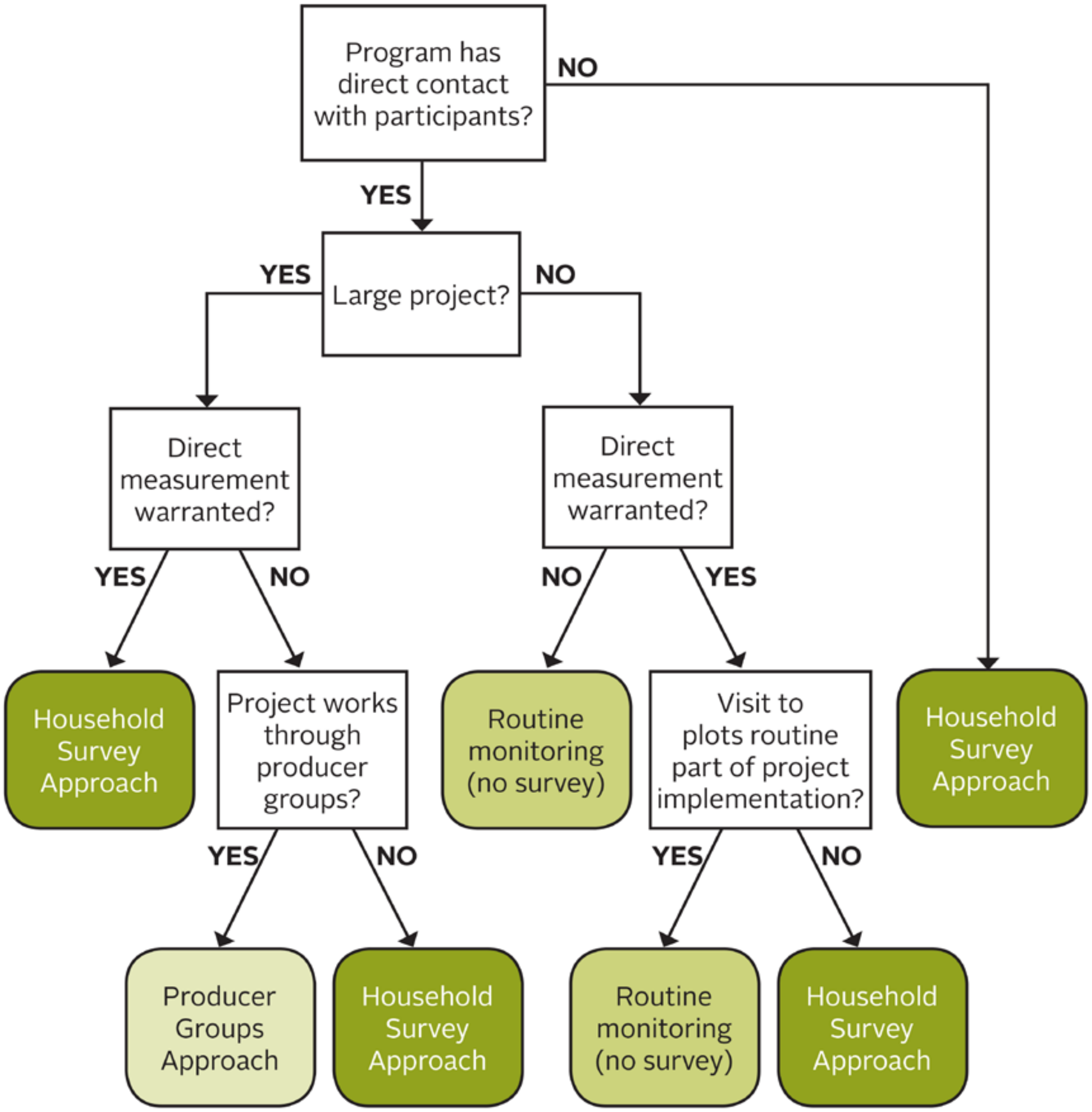
## 8.3 How to Choose the Right Approach

**Figure 2** summarizes the decision-making process for deciding which of the two approaches is most appropriate for a given project. Note that if the project has direct contact with participants and does not have a large pool of participants and it is deemed that direct measurements are not necessary, then the best option is to collect all relevant data through routine monitoring. Alternatively, if the project has direct contact with participants and does not have a large pool of participants, but it is deemed that direct measurements **are** necessary and visits to farmer plots (during which measurements on plot sizes can be taken) are a routine part of project implementation, then the best option is to collect all relevant data through routine monitoring.

## 8.4 Details on the Two Approaches

The next two chapters (Chapters 9 and 10) provide details on the two approaches described in this chapter. Chapter 9 provides detailed information on the various steps of the survey design process for the household survey approach. The chapter outlines three survey design options under this approach and how to choose from among them, how to calculate the sample size for the survey, how to choose the number of clusters to select, how to randomly select a sample of clusters in accordance with that number, and how to randomly select survey respondents within sampled clusters. Chapter 10 provides detailed information on the PGs approach.

## Figure 2. Determining Which Approach Is Most Appropriate



# PART 5

# THE TWO APPROACHES

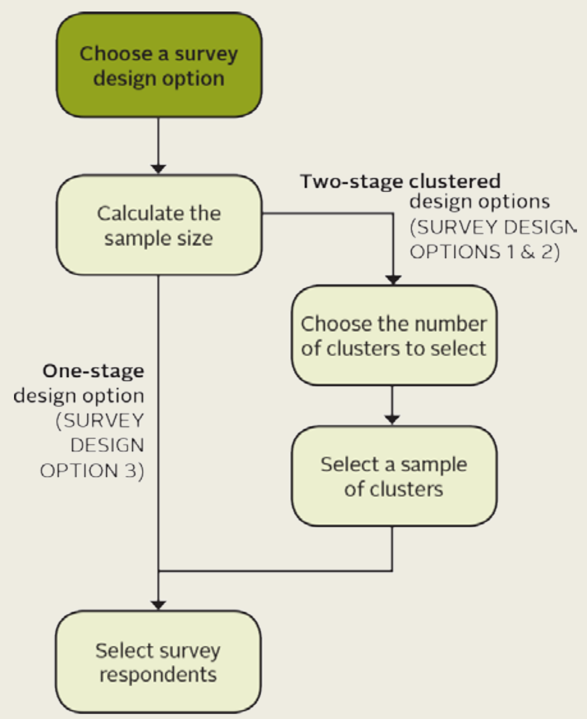
## CHAPTERS

CHAPTER

# 9. The Household Survey Approach (Approach 1)

This chapter provides details on how to implement the household survey approach. Three survey design options are suggested for the household survey approach. The simplest survey design option involves only one stage of sample selection, while two more-complex survey design options involve clustering and two stages of sample selection. Once a survey design option is chosen (from among the three options), there are a number of additional steps to be followed. All three survey designs have two steps that are common to them: calculating the sample size and selecting survey respondents. The two more-complex survey design options have two additional steps: choosing the number of clusters to select and selecting a sample of clusters. **Figure 3a** provides a visual representation of these steps. The details for each of the steps are outlined in the sections that follow.

**Figure 3a. Steps in the Approach**




## 9.1 Choosing a Survey Design Option

The three recommended survey design options under the household survey approach are:

- **Survey design option 1:** Two-stage cluster design with systematic selection of participants
- **Survey design option 2:** Two-stage cluster design with a listing operation and systematic selection of participants
- **Survey design option 3:** One-stage design with systematic selection of participants

The following sections briefly describe each of these options.

### 9.1.1 Survey Design Option 1: Two-Stage Cluster Design with Systematic Selection of Participants

The two-stage cluster design with systematic selection of participants survey design option requires a **first stage cluster frame** (consisting of a complete set of project implementation clusters, i.e., villages or communities) and a **second stage participant frame** (consisting of the complete list of participants within all sampled implementation clusters served by the project). At the first stage of sampling, a random sample of clusters is selected from the first stage cluster frame. At the second stage of sampling, participants from the second stage participant frame for each of the sampled clusters are randomly selected and interviewed. (More details on first and second stage sampling are provided in Sections 9.4 and 9.5.)

In general, a two-stage cluster sampling design is preferred over a one-stage sampling design in most cases, because direct sampling of participants in one stage can be logistically difficult, particularly if there is a large number of clusters in which the project is implemented; the difficulty is exacerbated if travel between the clusters is challenging due to distance or physical conditions. To elaborate, if a project selects participants directly using one-stage systematic sampling, then, if the cluster sizes are roughly equal, the result is a random selection of an approximately equal number of participants from **almost every** cluster in which the project works. If the project operates in a large number of clusters, particularly where the clusters are geographically spread out or difficult to access, it will be costly and logistically burdensome to visit all project clusters for the purposes of survey. In this case, a two-stage cluster sampling approach may be preferable to economize on the time and resources expended, because it allows for surveying in only a subset of the project clusters (rather than in all of them).

However, one of the main disadvantages of using a two-stage cluster design is that, in order to account for the increase in sampling error due to clustering, the sample size likely has to be significantly larger than what would be required for a simple one-stage design using systematic sampling.[36] Still, if it is deemed that the cost savings and logistical ease of surveying in some, not all, clusters under two-stage sampling is a reasonable offset to the additional burden of the increased cost of a greater sample size under one-stage sampling, then a two-stage cluster design should be chosen.

### 9.1.2 Survey Design Option 2: Two-Stage Cluster Design with a Listing Operation and Systematic Selection of Participants

The second survey design option under the household survey approach also uses a two-stage cluster design, but has an additional listing operation between the first and second stages of sampling.

Both two-stage cluster design options require the existence of a **first stage cluster frame** (consisting of a complete set of project implementation clusters) for sample selection at the first stage. The main difference between survey design options 1 and 2 is that in option 1, the project must have a **second stage participant frame** in hand before fieldwork commences, while in option 2, there is no requirement to have a comprehensive, complete, and up-to-date list of participants within all sampled clusters at the time of first-stage sampling.

For survey design option 2, the first stage sampling of clusters is identical to that of survey design option 1. However, before a second stage selection of participants occurs, a listing operation is undertaken in the field in each of the clusters selected for sampling (see Section 9.5.2 for more detailed information on listing operations), and in doing so, a second stage sampling frame is created dynamically while in the field. The listing can be created by walking through the sampled cluster and identifying households in which participants reside. After the listing is created, the second stage of sampling is identical to that of survey design option 1, namely, a random systematic sample of participants within the sampled clusters is selected for interviewing.

[36] In addition, data analysis is more complicated for two-stage cluster designs than it is for one-stage designs.

Because an additional step—a listing operation—is needed during survey implementation, the choice of this survey option design usually necessitates a longer timeline (several days to several weeks), depending on the number of clusters that must be listed and the resources available (e.g., the number of interviewers available).

Generally speaking, this option is suitable when two-stage sampling is warranted (as explained in Section 9.1.1) and when a second stage participant frame does not exist.

### 9.1.3 Survey Design Option 3: One-Stage Design with Systematic Selection of Participants

For the one-stage design with systematic selection of participants, it is essential that there be a comprehensive, complete, and up-to-date **second stage participant frame** (consisting of the complete list of participants within all implementation clusters served by the project). However, unlike options 1 and 2, there is no requirement for a **first stage cluster frame** (consisting of a complete set of project implementation clusters) because there is no sampling of clusters.

In general, there are two ways to sample participants directly using one stage of sampling: systematic sampling and simple random sampling (SRS). In **systematic sampling**, the complete list of participants is ordered by cluster and a subset of the participants is selected using a fixed interval across the entire list. If the cluster sizes are roughly equal, roughly the same number of participants is selected from each implementation cluster, and every (or almost every) implementation cluster is included in the sample (assuming the sample size is greater than or equal to the number of implementation clusters). In contrast, in **SRS**, a sample of participants is selected without regard to the cluster in which they belong. In this case, one cannot determine in advance how many participants from each implementation cluster will be in the sample, or even how many of the implementation clusters will be in the sample. At the extremes, either one participant or all participants might be selected from any given cluster. Depending on the sample that is drawn, this can result in fieldwork that is very costly and inefficient from a logistical point of view, given the unpredictable geographic spread of the sample. Therefore, when sampling participants directly using one stage of sampling, it is always preferable to use systematic sampling over SRS.

Survey design option 3 using systematic sampling is most suitable when there is a modest number of clusters in which the project is implemented and where travel conditions between clusters are not difficult. This is particularly true when the project covers villages within a reasonably compact geographical area and all participants can be accessed easily and relatively quickly. In this case, it is not logistically burdensome to use systematic sampling of participants, which may result in travel to all (or nearly all) project clusters.

When the number of clusters is large, implementing systematic sampling can become logistically challenging. For example, if a project has 65,000 participants across 300 clusters and wishes to sample 500 participants, then, under a one-stage systematic sampling design, the 500 participants would be sampled from the sample frame of all 65,000 participants (sorted by cluster) by selecting every 130th farmer (65,000 / 500 = 130) across the 300 clusters. In this case, the resultant sample will span all or almost all of the 300 clusters and only 2–3 participants will be sampled in each cluster, which is a logistically inefficient design. Therefore, in this case, a two-stage design should be used instead. If, on the other hand, the project works in only 25 clusters, then, although it would still be necessary to visit all or almost all of the 25 clusters, 20 participants per cluster would be sampled, making it much more logistically efficient to use one-stage sampling.

### 9.1.4 Summary of the Recommended Survey Design Options under the Household Survey Approach

**Table 2** summarizes the main characteristics of the three recommended survey design options.

**Table 2. Summary of the Main Characteristics of the Three Recommended Survey Design Options**

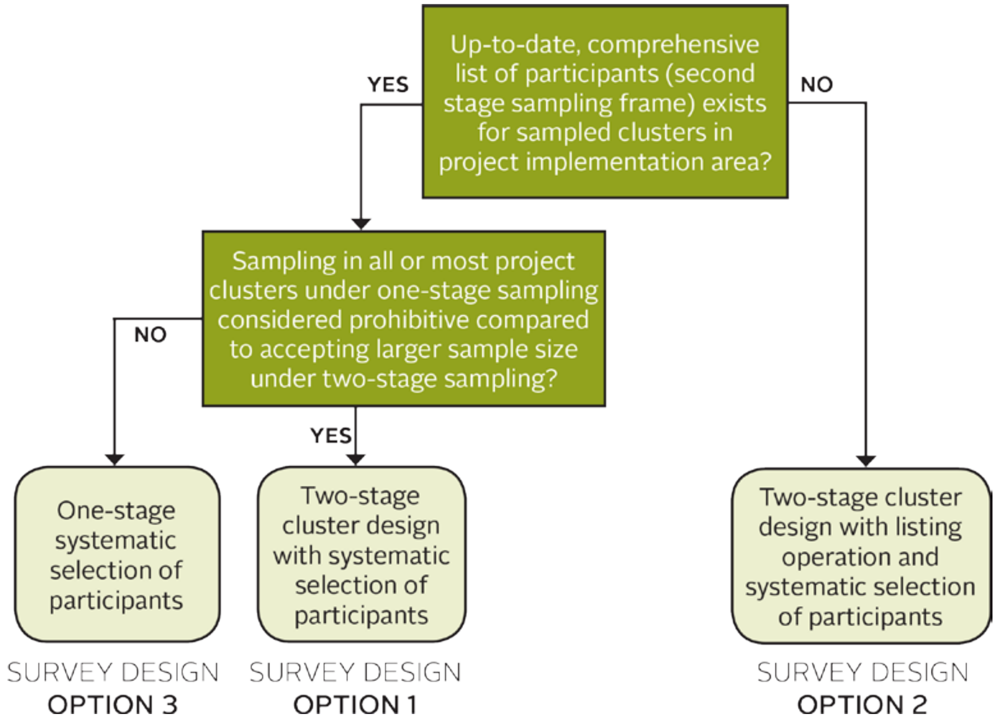
| Option number | Survey design option | Sampling frame requirements | Sample size | Other implications |
|---|---|---|---|---|
| 1 | Two-stage cluster design with systematic selection of participants | Comprehensive, complete, up-to-date list of clusters and participants | Larger | More-complicated data analysis (due to clustering) |
| 2 | Two-stage cluster design with a listing operation and systematic selection of participants | Comprehensive, complete, up-to-date list of clusters only | Larger | More time and resources needed due to listing operation AND more-complicated data analysis (due to clustering) |
| 3 | One-stage design with systematic selection of participants | Comprehensive, complete, up-to-date list of participants only | Smaller | Easiest data analysis |

The flowchart in **Figure 4** describes how two criteria lead to the choice of the appropriate survey design option.

### 9.1.5 A Cautionary Note on the Use of Lot Quality Assurance Sampling

There is a survey design called Lot Quality Assurance Sampling (LQAS) that is sometimes used by humanitarian and development projects, and, when properly executed, is an appropriate option to consider for projects measuring categorizations of “success” or “failure” of various initiatives. Such categorizations of success or failure can be made in each “supervision area” or other relevant geographic area related to management, using very small sample sizes—which is viewed as a substantial cost savings by survey practitioners. A byproduct of this approach is that estimates of totals at higher levels of geography (e.g., at the province or district level) can be constructed with reasonable precision by “summing the results” across these geographic areas. However, if the primary aim of a survey is to produce estimates of totals (as is the case for most Feed the Future IPs) rather than to construct categorizations of “success” or “failure,” then LQAS is a logistically inefficient design because it allocates very small sample sizes to a large number of geographic areas (akin to clusters). Therefore, the survey design options discussed in the previous sections are more appropriate and survey implementers should not use an LQAS design to collect data for the annual monitoring indicators.

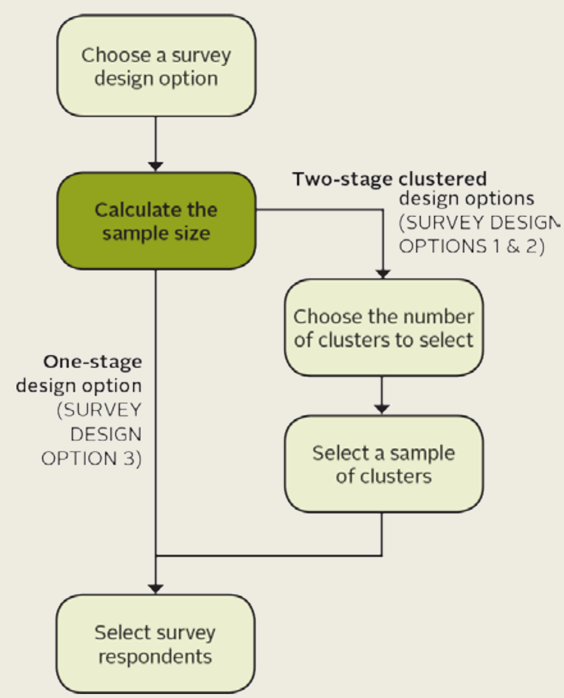
**Figure 4. How to Choose the Appropriate Survey Design Option**




## 9.2 Calculating the Sample Size for All Survey Design Options of the Household Survey Approach

After choosing the survey design option, the next step in the survey design process for the household survey approach is to calculate the sample size. This section starts by describing the different types of surveys and indicators and the different sample size calculations associated with each. The various indicators that can drive the sample size calculation are discussed, and a formula for determining the initial sample size is provided. Each of the input parameters to the initial sample size calculation is described in depth, and recommendations on how to estimate the input parameters are given. Three multiplicative adjustments to the initial sample size formula are provided, to permit the computation of a final sample size for the household survey approach. Illustrative examples are provided throughout the section.

**Figure 3b. Steps in the Approach**



### 9.2.1 Types of Surveys and Indicators

The formulas used to calculate sample size depend on two factors: the type of survey and the type of indicator.

The first factor is the **type of survey**. There are two types of surveys that are typically conducted by Feed the Future IPs: descriptive and comparative analytical.

- The first type of survey, a **descriptive survey***,* is one in which data are collected at a single point in time in order to provide a snapshot of a situation. For these surveys, the intention is to achieve a reasonable level of precision (i.e., a small standard error) for estimators by controlling the sample size. These are typically the types of surveys that are conducted in support of annual monitoring by Feed the Future IPs.
- The second type of survey, a **comparative analytical survey**, is one where the main aim is to conduct statistical tests of differences between estimates—typically where the underlying data are collected at different points in time (e.g., at project start and project end) and typically for indicators of proportions or means. For these surveys, the intention is to provide a sample size that controls the levels of inferential errors associated with the statistical tests of differences. These are typically the types of surveys that are conducted in support of performance evaluations (using baseline, interim, or end-line surveys).

The two types of surveys use different formulas to calculate the overall sample size. The formulas for descriptive surveys are simpler and tend to result in smaller sample sizes than those for comparative analytical surveys, although this is not always the case. The aim of PaBSs for annual monitoring is to provide a variety of single-point-in-time estimates of indicators, where the precision of the estimates is controlled. Feed the Future projects cannot conduct tests of differences on most annual monitoring indicators over time because most annually reported indicators reflect estimates of totals and a statistical test of differences for totals does not exist. Furthermore, an increase in an indicator of a total over successive years may reflect an increase in the quantity being measured, but may also reflect an increase in the number of participants with whom the project is working—and it is difficult to disentangle the two phenomena. Therefore, survey implementers should use the formulas associated with descriptive surveys when conducting PaBSs.

The second factor that influences the formula to use to calculate sample size for a PaBS is the **type of indicator**. There are several types of indicators (collected through either PaBSs or PBSs) for which data can be collected through sample surveys, for example, means or averages (e.g., "Per Capita Expenditure"), proportions (e.g., "Percentage of Female Participants of USG Nutrition-Sensitive Agriculture Activities Consuming a Diet of Minimum Diversity"), and totals (e.g., "Number of Hectares under Improved Management Practices" or "Value of Sales").

The majority of Feed the Future agriculture-related annual monitoring indicators (i.e., IM indicators) are totals, although a few take the form of proportions.

Each type of indicator (mean, proportion, and total) necessitates a different formula for calculating the associated sample size. Three of the four focus indicators covered by this guide are totals (i.e., "Number of Hectares under Improved Management Practices," "Number of Individuals Using Improved Management Practices," and "Value of Sales"), so the use of a formula that is based on a total is appropriate for these three indicators; this formula is described in detail in the next section.[37] The fourth indicator, "Yield of Agricultural Commodities," can be expressed as a ratio of two totals. Because no sample size formula exists for an indicator of ratios, this indicator is treated as a mean for the purposes of this guide.[38] The sample size formula for an indicator of means is described in Annex 4.

### 9.2.2 Calculating the Sample Size

#### *Indicators to Use as a Basis for Sample Size Calculation*

When calculating an overall sample size for a PaBS, it must be kept in mind that the survey may collect data in support of a number of annual monitoring indicators, each having its own sample size requirement. However, one indicator only, from among all indicators on which data are to be collected through the survey, can determine the overall sample size for the survey. The challenge lies in selecting that indicator.

The general recommendation is that the sample size for all **key** indicators from among the indicators being collected in the survey be calculated and that the **largest sample size** resulting from all candidate sample sizes computed be chosen.

In the case of PaBSs in support of agriculture-related indicators, the recommended key indicators on which to base the sample size calculation are the following six indicators, based on the four indicators that are the focus of this guide:

1. "Number of Hectares under Improved Management Practices"
2. "Number of Individuals Using Improved Management Practices"
3. "Value of Sales"
4. "Yield of Key Agricultural Commodity A"
5. "Yield of Key Agricultural Commodity B"
6. "Yield of Key Agricultural Commodity C"

As noted earlier, the "Yield of Agricultural Commodities" indicator is **not** reported at the overall level; rather, the highest level of reporting for this indicator is by commodity type. A separate sample size calculation is necessary for each commodity because the parameters that form the basis of the sample size computation, such as mean and standard deviation, vary by commodity. Because the total sample size for the PaBS may become unmanageable if all commodities being supported by a project are

[37] It is acknowledged that IPs may also wish to undertake PaBSs in support of other sectors, such as MCHN. In this case, key indicators often take the form of proportions or means. The sample size computation for indicators of proportions or means is addressed in Annex 4.

[38] The difference between an indicator of ratios and an indicator of means is subtle. For the former, it is assumed that both the numerator and the denominator are estimated as totals (see Chapter 12 for more details). For the latter, it is assumed that the denominator is a fixed, known quantity that represents the target population under consideration (e.g., the number of project participants). By treating an indicator of ratios as an indicator of means, there is some loss of precision in the estimate because the denominator is treated as fixed (as an indicator of means), and therefore the variability that would stem from estimating the denominator (as an indicator of ratios) is not accounted for.

included, Feed the Future recommends that IPs base sample size calculations on the three most important commodities (i.e., those most widely cultivated/raised, denoted A, B, and C)[39] and compute the sample size for yield for these three key commodities separately. This is reflected above in indicators 4, 5, and 6.

### *Formula to Calculate the Sample Size Based on a Total*

The formula for calculating the initial sample size for the estimation of indicators of totals (such as indicators 1, 2, and 3 above) is given by:

$$initial\ sample\ size = n_{initial} = \frac{N^2 * z^2 * s^2}{MOE^2}$$

where:

> *N* = total number of participants
> *z* = critical value from the Normal Probability Distribution
> *s* = standard deviation of the distribution of participant data
> *MOE* = margin of error

### *Components of the Formula*

The following section provides a description of each of the components of the sample size formula given above, along with recommendations on how to estimate each of them.

**Total Number of Participants (*N*).** The first component of the formula is ***N***, which is the total number of participants in the relevant project interventions tracked by the above indicators at the time of the design of the survey. However, each of the three candidate indicators encompasses a slightly different universe, according to its specific definition (see Table 1a) and, for the purposes of this guide, is limited to include the universe described in Table 1b. The limited universe for purposes of this guide is defined as "smallholder and non-smallholder producers in crop, livestock, and aquaculture production systems" for all three indicators.

**Critical Value from the Normal Probability Distribution (*z*).** The next component is ***z***, the critical value that is a fixed value from the Normal Probability Distribution, which is one of the most commonly used probability distributions in statistics and which follows the well-recognized "bell" shape. The point on the Normal Probability Distribution curve corresponding to a 95% "confidence level"[40] is typically chosen; this corresponds to a critical value of 1.96 on the Normal Probability Distribution. Therefore,

---

[39] IPs in Feed the Future target countries should prioritize the same key commodities for annual monitoring as the Feed the Future country teams prioritize for the Zone of Influence PBS.

[40] A confidence interval is a measure of the precision of an estimate and is expressed as a range of numbers that have a specific interpretation. If a large number of surveys was repeatedly conducted on the same participant population and if confidence intervals were calculated for each survey, 95% of the confidence intervals would contain the true population value for the indicator. The "confidence level" associated with such a confidence interval is 95%. A confidence interval should **not** be interpreted to mean that there is 95% probability that the true population value falls within a specific survey's confidence interval, which is a common misinterpretation. See Chapter 13 for details on how to compute confidence intervals.

Feed the Future IPs should use a fixed value of $z$ = 1.96 for the purposes of calculating sample sizes in the current context.

**Standard Deviation of the Distribution of Participant Data.** The third component of the sample size formula is $s$, the standard deviation of the distribution of participant data. This standard deviation is a measure of dispersion in the participant-level data around the central value in the sample distribution and provides an indication of how much variation there is in the individual data points. The standard deviation is expressed in the same units as the indicator, and can be calculated directly from survey data.

Note that in the context of Feed the Future projects, values for the standard deviation calculated from survey data will be available for the second and subsequent years that IPs conduct PaBSs, because the values can be computed directly using the data from the survey(s) conducted in the previous year. However, the first year that IPs conduct such surveys there may be no estimates for the standard deviation available.

In the event that an estimate for the standard deviation is not available (because it is the first year a PaBS is conducted), a rough estimate can be derived using the following formula[41]:

$$Standard\ Deviation\ (distribution) = \frac{(estimate\ of\ maximum\ value\ of\ indicator\ for\ an\ individual\ participant) - (estimate\ of\ minimum\ value\ of\ indicator\ for\ an\ individual\ participant)}{6}$$

Plausible maximum and minimum values for an individual participant are estimated by the IP, using experience and expert knowledge as guides.

## EXAMPLE A

For the "Number of Hectares under Improved Management Practices" indicator, an IP might estimate that a participant in the project area could have a farm size that ranges between 0.5 hectares and 4.0 hectares, and the participant may choose to apply new management practices or technologies on a portion of his or her land ranging from none of it to all of it. In this case, the minimum value of the indicator for any given participant is 0 and the maximum value is 4. Applying the above formula gives a standard deviation of (4 − 0) / 6 = 0.667 hectares.

## EXAMPLE B

For the "Value of Sales" indicator, an IP may estimate that a participant in a particular country could have a current year's value of sales that ranges between US$0 and US$1,200. In this case, the maximum value for the participant is 1,200 and the minimum value is 0. Applying the above formula gives a standard deviation of (1,200 − 0) / 6 = US$200.

[41] This approximation for the standard deviation of the distribution is derived from the fact that three standard deviations from the "central point" or mean of the distribution cover roughly 99.7 percent of the distribution, assuming an underlying Normal Probability Distribution. The entire range of the distribution (maximum − minimum) then covers roughly six standard deviations. Hence one-sixth of the entire range (maximum – minimum) equals approximately one standard deviation.

### EXAMPLE C

For the “Number of Individuals Using Improved Management Practices” indicator, a participant will be counted as either a “yes” in terms of using the new management practice or technology (coded as a 1) or a “no” in terms of **not** using the new management practice or technology (coded as a 0). In this case, the maximum value for a participant would be 1 and the minimum value would be 0. Note that for this indicator, we are not measuring attributes of a participant (such as hectares or value of sales), but rather number of participants themselves. This is the reason that the “attribute value” of a particular participant is either a 0 or a 1. (The underlying statistical distribution is “Bernoulli,” which means that the only values that are possible are 0 and 1 for individual participants.) In this case, the above formula for standard deviations does not apply. Instead, and in the absence of any other information, survey implementers can use a “rule of thumb” value of 0.5 participants for the standard deviation (because the standard deviation from a Bernoulli distribution is 0.5, assuming that 0 and 1 are equally likely values for a given participant to assume).[42]

**Margin of Error (MOE).** The final component of the sample size formula is ***MOE***, the margin of error, which is the half-width of a confidence interval around the estimate of the indicator of a total, and is expressed in the same units as the indicator used as a basis for the sample size calculation. A smaller MOE results in a larger sample size, whereas a larger MOE results in a smaller sample size.

There is no generalized rule of thumb for specifying the value of the MOE to use in the sample size calculation relating to indicators of totals. However, an estimate can be obtained for the MOE using the following formula:

$$MOE = p * \ target\ value\ of\ the\ indicator$$

This formula has two terms. The first term, $p$, denotes an acceptable percentage error, and is typically subjectively specified to range between 5% and 10% (expressed as $p = 0.05$ and $p = 0.10$, respectively). Specifying $p = 0.05$ will result in a sample size that is greater (and often much greater) than specifying $p = 0.10$. For purposes of Feed the Future annual performance monitoring for both FFP and non-FFP projects, $p = 0.10$ should be used. More detail on this guidance is provided in Section 9.2.5. The second term, *target value of the indicator*, is set by the IPs in their indicator performance tracking tables (IPTTs) as the target value for the indicator to be achieved in the year in which the survey is being conducted.[43]

### EXAMPLE A (revisited)

If we revisit the earlier example for the “Number of Hectares under Improved Management Practices” indicator, we can specify that we are willing to accept 10% error ($p = 0.10$), as per the Feed the Future guidance. If we assume that we have $N = 60{,}000$ participants and we have set a target of 60,000 hectares under improved management practices or technologies across those participants, then $MOE = 0.10 * 60{,}000 = 6{,}000$. In other words, we are willing to accept a MOE of ±6,000 hectares in our estimate of the total number of hectares cultivated under improved management practices or technologies

[42] Strictly speaking, the receipt of the project’s intervention might make a value of 1 more likely than a value of 0. If survey implementers feel that this is the case, a value that is greater than 0.5 and less than 1 can be used for the standard deviation, but the particular choice of value between 0.5 and 1 is subjective.

[43] If the PaBS is being designed to establish base year values for the project, then using target values to be achieved after one year of project implementation does not make sense. In this case, it is recommended to use an estimated value of the indicator obtained through external sources instead.

across all 60,000 participants. Alternatively, if we are willing to accept 5% error ($p$ = 0.05), then *MOE* = 3,000, but this more stringent specification would require a larger sample size.

### EXAMPLE B (revisited)

Revisiting the earlier example for the "Value of Sales" indicator, suppose that we are willing to accept 10% error ($p$ = 0.10) and we assume that $N$ = 60,000 participants (as in example A). If we have set a target of US$250 in sales for each participant, or a total target of US$250 * 60,000 = US$15 million, then *MOE* = 0.10 * US$15 million = US$1.5 million. In other words, we are willing to accept a MOE of ±US$1.5 million in our estimate of the total sales across all 60,000 participants.

### EXAMPLE C (revisited)

Finally, revisiting the earlier example for the "Number of Individuals Using Improved Management Practices" indicator, suppose that we again specify that we are willing to accept 10% error ($p$ = 0.10). Again, if we assume that we have $N$ = 60,000 participants, and we have set a target that 30,000 of them who will apply new management practices or technologies, then *MOE* = 0.10 * 30,000 = 3,000. Therefore, we are willing to accept a MOE of ±3,000 participants in our estimate of the "Number of Individuals Using Improved Management Practices."

Once all of the input parameters for sample size calculation have been specified (the total number of participants, $N$; the minimum and maximum values for the specification of standard deviation, $s$; the target value of the indicator and the acceptable percentage error, $p$, for the specification of *MOE*), these can be inserted into the formula for $n_{initial}$ to obtain the initial sample size.

The table below provides an illustrative example of calculating the initial sample size for the "Number of Hectares under Improved Management Practices" indicator using a hypothetical sample size calculator. In the example, the input parameters are specified by the user in the highlighted areas. For this example, the population of participants is set at $N$ = 60,000. There is no external estimate of standard deviation available because this is the first year the PaBS is being conducted, and therefore the standard deviation must be approximated. For the standard deviation computation, the minimum number of hectares is specified as 0, while the maximum number of hectares is specified as 4. This results in a standard deviation of $s$ = 0.667 hectares. For the MOE computation, the "target value of the indicator" is specified as 1 hectare for every participant (or 60,000 hectares across all participants), while the "acceptable percentage error" is specified as 10% ($p$ = 0.10). This results in a MOE of 6,000 hectares. For an assumed 95% confidence level, the initial sample size is then computed to be $n_{initial}$ = 171.

| | | | | | |
|---|---|---|---|---|---|
| **SURVEY DESIGN OPTION** | 1 - Two-stage cluster design with systematic selection of participants | | | | |
| **INDICATOR** | 1 - Number of hectares under improved management practices or technologies with USG assistance | | | | |
| **INITIAL SAMPLE SIZE** | N | Population of participants | 60,000 | participants | |
| | | Estimate of standard deviation available? | NO | | |
| | | If YES, write estimate here: | | | |
| | | If NO, provide best estimates of indicator | | | |
| | max | Estimate of maximum (per participant) | 4.00 | hectares | |
| | min | Estimate of minimum (per participant) | 0.00 | hectares | |
| | s | Standard deviation | 0.667 | = (4 - 0) / 6 | |
| | p | Margin of error (acceptable percentage error) | 10% | p=.10 | |
| | | Margin of error (target value of indicator) | 60,000 | | |
| | MOE | Margin of error | 6,000 | = 0.10 x 60,000 | |
| | | Confidence level | 95% | | |
| | z | Critical value from Normal Probability Distribution | 1.96 | | |
| | $n_{initial}$ | Initial sample size | 171 | $= \frac{60{,}000^2 \times 0.667^2 \times 1.96^2}{6{,}000^2}$ | |

## *Relationship between Formula Components and Sample Size*

The following chart summarizes the relationship between the components of the initial sample size formula (presented in Section 9.2.2) and the resulting initial sample size:

| If there is an increase in the… | …then the initial sample size: |
|---|---|
| Total number of participants (*N*) | ↑ increases |
| Critical value (*z*) | ↑ increases |
| Standard deviation (*s*) | ↑ increases |
| Margin of error (*MOE*) | ↓ decreases |

## *Output of the Formula*

The sample size calculation results in the total number of participants who need to be interviewed ($n_{initial}$) to achieve the targeted level of precision in the results (e.g., ±6,000 MOE or 10% error in the last example). There are, however, potentially three adjustments that need to be made before the initial sample size can be considered final: an adjustment for a small population of participants, an adjustment for the design effect due to clustering, and an adjustment for anticipated individual non-response.

### 9.2.3 Adjustments to the Sample Size Calculation

#### *Adjustment for a Small Population of Participants (Finite Population Correction)*

The first adjustment that should be considered is called the **finite population correction** (denoted by $adj_{FPC}$). This adjustment decreases the sample size in cases where the initial sample size, $n_{initial}$, is 5% or more of the total number of participants, $N$. That is to say that this adjustment is required if $n_{initial} \geq 0.05 * N$. This usually happens when the population of participants served by the project is relatively small.[44] In these cases, the sample size can be decreased from the initial sample size ($n_{initial}$) because each new survey respondent adds a smaller amount of new information than when the population of participants is large.

This adjustment is often not necessary, as initial sample sizes are infrequently 5% or more of the underlying population of participants listed on the sampling frame. However, a check should be made to see if this is the case and if the adjustment is necessary.

If an adjustment is necessary, it is made by multiplying the initial sample size by the quantity given in the following formula:

$$adj_{FPC} = \frac{1}{\left(1 + \frac{n_{initial}}{N}\right)}$$

so that the adjusted initial sample size is:

$$n_{adj1} = n_{initial} * adj_{FPC} = \frac{n_{initial}}{\left(1 + \frac{n_{initial}}{N}\right)}$$

If an adjustment is not necessary, let $adj_{FPC} = 1$ in the above formula.

This adjustment is required for all survey design options (i.e., options 1, 2, and 3) where the initial sample size is 5% or more of the entire population of participants.

#### *Adjustment for the Design Effect Due to Clustering*

Survey design options 1 and 2 use a two-stage cluster design. A two-stage cluster design has greater sampling error than that of the one-stage systematic sampling design of option 3. This is because survey respondents within a cluster are likely to share similar characteristics in relation to some (or all) of the indicators of interest. When this happens, the amount of new information that each new survey respondent provides from within the same sampled cluster is less than that of a new respondent using a systematic sampling design.

This increase in sampling error due to the cluster survey design must be taken into account to reach the targeted level of precision in the survey results. To do this, an adjustment to the sample size needs to be made. This adjustment is made by multiplying the adjusted sample size $n_{adj1}$ by a quantity called the **design effect due to clustering** (denoted $adj_{designeffect}$).

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[44] In such cases, a PaBS is not recommended (because the project is not large) unless other conditions hold. See Chapter 4 for a discussion of the circumstances under which PaBSs are appropriate.

Each indicator has its own separate design effect due to clustering relating to the degree of homogeneity within the cluster in relation to that particular indicator. In principle, design effects can be calculated only after a survey has been conducted. In the first year that IPs conduct such surveys, it may not be possible to estimate the design effect due to clustering. In that case, the recommended practice for estimating the cluster design effect is to look to survey reports that have been conducted using the same (or similar) indicators on the same (or similar) survey population and ideally using the same sample design (in particular, the same number of participants interviewed per cluster).

In the event that there are no previous surveys to use as a reference, a longstanding rule of thumb is to use an estimate of $adj_{design\ effect}$ = 2 for the design effect for PaBSs that use one level of clustering (as is the case in this guide). Survey implementers should follow this rule of thumb if no other source of information with information on design effects is available prior to conducting the survey.

In the second and subsequent years that IPs conduct PaBSs, values for the design effect due to clustering can be computed through statistical software directly using the data from the survey(s) conducted in the previous year (assuming the survey design remains roughly the same).

This adjustment is required only for survey design options 1 and 2 because design option 3 does not use clustering. Therefore, for design option 3, let $adj_{designeffect} = 1$.

After applying the adjustment for the design effect due to clustering, the adjusted sample size, $n_{adj2}$, can be expressed as:

$$n_{adj2} = n_{adj1} * adj_{designeffect} = n_{initial} * \ adj_{FPC} * adj_{designeffect}$$

### *Adjustment for Anticipated Individual Non-Response*

Another adjustment that needs to be made relates to the **anticipated individual non-response** (denoted by $adj_{non\text{-}response}$). In all surveys, it is expected that some percentage of individuals selected for the survey will be unreachable, unavailable, or unwilling to respond to any or all of the survey questions; this is called individual non-response.

Despite the best efforts of interviewers, there is usually some residual non-response that remains, even after several attempts to complete an interview with participants selected for the sample. To ensure that the targeted number of participants actually completes interviews despite individual non-response, the initial sample size is pre-inflated by multiplying it by the inverse of the expected response rate so that the resultant sample size after fieldwork is as close as possible to the targeted initial sample size.

The expected response rate can be estimated using information from past survey reports drafted by other organizations conducting surveys in the same geographic area and with the same (or similar) survey population as a guide. Such information might also be found in reports from large-scale internationally sponsored surveys, such as the Demographic and Health Surveys (DHS), the Living Standards Measurement Studies (LSMS), or the Multiple Indicator Cluster Surveys (MICS). However, use of these sources may overestimate potential non-response, because project staff is likely to have an established relationship with and knowledge of participants who are the survey respondents, and therefore participants are more likely to respond to Feed the Future PaBSs. Even if project staff is not directly involved in data collection, they can apprise participants of the upcoming survey and can urge them to participate.

If no past information is available on non-response rates, a generally accepted rule of thumb is to assume an estimated response rate of 90%–95%. That is to say, if a response rate of 95% is assumed, then the sample size should be multiplied by $adj_{non\text{-}response} = 1/\ 0.95$. If there are reasons to believe that the response rate will be low (e.g., if the planned number of attempts to reach selected respondents is low, if the length of the survey questionnaire is long, or if there is known heavy migration causing high rates of absenteeism), then it is best to assume a response rate that is closer to 90%. However, in the absence of these conditions, Feed the Future recommends assuming an anticipated response rate of 95% given the project staff's established relationship with the participants.

This adjustment is required for all survey design options (i.e., options 1, 2, and 3).

The final sample size (denoted by $n_{final}$), which is a product of the initial sample size and all three adjustments (where applicable) then becomes:

$$n_{final} = n_{initial} * adj_{FPC} * adj_{design\ effect} * adj_{non\text{-}response}$$

### 9.2.4 Final Sample Size

The sample size is final after all necessary adjustments are made to the initial sample size ($n_{initial}$). **Table 3** summarizes the adjustments to the initial sample size that need to be considered for each survey design option.

#### Table 3. When to Use the Different Types of Adjustments

| Adjustment | Type of adjustment | Survey design option 1 | Survey design option 2 | Survey design option 3 |
|---|---|---|---|---|
| 1 | Finite Population Correction (if $n_{initial} \geq 0.05 * N$) | ✓ | ✓ | ✓ |
| 2 | Design Effect Due to Clustering | ✓ | ✓ | |
| 3 | Anticipated Individual Non-Response | ✓ | ✓ | ✓ |

The formulas for the final sample size for each survey design option are given in **Table 4**. Note that for the third survey design option, $adj_{design\ effect}$ is not needed. Also note that it is important that the finite population correction be carried out first; the other two corrections are interchangeable in terms of order.

### Table 4. Final Sample Size Formulas for the Three Survey Design Options

| Option | Survey design | Final sample size formula |
|---|---|---|
| 1 | Two-stage cluster design with systematic selection of participants | $n_{final} = n_{initial} * adj_{FPC} * adj_{design\ effect} * adj_{non\text{-}response}$ |
| 2 | Two-stage cluster design with a listing operation and systematic selection of participants | $n_{final} = n_{initial} * adj_{FPC} * adj_{design\ effect} * adj_{non\text{-}response}$ |
| 3 | One-stage design with systematic selection of participants | $n_{final} = n_{initial} * adj_{FPC} * adj_{non\text{-}response}$ |

The illustrative example provided earlier for the “Number of Hectares under Improved Management Practices” indicator is continued as an illustration to demonstrate the use of the three adjustments, and the results are given in the table on the next page.

For the first adjustment, the finite population correction is not necessary because the initial sample size ($n_{initial}$ = 171) comprises only 0.3% of the participant population size (*N* = 60,000). Therefore, the initial sample size of 171 remains unchanged.

For the second adjustment, it is assumed that it is the first year that the IP is conducting a PaBS and that there is no external information on the design effect from previous similar surveys. Therefore, for the purposes of the sample size calculation, an estimated design effect of 2 is specified. This adjustment due to the design effect then doubles the initial sample size from 171 to 342.

For the third and final adjustment, there is no external information on the non-response rates available from previous similar surveys. Therefore, for the purposes of the sample size calculation, an anticipated response rate of 95% is specified. The multiplicative adjustment due to non-response then increases the sample size to 360, which is the final sample size ($n_{final}$). Note that if the final sample size is a fraction, it is necessary to round up to the next nearest integer to obtain a final resultant figure, as indicated in the final row of the example.

| | | | | |
|---|---|---|---|---|
| **SURVEY DESIGN OPTION** | 1 - Two-stage cluster design with systematic selection of participants | | | |
| **INDICATOR** | 1 - Number of hectares under improved management practices or technologies with USG assistance | | | |
| **INITIAL SAMPLE SIZE** | N | Population of participants | 60,000 | participants |
| | | Estimate of standard deviation available? | NO | |
| | | If YES, write estimate here: | | |
| | | If NO, provide best estimates of indicator | | |
| | max | Estimate of maximum (per participant) | 4.00 | hectares |
| | min | Estimate of minimum (per participant) | 0.00 | hectares |
| | s | Standard deviation | 0.667 | = (4 - 0) / 6 |
| | p | Margin of error (acceptable percentage error) | 10% | p=.10 |
| | | Margin of error (target value of indicator) | 60,000 | |
| | MOE | Margin of error | 6,000 | = 0.10 x 60,000 |
| | | Confidence level | 95% | |
| | z | Critical value from Normal Probability Distribution | 1.96 | |
| | $n_{initial}$ | Initial sample size | 171 | $= \frac{60{,}000^2 \times 0.667^2 \times 1.96^2}{6{,}000^2}$ |
| **ADJUSTMENT 1** | | Use adjustment 1? (if survey designs 1,2,3 and if initial sample size ≥ 5% of population size) | NO | |
| **Finite population correction** | $n_{initial}$ / N | % sample of survey population | 0.3% | |
| | | Adjusted sample size (1) | 171 | |
| **ADJUSTMENT 2** | | Use adjustment 2? (survey designs 1,2) | YES | |
| **Design effect** | | Design effect | 2.00 | |
| | | Adjusted sample size (1,2) | 342 | = 171 x 2 |
| **ADJUSTMENT 3** | | Use adjustment 3? (survey designs 1,2,3) | YES | |
| **Non-response** | | Non-response rate | 5% | |
| | | Adjusted sample size (1,2,3) | 360 | = 342/(1 - 0.05) = 342/0.95 |
| **FINAL SAMPLE SIZE** | $n_{final}$ | Final sample size | 360 | = roundup(360) |

### 9.2.5 Determining the Overall Sample Size for the Survey

As mentioned earlier, to arrive at an overall sample size for the survey, the **general** recommended practice is to calculate the final sample size for all candidate agriculture-related indicators outlined in Section 9.2.2 and then to choose the **largest sample size** from among those computed. It is very important that survey practitioners budget sufficiently so that they are able to support data collection associated with the largest sample size generated from among the key indicators. If a smaller than optimal sample size is used for the survey, the precision of some of the annual monitoring indicators for which estimates are desired will suffer.

In reference to the recommended agriculture-related indicators on which to base the overall sample size (outlined in Section 9.2.2), a special adaptation has been made in relation to the "Yield of Agricultural Commodities" indicator. Because this indicator must be reported at the level of agricultural commodity (rather than at the overall level), a sample size computation for the indicator must be performed separately for each of the three commodities considered most important (i.e., most widely cultivated or raised).

Note that the computation of estimates of "Yield of Agricultural Commodities" for each commodity type uses only part of the sample of participants that comes from the portion of the overall sampling frame relating to the specific commodity in question. Because not all participants necessarily produce all commodities promoted by the project, the sample generating the commodity-specific yield indicators may not be based on a representative sample of the entire frame of participants.[45]

As such, because the overall sample size is randomly drawn from the entire frame of participants with no specified sample allocation to each part of the frame (i.e., sub-frame) relating to the participants associated with the three yield indicators, the sample size realized for the three yield indicators cannot be predicted in advance. Therefore, it is not possible to predict the exact precision that will be associated with the estimates of each of the three yield indicators. While a specific allocation of the overall sample size to the three sub-frames is possible in principle, it is extremely complex to enact given the potential for the multiple pairwise overlap of participants in relation to the three commodity types. Therefore, such an allocation scheme is considered beyond the scope of this guide.

Given the above constraint, as a strategy for computing the overall sample size for the survey, Feed the Future recommends that survey implementers sum the sample size requirements for the three yield indicators (indicators 4, 5, and 6 in Section 9.2.2), to increase the overall sample size for the survey, and therefore to increase the chance that a sufficiently large number of participants engaged in producing each commodity is randomly selected to meet the precision requirements for each of the three yield indicators.

Next, survey implementers should compare the sum of the sample sizes from the three yield indicators to the sample sizes required for indicators 1, 2, and 3 individually, and then choose the largest sample size from among the four quantities as the final sample size for the survey.

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[45] It is also possible that the portion of the sampling frame that includes participants producing any of the three commodities does not cover the entire frame and therefore does not constitute a complete frame of participants. This is because there may be more than three commodities promoted by the project, and there may be participants who are producing one or more of the other commodities promoted by the project, but not any of the three key commodities.

In the example below, the final sample size has been calculated for six candidate indicators. First, the sample size is computed for the three indicators of totals: “Number of Hectares under Improved Management Practices,” “Value of Sales,” and “Number of Individuals Using Improved Management Practices,” using a variety of input parameter values. The resulting sample sizes are 360, 517, and 809, respectively. Then, the sample size is computed for the three yield indicators (using the formula for means found in Annex 4): “Yield of Agricultural Commodity – Coffee,” “Yield of Agricultural Commodity – Beans,” and “Yield of Agricultural Commodity – Maize.” The resulting sample sizes are 221, 272, and 198, respectively; these are then added together, summing to 691.

In the example below, it is clear that the largest sample size among the values 360, 517, 809, and 691 is 809 participants, corresponding to the “Number of Individuals Using Improved Management Practices” indicator. Therefore, the final overall sample size for the survey will be fixed at $n_{final}$ = 809. This means that the PaBS will randomly select and conduct interviews on 809 participants for all agricultural annual monitoring indicators. Because the largest sample size is chosen as the overall sample size for the survey, it **will meet** (and in fact exceed) the needs of the indicators “Number of Hectares under Improved Management Practices” and “Value of Sales.” On the other hand, this same sample size **may or may not meet** the needs of the indicators “Yield of Agricultural Commodity – Coffee,” “Yield of Agricultural Commodity – Beans,” and “Yield of Agricultural Commodity – Maize.” This is because there may be fewer than 221, 272 and 198 participants growing coffee, beans and maize, respectively, from among the 809 participants that are sampled overall.

It is also interesting to note from the example below that the population of participants for each of the three yield indicators (i.e., 30,000, 20,000, and 40,000, respectively, from the third column) is less than the overall population of participants (i.e., 60,000) implied by the other three indicators; this is indicative of the fact that not all participants included on the sampling frame produce at least one of the three key commodities. Furthermore, the sum of the three population values across the three commodities (i.e., 90,000) exceeds the overall population of participants (i.e., 60,000), which is indicative that there is overlap in the participants engaged in producing the three commodities because some participants produce more than one of the key commodities.

| INDICATOR | Type of Indicator | $N$<br>Population of participants | $max$<br>Estimate of maximum (for s) | $min$<br>Estimate of minimum (for s) | $s$<br>Standard deviation | $p$<br>Acceptable percentage error (for MOE) | Target value of indicator (for MOE) | $MOE$<br>Margin of Error | $z$<br>Critical Value | $n_{initial}$<br>Initial Sample Size | Finite Population Correction needed? | Design effect | Non response rate | $n_{final}$<br>Final sample size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 - Number of hectares under improved management practices | Total | 60,000 | 4 | 0 | 0.67 | 10% | 60,000 | 6,000 | 1.96 | 171 | No | 2.00 | 5% | 360 |
| 2 - Value of sales | Total | 60,000 | 1,200 | 0 | 200.00 | 10% | 15,000,000 | 1,500,000 | 1.96 | 246 | No | 2.00 | 5% | 517 |
| 3 - Number of individuals using improved management practices | Total | 60,000 | - | - | 0.50 | 10% | 30,000 | 3,000 | 1.96 | 385 | No | 2.00 | 5% | 809 |
| 4 - Yield of Agricultural Commodity - Coffee | Mean | 30,000 | - | - | 1,582.02 | 10% | 2,627 | 263 | 1.96 | 140 | No | 1.51 | 5% | 221 |
| 5 - Yield of Agricultural Commodity - Beans | Mean | 20,000 | - | - | 1,911.37 | 10% | 2,903 | 290 | 1.96 | 167 | No | 1.55 | 5% | 272 |
| 6 - Yield of Agricultural Commodity - Maize | Mean | 40,000 | - | - | 2,207.45 | 10% | 4,184 | 418 | 1.96 | 107 | No | 1.75 | 5% | 198 |
| **Sum of sample sizes for 3 "Yield of Agricultural Commodity" indicators** | | | | | | | | | | | | | | **691** |

Note that Feed the Future requires that IPs produce estimates for the indicators above according to specified disaggregates. The “Number of Hectares under Improved Management Practices” indicator requires first-level disaggregated estimates by type of hectare (i.e., cropland, cultivated pasture, aquaculture, rangeland, conservation area, freshwater or marine ecosystem, or other). The “Number of Individuals Using Improved Management Practices” indicator requires a first-level disaggregated estimate by value chain actor type (i.e., smallholder producer, non-smallholder producer, people in government, people in private sector firms, people in civil society, and others). The “Value of Sales” indicator requires a first-level disaggregated estimate by type of product or service. There are also varying requirements for second-level disaggregated estimates (e.g., sex and age) that are nested within first-level disaggregated estimates for all three indicators above. The “Value of Sales” indicator has an additional requirement for third-level disaggregated estimates nested within the first two levels. The “Yield of Agricultural Commodities” indicator requires reporting by commodity and requires second-level disaggregated estimates by farm size (i.e., smallholder, non-smallholder), as well as third-level disaggregated estimates by sex and age (i.e., 15–29 and 30+).

However, survey implementers should not produce estimates for required disaggregates based on separate sample size calculations for those disaggregates. While it would be ideal to ensure precision for the indicator estimate for a disaggregate at the same level as that for the overall estimate for the indicator, this would entail a separate sample size calculation at the disaggregate level. Such a calculation would mean taking into account the input parameters specific to disaggregates (e.g., the total number of participants for the disaggregates and the target value of the indicator at the level of the disaggregate population of participants).

More importantly, a sample size calculation for disaggregates separately could substantially increase the overall sample size for the survey, making estimates at such levels of precision costly. For instance, in the example above, for the “Number of Individuals Using Improved Management Practices” indicator, assume there is only one first-level disaggregate by value chain actor type, say, smallholder producer. Then, assuming the same input parameters as those used at the overall level, at the second level of disaggregation, a separate sample size calculation for males and females would result in a requirement of 809 sampled participants for each category of males and females, for a total sample size of 1,618 across both sexes. Increasing the overall sample size twofold (in this example) would drive up the cost of the survey substantially. Therefore, survey implementers should not produce estimates of indicators by their required disaggregates based on separate sample size calculations. Instead, they should compute the estimates of disaggregated indicators based on the portion of the overall sample size that happens to fall into the category of disaggregate, and accept the loss in precision. For instance, In the above example, if we assume that the overall sample size for the survey is 809 of whom 500 respondents are males and the remainder are females, then the disaggregated estimates by male and female should be based on the reduced sample sizes of 500 and 309, respectively, even though there will be a loss in precision for these estimates. However, IPs may decide that it is worth the additional investment of resources to collect more precise sex-disaggregated data at some points in the project.

Finally, in light of the discussion above, Feed the Future recommends that IPs adopt a minimum overall sample size for the survey of 525 participants. That is to say $n_{final}$ should be 525 or more after taking into account the three adjustments to $n_{initial}$ and assuming an anticipated response rate of 95%. If the actual response rate encountered in the field is 95%, there will be completed interviews for 500 sampled participants. In the example above, the final sample size for "Number of Hectares under Improved Management Practices," "Value of Sales," "Number of Individuals Using Improved Management Practices," "Yield of Agricultural Commodity – Coffee," "Yield of Agricultural Commodity – Beans," and "Yield of Agricultural Commodity – Maize" is 360, 517, 809, and 691, respectively (assuming the sum of the three yield indicators for the last figure). If, instead, the final sample sizes had been 360, 517, 492, and 450, respectively, then the Feed the Future recommendation would be to adopt a minimum overall sample size for the survey of 525 participants (or 500 participants after taking into account non-response).

A minimum final sample size of 525 (or 500 after non-response) participants is recommended based on the need to:

- Ensure reasonable precision for Feed the Future-required disaggregates, given that each category of disaggregate will have a sample size of less than 525 (or 500 after non-response)
- Ensure reasonable precision for district or other subproject-level geographic areas, should the IPs wish to produce these for their own internal monitoring needs

In addition to setting a minimum final sample size, Feed the Future also recommends setting a maximum final sample size for the survey of 2,000 participants (or 2,105 before non-response is taken into account). Because survey implementers must sum the sample size for the three yield indicators as part of the strategy for arriving at a final sample size for the survey, it is possible that this sum may become prohibitively large (and in that case, would be the determining value for the overall sample size for the survey). Therefore, survey implementers who have limited resources to conduct PaBSs are permitted to cap the overall sample size to 2,000 participants. On the other hand, survey implementers with sufficient resources may choose to accept larger final sample sizes for the PaBSs.

### 9.2.6 Updating Elements of the Sample Size Formula in Future Survey Rounds

The sample size calculation for PaBSs will most likely result in different sample sizes for different rounds of the survey.[46] Several of the input parameters of the final sample size formula given earlier in the guide (i.e., the initial sample size and the three adjustments) may be unknown, and therefore may need to be estimated at the planning stages the first time a project conducts a PaBS for collecting data in support of agriculture-related annual monitoring indicators. For subsequent rounds of surveys, these input parameters can be directly computed from the survey data in the prior round. Such input parameters include:

- Standard deviation
- Design effect for clustering
- Anticipated non-response rate

For the second round of PaBSs, values for these input parameters derived from the results of the first survey round should be used. This will ensure a more accurate sample size calculation in the second

[46] A "round" of PaBSs is defined as all PaBSs (one or more) that take place within 1 year. All surveys conducted within the same year should use the same set of sampled participants over the various time points. Therefore, once a sample size is calculated for the first survey in a year, the sample size remains the same for subsequent surveys within the same year or round. See Section 7.3 for more details.

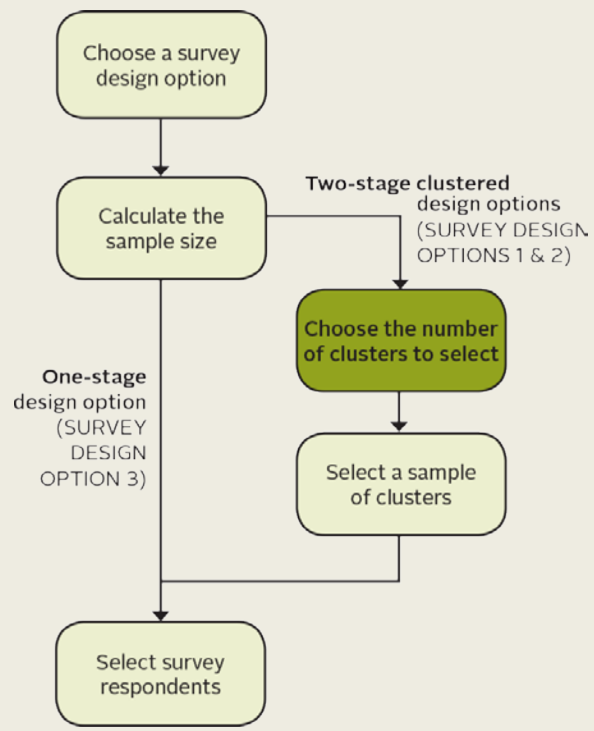
round. For the third round of PaBSs, values derived from the results of the second survey should be used—and so forth until the end of the project.

Note also that the size of the survey population of participants (*N*) and the target values for the indicators (used in the computation of *MOE*) are also likely to change from one survey round to the next, given that project recruitment and graduation tends to be a dynamic process. Therefore, the updated value of *N* and the target values for the indicators should be reflected in subsequent survey rounds for the purposes of the sample size calculations.

## 9.3 Choosing the Number of Clusters to Select for Survey Design Options 1 and 2 of the Household Survey Approach

After the sample size has been determined, the next step in the survey design process for the household survey approach is to choose the number of clusters to be randomly selected at the first stage of sampling and to determine how much of the final sample size to allocate to each of the clusters. This is relevant only to survey design options 1 and 2 as only they employ a two-stage cluster design.

**Figure 3c. Steps in the Approach**




In a two-stage sampling design with a given sample size, there is no prescriptive formula for determining how many clusters to choose and how many participants to choose within each cluster. There are competing interests in terms of what is most operationally expedient versus what is most statistically efficient.

On one hand, for operational expediency, it is clearly optimal to select the smallest number of clusters possible, with greater sample size per cluster (assuming a given sample size). When a smaller number of clusters is selected, the time for and cost of transportation to, from, and in between the clusters are decreased—and potentially the number of interviewers can also be decreased. However, the survey efficiency decreases, as measured by an increase in the design effect.

On the other hand, for statistical efficiency, it is recommended that the smallest number of participants possible from each cluster be selected, and therefore that the largest number of clusters be selected, for a given sample size. This is because each additional survey respondent within the same cluster adds a decreasing amount of new information, assuming that clusters tend to be homogeneous in terms of the characteristics of the participants who reside within.

Given these opposing considerations, a compromise must be struck, and the two considerations must be balanced against each other.

To make an appropriate decision on the number of clusters and the number of participants to allocate per cluster, the following attributes must be weighed against one another:

1. Adequate number of available interviewers
2. Available transportation and lodging options (in the event that interviewers have to stay overnight in a sampled cluster)
3. Ease of access to all potential sampled clusters
4. Adequate budget
5. Reasonable time constraints

Possessing as many of the above attributes as possible translates into the ability to sample a greater number of clusters to ensure greater statistical efficiency. However, each survey potentially faces a different set of constraints, and it is not possible to provide a definitive recommended number of clusters to select in each instance.

It is possible, however, to provide a rule of thumb concerning the number of sampled participants to allocate to each sampled cluster. A range of 15–35 participants for each selected cluster is appropriate because, in most cases, this represents a logistically feasible number of participants per cluster to sample without inducing a very large design effect.

Based on this "15–35 participants per cluster" rule of thumb, one can then use the following approach to decide on the actual number of clusters and participants per cluster to choose.

**STEP 1.** Divide the final sample size ($n_{final}$) by *b*, the minimum and maximum points of the rule of thumb range (15 and 35, respectively), to obtain *m*, a range for the numbers of clusters to choose. The resultant numbers of clusters, *m*, must be rounded up (because it is not possible to visit a fraction of a cluster). The following is an example:

| | | | |
|---|---|---|---|
| Final sample size | $n_{final}$ | 809 | participants |

| | | | |
|---|---|---|---|
| # participants per cluster to select | b | min = 15 | max = 35 |
| # clusters to select | m = round($n_{final}$ / b) | 54 | 24 |
| Actual final sample size | $n_{final}$ = b * m | 810 | 840 |

In this example, the final sample size calculated was $n_{final}$= 809 participants. The number of participants that a data collection team could interview per cluster ranges from a minimum of 15 to a maximum of 35 (according to the rule of thumb), while the number of clusters that correspond to carrying out a minimum of 15 interviews per cluster and a maximum of 35 interviews per cluster is 54 and 24, respectively. The actual final sample size is computed by multiplying *b* by *m*. Note that the actual final sample size achieved at the minimum and maximum endpoints of the range in the table above does not correspond exactly to 809, due to the rounding that takes place in *m*.

**STEP 2.** Choose the largest number of clusters within the range for *m* (24–54 in the above example) that best conforms to the logistical considerations listed earlier. For example, if the overall target sample size is 809, it may be decided, using the table above and considering project constraints, that *m* = 40 clusters should be chosen. This decision might be based on, for instance, the fact that the budget allows for engaging eight survey teams to undertake interviewing in five clusters each, and it is deemed that the survey work can be completed over a period of 5 weeks given the accessibility of the terrain in the area. Surveying in *m* = 40 clusters means that $b = round(\frac{n_{final}}{m}) = 21$ participants per cluster will be selected, for an overall actual final sample size of $n_{final}$ = 840 (= 40 * 21).

**STEP 3.** Check to ensure that for the number of participants per cluster chosen, most (but not necessarily all) clusters on the first stage cluster frame have at least the minimum required number of participants. For instance, in the example in Step 2, most clusters on the first stage cluster frame need to have at least 21 participants. If most clusters do not have a minimum of 21 participants, choose a slightly larger number of clusters (*m*) and a slightly smaller number of participants (*b*) per cluster until this criterion is met for most (but not necessarily all) clusters on the frame. Note that it may not be worth adjusting the combination until the criterion is met for **all** clusters on the frame because a few "outlier" clusters may require an adjustment of the combination of *b* and *m* that results in a very large number of clusters (*m*) and a very small number of participants per cluster (*b*), which, in turn, would generate logistical inefficiencies in the fieldwork. In such cases, it is preferable to live with the shortfall of participants sampled in the particular outlier cluster, if that cluster happens to be selected in the sample. This approach may lead to a slightly smaller overall sample size than the actual (or final) projected sample size, but should not radically alter the precision of the survey results, particularly considering that the expected sample size of 840 considerably exceeds the target sample size of 809.

There are a few issues to keep in mind when using this process.

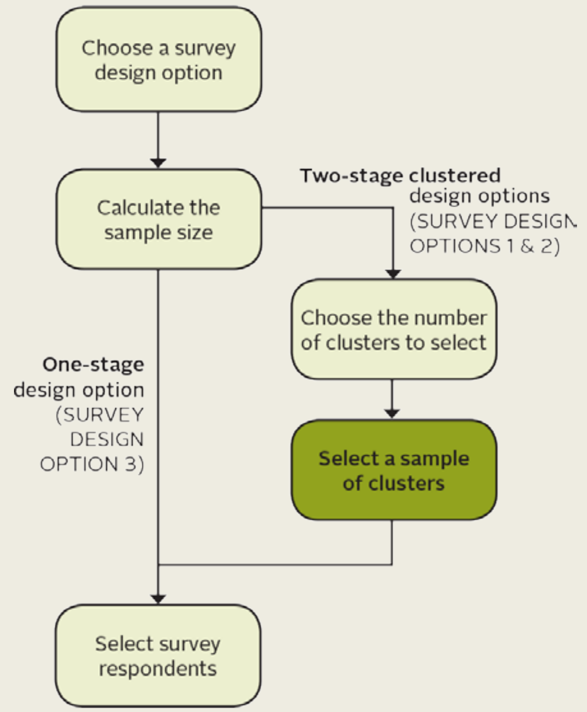
1. For Step 1, the range of 15–35 participants (*b*) is a suggested rule of thumb, but not a rigid rule. A smaller or greater number can be used in cases where it is appropriate (e.g., due to time or budget constraints, or when it is foreseen that a greater or lesser number of interviews can be completed by a team per day). However, it is advisable to avoid exceeding 35 participants per cluster if possible, because a larger number of participants per cluster unduly drives up the design effect of the survey and in turn compromises the precision of the estimates resulting from the survey.
2. Because the recommendation is to round up the resulting value of *b* (Step 2), the actual final sample size will always be somewhat larger than the original final sample size. However, this increase in the sample size should not create a significant burden on the budget, and it should be understood that additional sample always improves the precision of the survey results.

## 9.4 Selecting a Sample of Clusters for Survey Design Options 1 and 2 for the Household Survey Approach

After the number of clusters to be randomly selected has been determined, the next step in the survey design process for the household survey approach is to randomly select a sample of clusters from all the project implementation clusters. As a reminder, this step is relevant only for survey design options 1 and 2 because these two options use a two-stage cluster design and this step corresponds to the first stage of sampling.

In most instances, the method used to randomly select a sample of clusters at the first stage of sampling is called **systematic probability-proportional-to-size (PPS) sampling**, or **systematic PPS sampling**. In general, PPS sampling selects clusters according to a "size measure" that is related to the indicators of interest, which in the case of the household survey approach is the total number of project participants in each cluster.

**Figure 3d. Steps in the Approach**




Therefore, the minimum information that is required for using systematic PPS sampling at the first stage of sampling is a comprehensive list of clusters (i.e., villages or communities) in which participants reside and a count of the number of participants in each cluster (to be used as a size measure). If this sampling frame does not contain a count of the number of participants per cluster for all of the clusters, it will not be possible to use systematic PPS sampling at the first stage, and an alternative method called **fractional interval systematic sampling** may be used instead.

For survey design option 1, it is assumed that there is complete information on participants in each cluster on the second stage participant frame and therefore that there is also complete size information on the first stage cluster frame regarding the number of participants in each cluster. Therefore, systematic PPS sampling can and should be used at the first stage of sampling in this case. However, for survey design option 2, it is assumed that there is no up-to-date and comprehensive list of participants within all implementation clusters served by the project (i.e., no second stage participant frame), and so "size" information on a first stage cluster frame may or may not exist. Therefore, for survey design option 2, either systematic PPS sampling or fractional interval systematic sampling should be used at the first stage, depending on the available information on the first stage sampling frame.

### 9.4.1 Systematic PPS Sampling

The majority of surveys that use survey design options 1 and 2 will likely use systematic PPS sampling to select the sample of clusters at the first stage of sampling, assuming that there is size information on the first stage cluster frame.

In general, using PPS sampling ensures that clusters with a greater number of project participants have a greater chance of being selected from the frame, while clusters with fewer project participants have a smaller chance of being selected from the frame. It is an efficient way of sampling if the number of participants per cluster varies greatly across all the clusters on the sampling frame.[47] Systematic PPS sampling is a special variant of PPS sampling that is simpler to implement than other types of PPS sampling.

The steps to select a sample of clusters using systematic PPS sampling are given below. The steps can be carried out using any appropriate statistical software application. By way of example, the syntax provided below is what would be used in Microsoft Excel.

**STEP 1. Create a list of all clusters in the project implementation area.** This is essentially the first stage cluster frame described in Chapter 7. Information for each cluster on the list should include the following:

- A unique ID number for the cluster
- The name of the cluster (e.g., village or community)
- The location of the cluster (census geography code, GPS coordinates, etc.)
- Information on all appropriate higher-level geographic areas (e.g., province or district)
- The number of project participants in the cluster

**STEP 2. Order the list of clusters by a chosen geographic level.** This can be done in any way, as long as all clusters in one geographic area are next to each other in the list and the choice of geographic level by which to order the clusters has relevance with respect to project implementation. For instance, if a Feed the Future IP operates in distinct districts, then clusters should be grouped together by district.

The reason for ordering clusters geographically before systematic PPS selection of clusters is to achieve "implicit stratification." Implicit stratification increases the chances that at least some sampled clusters fall in each of the geographic areas (e.g., districts, provinces, or departments) encompassed by the project—although it is not **guaranteed** that all geographic areas will have even one sampled cluster. Using implicit stratification ensures that more of the overall variability is captured in the sample. Furthermore, it facilitates disaggregation of the results by geographic area because there will be some (albeit an unplanned number of) sampled clusters in each (or at least in most) of the geographic areas.[48]

**STEP 3. Calculate a cumulative total number of participants.** Create a new column on the first stage cluster frame that contains a cumulative total number of participants per cluster. This column of cumulative totals is used for selecting the sample of clusters. The first row of the cumulative total equals the number of participants in the first cluster on the list. The second row of the cumulative total equals

[47] Even if the number of participants per cluster does not vary greatly across clusters, it may still be useful to use PPS sampling at the first stage as a way of ensuring a self-weighting design. If PPS sampling is used at the first stage sampling of clusters and systematic sampling with an identical sample size of participants in each sampled cluster is used at the second stage of sampling, then the overall sampling weights across the two stages can be shown to be constant or "self-weighting."

[48] Note that the disaggregated results will have a lower level of precision than the non-disaggregated results. This is because each geographic area will have a smaller sample size than that of the total project area.

the number of participants in the second cluster **plus** the number from the first row. This pattern of accumulation continues in the same way through to the end of the list. The following is an example.

**List of all clusters (ordered by region)**

| Cluster number | Region | Cluster name | Number of participants per cluster | | Cumulative total of participants |
|---|---|---|---|---|---|
| 1 | Central Region | Kvothe | 6 | | 6 |
| 2 | Central Region | Gumbo | 13 | *+ 6 =* | 19 |
| 3 | Central Region | Pancho | 27 | *+ 19 =* | 46 |
| 4 | Central Region | Glokta | 22 | *+ 46 =* | 68 |
| 5 | Shattered Plains | Rainbow's End | 21 | *+ 68 =* | 89 |
| 6 | Shattered Plains | Furculita | 27 | *+ 89 =* | 116 |
| 7 | Shattered Plains | Stanka | 25 | *+ 116 =* | 141 |
| 8 | Shattered Plains | Stormlight | 26 | *+ 141 =* | 167 |
| 9 | Shattered Plains | Deepness | 26 | *+ 167 =* | 193 |
| 10 | The North | Black Dow | 9 | *+ 193 =* | 202 |
| 11 | The North | Logan | 12 | *+ 202 =* | 214 |
| 12 | The North | Tul Duru | 33 | *+ 214 =* | 247 |
| 13 | The North | Bast | 34 | *+ 247 =* | 281 |
| 14 | The North | Kaladin | 34 | *+ 281 =* | 315 |
| 15 | The North | Arya | 35 | *+ 315 =* | 350 |

In this example, the clusters are ordered by region (Central Region, Shattered Plains, and The North), and the total number of participants across all clusters is 350 (which is the value in the last row of the cumulative total column).

**STEP 4. Calculate a sampling interval.** The sampling interval (denoted by *k*) is calculated by dividing the total number of participants in all implementation clusters (denoted by *N* in Section 9.2.2) by the number of clusters to select (denoted by *m*), where the value of *m* is determined as per the instructions in Section 9.3. For instance, if $N = 350$ and $m = 4$,[49] then the sampling interval is 87.5.

$$sampling\ interval = k = \frac{total\ number\ of\ beneficiaries\ in\ all\ clusters\ (N)}{number\ of\ clusters\ to\ select\ (m)}$$

[49] Note that the value of $N = 350$ is artificially small because most IPs work with considerably more participants than that across their entire project (i.e., in the tens of thousands or hundreds of thousands). Similarly, the value of $m = 4$ sampled clusters is artificially small as many more clusters will likely need to be selected at the first stage of sampling to achieve a minimum sample size of 525. The small numbers are used for illustration purposes only.

**STEP 5. Calculate a random start.** The random start (denoted by *RS*) determines the first cluster to select. It is calculated by choosing a random number greater than or equal to 0 and less than 1 and multiplying it by the sampling interval (*k*). The following is the formula to use to calculate the random start:

$$random\ start = RS = rand(\ ) * sampling\ interval$$

The Microsoft Excel function *rand*( ) generates a random (fractional) number greater than or equal to 0 and less than 1. To compute the random start *RS*, this random number is multiplied by the sampling interval. For instance, if the sampling interval is 87.5 (from above) and the random number is 0.7146, then the random start is *RS* = 0.7146 * 87.5 = 62.53.

**STEP 6. Select the first cluster.** The first cluster to select according to this scheme is the one that corresponds to the value of the random start. To do this, identify the pair of consecutive clusters in the list for which the cumulative total of participants in the first cluster is less than the random start and for which the cumulative total of participants in the second cluster is greater than or equal to the random start. Choose the second cluster in the pair. The following chart provides an example.

| | | |
|---|---|---|
| Total number of participants (across all clusters) | N | 350 |
| Number of clusters to select | m | 4 |
| Sampling interval | k = N/m | 87.50 |
| Random start | RS = rand()*k | 62.53 |
| 1ST CLUSTER TO SELECT | $a_1$ = RS | = 62.53 = |

**List of all clusters (ordered by region)**

| Cluster number | Region | Cluster name | Number of participants per cluster | Cumulative total of participants |
|---|---|---|---|---|
| 1 | Central Region | Kvothe | 6 | 6 |
| 2 | Central Region | Gumbo | 13 | 19 |
| 3 | Central Region | Pancho | 27 | 46 |
| 4 | Central Region | Glokta | 22 | 68 |

62.53 → cluster 4. 62.53 is greater than 46, but less than 68

In the example above, because the random start (62.53) is greater than 46 (the cumulative total of participants in cluster 3) and less than 68 (the cumulative total of participants in cluster 4), cluster 4 (Glokta) is selected as the first cluster in the sample.

Note that if, by chance, *rand*( ) generates the number 0, then the random start is also 0. In this case, simply choose the first cluster on the list to be the first cluster in the sample.

**STEP 7. Select the second cluster.** The second cluster to select for the sample is determined using the following process. Compute a number $a_2$ that corresponds to the number obtained by adding the sampling interval (*k*) to the random start (*RS*). Identify the pair of consecutive clusters in the list for which the cumulative total of participants in the first cluster is less than $a_2$ and for which the cumulative total of participants in the second cluster is greater than or equal to $a_2$. Choose the second cluster in the pair. The following chart provides an example.

| | | |
|---|---|---|
| Total number of participants (across all clusters) | N | 350 |
| Number of clusters to select | m | 4 |
| Sampling interval | k = N/m | 87.50 |
| Random start | RS = rand()*k | 62.53 |
| 1ST CLUSTER TO SELECT | $a_1$ = RS | = 62.53 = 62.53 |
| 2ND CLUSTER TO SELECT | $a_2$ = RS+k | = 62.53 + 87.5 = 150.03 |

**List of all clusters (ordered by region)**

| Cluster number | Region | Cluster name | Number of participants per cluster | Cumulative total of participants |
|---|---|---|---|---|
| 1 | Central Region | Kvothe | 6 | 6 |
| 2 | Central Region | Gumbo | 13 | 19 |
| 3 | Central Region | Pancho | 27 | 46 |
| 4 | Central Region | Glokta | 22 | 68 |
| 5 | Shattered Plains | Rainbow's End | 21 | 89 |
| 6 | Shattered Plains | Furculita | 27 | 116 |
| 7 | Shattered Plains | Stanka | 25 | 141 |
| 8 | Shattered Plains | Stormlight | 26 | 167 |

62.53 is greater than 46, but less than 68

150.03 is greater than 141, but less than 167

In this example, the sampling interval ($k$ = 87.5) is added to the random start ($RS$ = 62.53) to obtain $a_2$ = 150.03. Because $a_2$ = 150.03 is greater than 141 (the cumulative total of participants in cluster 7) and less than 167 (the cumulative total of participants in cluster 8), cluster 8 (Stormlight) is selected as the second cluster in the sample.

**STEP 8. Select the third cluster.** Create a number $a_3$ by adding twice the sampling interval ($k$) to the random start ($RS$) to determine the third cluster to select for the sample. Use the resultant number in exactly the same way as in Step 7 above. The following chart provides an example.

| | | |
|---|---|---|
| Total number of participants (across all clusters) | N | 350 |
| Number of clusters to select | m | 4 |
| Sampling interval | k = N/m | 87.50 |
| Random start | RS = rand()*k | 62.53 |
| 1ST CLUSTER TO SELECT | $a_1$ = RS | = 62.53 = 62.53 |
| 2ND CLUSTER TO SELECT | $a_2$ = RS+k | = 62.53 + 87.5 = 150.03 |
| 3RD CLUSTER TO SELECT | $a_3$ = RS+2*k | = 62.53 + (2 * 87.5) = 237.53 |

**List of all clusters (ordered by region)**

| Cluster number | Region | Cluster name | Number of participants per cluster | Cumulative total of participants |
|---|---|---|---|---|
| 1 | Central Region | Kvothe | 6 | 6 |
| 2 | Central Region | Gumbo | 13 | 19 |
| 3 | Central Region | Pancho | 27 | 46 |
| 4 | Central Region | Glokta | 22 | 68 |
| 5 | Shattered Plains | Rainbow's End | 21 | 89 |
| 6 | Shattered Plains | Furculita | 27 | 116 |
| 7 | Shattered Plains | Stanka | 25 | 141 |
| 8 | Shattered Plains | Stormlight | 26 | 167 |
| 9 | Shattered Plains | Deepness | 26 | 193 |
| 10 | The North | Black Dow | 9 | 202 |
| 11 | The North | Logan | 12 | 214 |
| 12 | The North | Tul Duru | 33 | 247 |

62.53 is greater than 46, but less than 68

150.03 is greater than 141, but less than 167

237.53 is greater than 214, but less than 247

In this example, twice the sampling interval (2 * *k* = 2 * 87.5 = 175) is added to the random start (*RS* = 62.53) to obtain $a_3$ = 237.53. Because $a_3$ = 237.53 is greater than 214 (the cumulative total of participants in cluster 11) and less than 247 (the cumulative total of participants in cluster 12), cluster 12 (Tul Duru) is selected as the third cluster in the sample.

**STEP 9. Continue in a similar fashion until the number of clusters (*m*) is reached.** The following chart provides the final result of the selection.

| | | |
|---|---|---|
| Total number of participants (across all clusters) | N | 350 |
| Number of clusters to select | m | 4 |
| Sampling interval | k = N/m | 87.50 |
| Random start | RS = rand()*k | 62.53 |

**List of all clusters (ordered by region)**

| Cluster to select | Formula | Calculation | Value | Cluster number | Region | Cluster name | Number of participants per cluster | Cumulative total of participants | Note |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | Central Region | Kvothe | 6 | 6 | |
| | | | | 2 | Central Region | Gumbo | 13 | 19 | |
| | | | | 3 | Central Region | Pancho | 27 | 46 | |
| 1ST CLUSTER TO SELECT | $a_1$ = RS | = 62.53 = | 62.53 | 4 | Central Region | Glokta | 22 | 68 | 62.53 is greater than 46, but less than 68 |
| | | | | 5 | Shattered Plains | Rainbow's End | 21 | 89 | |
| | | | | 6 | Shattered Plains | Furculita | 27 | 116 | |
| | | | | 7 | Shattered Plains | Stanka | 25 | 141 | |
| 2ND CLUSTER TO SELECT | $a_2$ = RS+k | = 62.53 + 87.5 = | 150.03 | 8 | Shattered Plains | Stormlight | 26 | 167 | 150.03 is greater than 141, but less than 167 |
| | | | | 9 | Shattered Plains | Deepness | 26 | 193 | |
| | | | | 10 | The North | Black Dow | 9 | 202 | |
| | | | | 11 | The North | Logan | 12 | 214 | |
| 3RD CLUSTER TO SELECT | $a_3$ = RS+2*k | = 62.53 + (2 * 87.5) = | 237.53 | 12 | The North | Tul Duru | 33 | 247 | 237.53 is greater than 214, but less than 247 |
| | | | | 13 | The North | Bast | 34 | 281 | |
| | | | | 14 | The North | Kaladin | 34 | 315 | |
| 4TH CLUSTER TO SELECT | $a_4$ = RS+3*k | = 62.53 + (3 * 87.5) = | 325.03 | 15 | The North | Arya | 35 | 350 | 325.03 is greater than 315, but less than 350 |

In this example, three times the sampling interval (3 * *k* = 3 * 87.5 = 262.5) is added to the random start (*RS* = 62.53), resulting in 325.03. Because 325.03 is greater than 315 (the cumulative total of participants in cluster 14) and less than 350 (the cumulative total of participants in cluster 15), cluster 15 (Arya) is selected as the fourth and last cluster in the sample.

Also note in the example above that using implicit stratification (i.e., by ordering the clusters by region) resulted in a sample that was spread out across all regions (Central Region, Shattered Plains, and The North). As noted in Step 2, by ordering the clusters prior to sampling, it is more likely to obtain a sample of clusters with at least one cluster chosen in each region.

Finally, it is also important to note that it is possible and acceptable to select the same cluster more than once using systematic PPS sampling. This can happen if the number of participants in a particular cluster is very large and the sampling interval is relatively small (e.g., less than half the number of participants in the cluster). The treatment of this situation will be dealt with at the second stage of sampling, which is discussed in Section 9.5.4.

### 9.4.2 Fractional Interval Systematic Sampling

A second method of sample selection that can be used at the first stage for selection of clusters is called fractional interval systematic sampling. This method is applicable for survey design option 2 in the case where the first stage cluster frame does not contain a count of the number of participants in each cluster. In this instance, it is not possible to implement systematic PPS sampling. Fractional interval systematic sampling does not use size measures, but instead assigns each cluster an equal probability of being selected.

The steps to apply fractional interval systematic sampling are similar to those used for systematic PPS sampling, although there are some nuanced differences. As with systematic PPS sampling, the steps can be carried out using any appropriate statistical software application. By way of example, the syntax provided here is what would be used in Microsoft Excel.

**STEP 1. Create a list of all clusters in the project implementation area.** This is essentially the first stage cluster frame described in Chapter 7, although it is not necessary to have information on the number of project participants in each cluster. However, information for each cluster on the list should include the following:

- A unique ID number for the cluster
- The name of the cluster (e.g., village or community)
- The location of the cluster (census geography, GPS coordinates, etc.)
- Information on all appropriate higher-level geographic areas (e.g., province or district)

**STEP 2. Order the list by a chosen geographic area.** This can be done in any way, as long as all clusters in one geographic area are next to each other in the list.

**STEP 3. Calculate a sampling interval.** The sampling interval is calculated by dividing the total number of clusters in the project implementation area on the sampling frame ($M$) by the number of clusters to select ($m$), where the value of $m$ is determined according to the instructions in Section 9.3. For instance, if $M$ = 15 and $m$ = 4, then the sampling interval is 3.75.

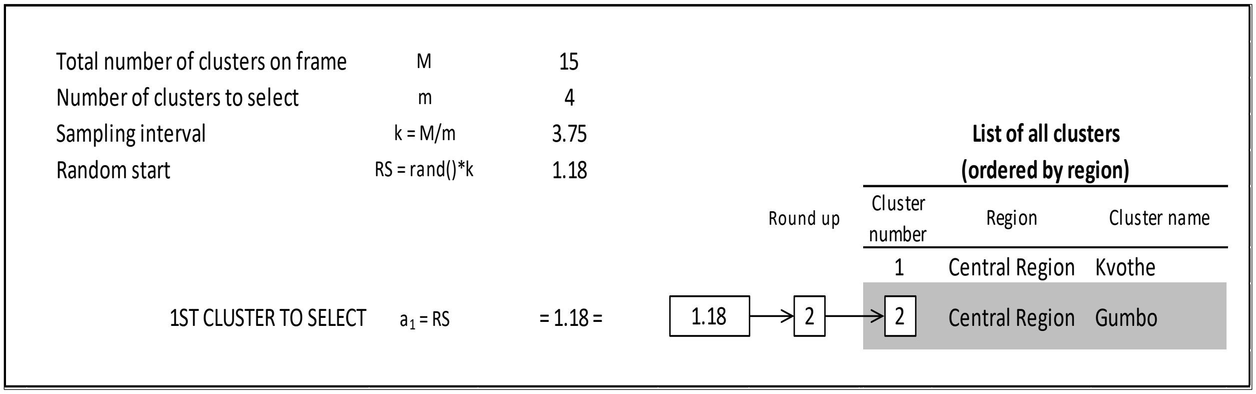
$$sampling\ interval = k = \frac{total\ number\ of\ clusters\ on\ the\ frame\ (M)}{number\ of\ clusters\ to\ select\ (m)}$$

**STEP 4. Calculate a random start.** The random start determines the first cluster to select. It is calculated by choosing a random number greater than or equal to 0 and less than 1 and multiplying the result by the sampling interval. The following is the formula to use to calculate the random start:

$$random\ start = RS = rand(\,) * sampling\ interval$$

The Microsoft Excel function *rand*( ) generates a fractional random number greater than or equal to 0 and less than 1. To compute the random start (*RS*), multiply this random number by the sampling interval ($k$). For instance, if the sampling interval is $k$ = 3.75 (from above) and the random number generated is *rand*( ) = 0.3146, the random start will be $RS$ = 0.3146 * 3.75 = 1.18.

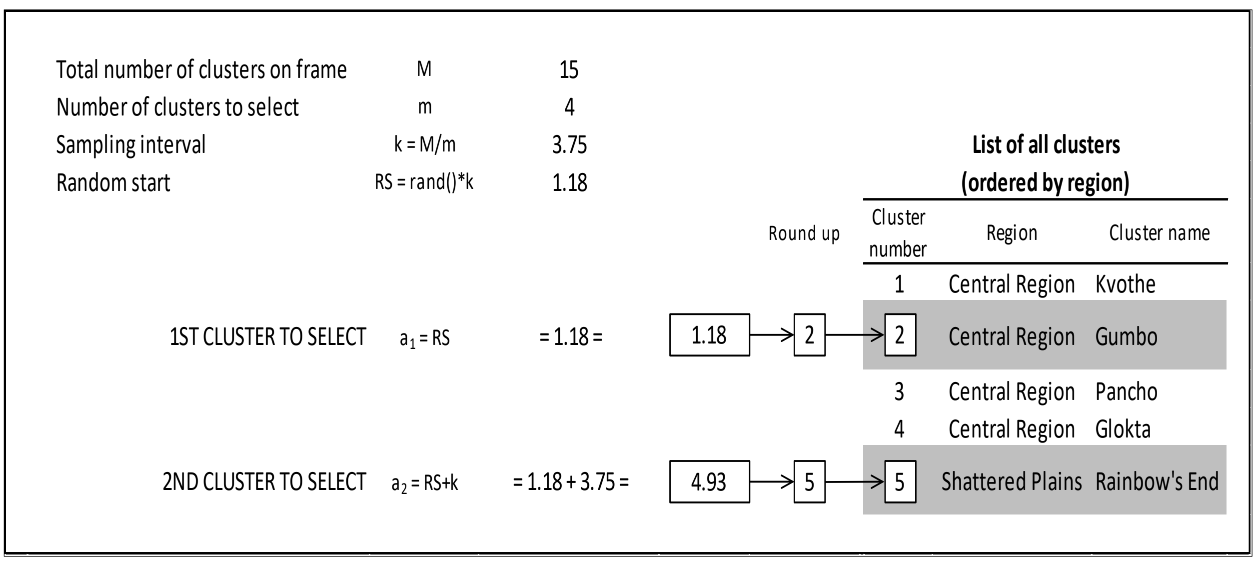
**STEP 5. Select the first cluster.** The first cluster to select according to this scheme is the one whose cluster number corresponds to the random start ($RS$) rounded up to the nearest integer. The following chart provides an example.




In the example above, the random start is $RS$ = 1.18 and it is rounded up to 2. Therefore, cluster 2 (Gumbo) is selected as the first cluster in the sample.

Note that if, by chance, *rand*( ) generates the number 0, then the random start is also 0. In this case, choose the first cluster on the list to be the first cluster in the sample.

**STEP 6. Select the second cluster.** The second cluster to select according to this scheme is the one whose cluster number corresponds to the number formed by adding the sampling interval $k$ (including the integer part and all decimals) to the random start $RS$ (including the integer part and all decimals), rounded up to the nearest integer. The following chart provides an example.




In this example, the sampling interval ($k$ = 3.75) is added to the random start ($RS$ = 1.18) to obtain 4.93. This is rounded up to 5, and therefore cluster 5 (Rainbow's End) is selected as the second cluster in the sample.

**STEP 7. Select the third cluster.** Add twice the sampling interval (*k*) to the random start (*RS*) to determine the third cluster to select for the sample. Use the resultant number in exactly the same way as in Step 6 above. The following chart provides an example.

| | | |
|---|---|---|
| Total number of clusters on frame | M | 15 |
| Number of clusters to select | m | 4 |
| Sampling interval | k = M/m | 3.75 |
| Random start | RS = rand()*k | 1.18 |

**List of all clusters (ordered by region)**

| | | | | Round up | Cluster number | Region | Cluster name |
|---|---|---|---|---|---|---|---|
| | | | | | 1 | Central Region | Kvothe |
| 1ST CLUSTER TO SELECT | $a_1$ = RS | = 1.18 = | 1.18 → | 2 → | 2 | Central Region | Gumbo |
| | | | | | 3 | Central Region | Pancho |
| | | | | | 4 | Central Region | Glokta |
| 2ND CLUSTER TO SELECT | $a_2$ = RS+k | = 1.18 + 3.75 = | 4.93 → | 5 → | 5 | Shattered Plains | Rainbow's End |
| | | | | | 6 | Shattered Plains | Furculita |
| | | | | | 7 | Shattered Plains | Stanka |
| | | | | | 8 | Shattered Plains | Stormlight |
| 3RD CLUSTER TO SELECT | $a_3$ = RS+2*k | = 1.18 + (2 * 3.75) = | 8.68 → | 9 → | 9 | Shattered Plains | Deepness |

In this example, twice the sampling interval (2 * *k* = 2 * 3.75 = 7.5) is added to the random start (*RS* = 1.18) to obtain 8.68. This is rounded up to 9, and therefore cluster 9 (Deepness) is selected as the third cluster in the sample.

**STEP 8. Continue in a similar fashion until the total number of clusters (*m*) to select is reached.** The following chart provides the final result of the selection.

| | | |
|---|---|---|
| Total number of clusters on frame | M | 15 |
| Number of clusters to select | m | 4 |
| Sampling interval | k = M/m | 3.75 |
| Random start | RS = rand()*k | 1.18 |

| | | | | Round up | List of all clusters (ordered by region): Cluster number | Region | Cluster name |
|---|---|---|---|---|---|---|---|
| | | | | | 1 | Central Region | Kvothe |
| 1ST CLUSTER TO SELECT | $a_1$ = RS | = 1.18 = | 1.18 | 2 | 2 | Central Region | Gumbo |
| | | | | | 3 | Central Region | Pancho |
| | | | | | 4 | Central Region | Glokta |
| 2ND CLUSTER TO SELECT | $a_2$ = RS+k | = 1.18 + 3.75 = | 4.93 | 5 | 5 | Shattered Plains | Rainbow's End |
| | | | | | 6 | Shattered Plains | Furculita |
| | | | | | 7 | Shattered Plains | Stanka |
| | | | | | 8 | Shattered Plains | Stormlight |
| 3RD CLUSTER TO SELECT | $a_3$ = RS+2*k | = 1.18 + (2 * 3.75) = | 8.68 | 9 | 9 | Shattered Plains | Deepness |
| | | | | | 10 | The North | Black Dow |
| | | | | | 11 | The North | Logan |
| | | | | | 12 | The North | Tul Duru |
| 4TH CLUSTER TO SELECT | $a_4$ = RS+3*k | = 1.18 + (3 * 3.75) = | 12.43 | 13 | 13 | The North | Bast |
| | | | | | 14 | The North | Kaladin |
| | | | | | 15 | The North | Arya |

In this example, three times the sampling interval (3 * *k* = 3 * 3.75 = 11.25) is added to the random start (*RS* = 1.18) to obtain 12.43. This is rounded up to 13, and therefore cluster 13 (Bast) is selected as the fourth and last cluster in the sample.

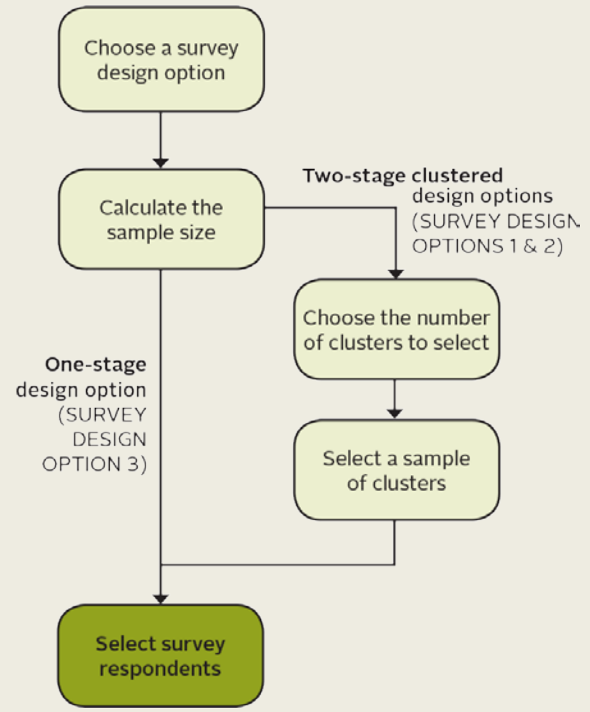
Note in the example above that, once again, using implicit stratification (i.e., by ordering the clusters by region) resulted in a sample that was spread out across all regions (Central Region, Shattered Plains, and The North), although even with ordering, it is still possible to have one or more regions with no clusters chosen.

Finally, note that with fractional interval systematic sampling, it is not possible to select the same cluster more than once, unlike with systematic PPS sampling (unless the number of clusters to select, *m*, exceeds the total number of clusters on the frame, *M*, which does not happen in practice).

## 9.5 Selecting the Survey Respondents for All Survey Design Options for the Household Survey Approach

The final step in the survey design process for the household survey approach is to randomly select the survey respondents to interview. The final step is relevant for all survey design options (1, 2, and 3), and it corresponds to the second stage of sampling for survey design options 1 and 2 and the first stage of sampling for survey option 3.

**Figure 3e. Steps in the Approach**




The process of selecting respondents is implemented by selecting participants from a list using one of two variants of an equal probability method: selecting survey respondents before fieldwork using **fractional interval systematic sampling** or selecting survey respondents in the field using **systematic sampling**. The former is appropriate for survey design options 1 and 3, while the latter is appropriate for survey design option 2.

For all three survey design options, before survey respondents can be selected using one of the two variants, a comprehensive list of participants must be constructed, whether through participant registration systems before fieldwork begins (survey design options 1 and 3) or through a listing operation during fieldwork (survey design option 2).

### 9.5.1 Selecting Survey Respondents before Fieldwork Using Fractional Interval Systematic Sampling (for Survey Design Options 1 and 3)

Survey design option 1 entails two stages of sampling, where clusters are selected at the first stage of sampling using the methods described in Section 9.4. For the second stage of sampling of survey respondents, a comprehensive list of participants is needed from which to sample—but only for the clusters that are selected at the first stage. That means that for every cluster that is selected at the first stage, a complete list of participants in that cluster is required for the second stage of sampling before fieldwork begins.

In contrast, survey design option 3 entails only one stage of sampling, where survey respondents are directly sampled from the frame of participants, without regard to clusters. In this case, a comprehensive list of **all** participants is required before fieldwork begins. Although the selection of participants from the list is undertaken without regard to clustering, survey implementers should order the list of participants by implementation villages/communities prior to sampling, so that the systematic selection of respondents will be spread across implementation villages/communities.

For both survey design options 1 and 3, no listing exercise is needed, because it is assumed that a comprehensive list or frame of participants already exists.

Randomly selecting participants from the sampling frame using **fractional interval systematic sampling** uses the same method described in the previous section for the selection of clusters at the first stage of sampling. The main difference is that, at the second stage, participants rather than clusters are selected.

For instance, for survey design option 1, the same steps described in Section 9.4.2 should be followed, but using the list of project participants for each cluster and the following formula for the sampling interval:

$$sampling\ interval = k = \frac{total\ number\ of\ participants\ in\ the\ cluster\ (B)}{number\ of\ participants\ to\ sample\ in\ each\ cluster\ (b)}$$

where *b*, the number of participants to select in each cluster, is determined following the instructions in Section 9.3, and *B*, the total number of participants in the cluster, is determined using a count from the second stage participant frame.

Note that for survey design option 1, a separate sampling interval needs to be calculated for each sampled cluster in the survey. An example of fractional interval systematic sampling for selecting from a list frame of participants assuming survey design option 1 is given next.

| | | |
|---|---|---|
| Number of participants in cluster | B | 22 |
| Number of participants per cluster to select | b | 8 |
| Sampling interval | k = B/b | 2.75 |
| Random start | RS = rand()*k | 1.77 |

| | | | Round up |
|---|---|---|---|
| 1ST PARTICIPANT TO SELECT | $b_1$ = RS | 1.77 | 2 |
| 2ND PARTICIPANT TO SELECT | $b_2$ = RS+k | 4.52 | 5 |
| | $b_3$ = RS+2*k | 7.27 | 8 |
| | $b_4$ = RS+3*k | 10.02 | 11 |
| | $b_5$ = RS+4*k | 12.77 | 13 |
| | $b_6$ = RS+5*k | 15.52 | 16 |
| | $b_7$ = RS+6*k | 18.27 | 19 |
| 8TH PARTICIPANT TO SELECT | $b_8$ = RS+7*k | 21.02 | 22 |

| **List of participants in cluster** | |
|---|---|
| 1 | L. Popescu |
| 2 | G. Grafiti |
| 3 | J.J. Abramov |
| 4 | K. Blessed |
| 5 | G. Smithy |
| 6 | B.B. Gigi |
| 7 | C. Shmaltz |
| 8 | Ch. Shaltitch |
| 9 | Sh. Choopah |
| 10 | B. Jobonei |
| 11 | W. Zebreeks |
| 12 | Th. Stankulets |
| 13 | V. Augustus |
| 14 | E. Starck |
| 15 | D. Targanovitch |
| 16 | R. Hornshnutz |
| 17 | P.O. Buxitz |
| 18 | Fh. Furbenty |
| 19 | Du. Poonts |
| 20 | R. Shteingartz |
| 21 | Q. Berts |
| 22 | M.N. Shevitz |

For survey design option 3, the following formula should be used for the sampling interval:

$$sampling\ interval = k = \frac{total\ number\ of\ participants\ in\ the\ project\ (B)}{number\ of\ overall\ participants\ to\ sample\ (b)}$$

Sampling is done in a manner very similar to the example above, except selection of participants is performed across clusters, not within each sampled cluster. Therefore, only one sampling interval is required for the entire operation.

### 9.5.2 Listing Operation in the Field (for Survey Design Option 2)

For survey option 2, because no second stage list frame of project participants exists, the frame must be created in the field for every sampled cluster through a listing operation. After the frame is created, survey participants are then randomly selected while in the field using systematic sampling (described in the next section). This section describes the listing operation.

Listing operations occur only in the clusters randomly selected in the first stage of sampling for survey design option 2. Listing is a separate activity that takes place before survey respondents are selected and interviewing starts. In general, a listing operation is implemented by having interviewers visit every household in a cluster, ascertain whether or not the household has project participants, and stop only at households that include project participants to collect basic information on each project participant in the household. If there are no project participants in a particular household, then no information is collected from that household. If there are multiple project participants in a given household, information on each of them is collected.

It is important to collect information on the location of participant households within sampled clusters, so that interviewers can potentially return at a later time to conduct interviews with the participants who reside within these clusters if they are randomly selected. GPS coordinates of households can also be taken and the coordinates can be recorded as part of the information on each participant.

As listing progresses through the cluster, each newly identified participant is added to a list, and, thus, a second stage frame of participants in each sampled cluster is dynamically created in the field. It is critical that all households in the cluster be visited to ensure that all project participants in the cluster are identified—so that the resultant list frame is as complete as possible.

The information to be included is the same as that required for the second type of sampling frame described in Chapter 7:

- Unique participant ID number
- Participant's complete name
- Participant's age and sex
- Participant's household location (e.g., address or relative location, GPS coordinates)
- Village name/community name to which the participant belongs
- Location of the village/community (e.g., census geographic code or GPS coordinates, if available)
- Any higher geographic levels (e.g., province or district) in which the participant resides

Additional information that should be included (if feasible and affordable) is outlined in Section 7.1.

Listing operations represent additional time and expense, and, as a result, survey design option 2 is more resource-intensive than survey design option 1, which does not include a listing operation. In most cases, a listing operation in a cluster lasts no more than a day or two, although this depends on the cluster size, the terrain, and any potential access issues. Given this additional burden, projects are encouraged to develop and maintain high-quality participant registration systems that will help eliminate the need for the listing operations—and that will allow projects to use survey design option 1 in subsequent surveys instead.

### 9.5.3 Selecting Survey Respondents in the Field Using Systematic Sampling (for Survey Design Option 2)

For survey design option 2, once the listing operation has been completed, survey respondents are then selected in the field using a method called **systematic sampling**. This method is similar to fractional interval systematic sampling used for selecting participants before fieldwork described in Section 9.5.1 for survey design options 1 and 3. The main differences between the two methods are the following two simplifications:

1. The sampling interval is rounded (either up or down) to the closest integer.
2. The random start is an integer (rather than a fractional number) greater than or equal to 1 and less than or equal to the rounded sampling interval, and a different Microsoft Excel function from the one given for fractional interval systematic sampling is used in its computation.

In this case, the rounded sampling interval, $k_{rounded}$, is calculated as:

$$sampling\ interval\ (rounded) = k_{rounded} = \ round(k, 0)$$

where:

$$k = \frac{total\ number\ of\ participants\ in\ the\ cluster\ (B)}{number\ of\ participants\ to\ sample\ in\ each\ cluster\ (b)}$$

and where the Microsoft Excel function *round*(*k,*0) rounds the number *k* up or down to the nearest integer.

The random start is computed as:

$$random\ start = RS = \ randbetween(1, k_{rounded})$$

where the Microsoft Excel function *randbetween*(1,$k_{rounded}$) generates a random integer (i.e., a discrete value) greater than or equal to 1 and less than or equal to $k_{rounded}$.

The above changes are made to the original fractional interval systematic sampling method to simplify the process of selecting participants for field staff, given that selection occurs in the field immediately following listing, and once the number of participants in the listed clusters is ascertained. Sampling intervals and random starts without decimals make it easier for field staff to undertake the computations required to identify the correct participants to interview.

This simplification does, however, add some uncertainty around the total number of participants that is ultimately selected for interviewing in each cluster. This is explained in more detail using the example below. Note that the example refers to sampling within one sampled cluster only. The same procedure needs to be repeated for each sampled cluster in the survey.

| | | | | |
|---|---|---|---|---|
| Number of participants in cluster | B | 25 | | |
| Number of participants to select in each cluster | b | 8 | | |
| Sampling interval | k = B/b | 3.13 | | |
| Sampling interval (rounded) | $k_{rounded}$ = round(k,0) | 3 | | |
| | | Sample 1 | Sample 2 | Sample 3 |
| Random start | RS = randbetween(1,$k_{rounded}$) | 1 | 2 | 3 |
| | | Participant number | Participant number | Participant number |
| 1ST PARTICIPANT TO SELECT | $b_1$ = RS | 1 | 2 | 3 |
| 2ND PARTICIPANT TO SELECT | $b_2$ = RS+$k_{rounded}$ | 4 | 5 | 6 |
| | $b_3$ = RS+2*$k_{rounded}$ | 7 | 8 | 9 |
| | $b_4$ = RS+3*$k_{rounded}$ | 10 | 11 | 12 |
| | $b_5$ = RS+4*$k_{rounded}$ | 13 | 14 | 15 |
| | $b_6$ = RS+5*$k_{rounded}$ | 16 | 17 | 18 |
| | $b_7$ = RS+6*$k_{rounded}$ | 19 | 20 | 21 |
| 8TH PARTICIPANT TO SELECT | $b_8$ = RS+7*$k_{rounded}$ | 22 | 23 | 24 |
| | $b_9$ = RS+8*$k_{rounded}$ | 25 | | |
| Number of participants selected: | | 9 | 8 | 8 |

In the above example, the sampling interval $k = B / b = 3.13$ is rounded to the nearest integer, which is $k_{rounded} = 3$. An integer random start, RS, between 1 and 3 is generated. For illustration purposes, all three possible random starts (1, 2, and 3) are shown in separate columns, as are the three different samples generated based on these random starts. The first sample consists of nine participants labeled 1, 4, 7, 10, 13, 16, 19, 22, and 25. The second sample consists of eight participants labeled 2, 5, 8, 11, 14, 17, 20, and 23. Finally, the third sample also consists of eight participants labeled 3, 6, 9, 12, 15, 18, 21, and 24. This example illustrates the fact that the actual number of participants selected through systematic sampling in a given cluster will not always be the targeted number (in this case, eight).[50] This is due to the rounding of the sampling interval that is used as a simplification to the more standard fractional interval systematic sampling.

In the case of Sample 1 above where nine participants are selected instead of the targeted eight, it is important to interview all nine participants and not stop after eight interviews. Stopping short will result in a sample where some of the participants have a zero probability of being selected. In probability-based sampling, all selection units must have a non-zero probability of being selected.

Note that if the number of participants to be selected in the cluster equals or exceeds the number of participants in the cluster (i.e., $b \geq B$), then there is no need to undertake the above computation, and in this case, all participants in the cluster should be selected even though there may be a shortfall in the sample size for that cluster.

### 9.5.4 Considerations to Take into Account When Selecting the Survey Respondent

1. For both fractional interval systematic sampling and systematic sampling, there should be no substitutions of sampled participants with replacement participants when collecting data in the field. For example, if the first sample is chosen in the example above using systematic sampling, then participants 1, 4, 7, 10, 13, 16, 19, 22, and 25 must be located (using the information from the second stage participant frame created through listing) and must be interviewed. If a selected participant is not present or chooses not to respond, survey implementers should not visit one of the other participants on the sampling frame that was not part of the selected sample as a substitute. If a participant is not available for interviewing, the interviewer should revisit the household up to three times to secure an interview. If, after three attempts, an interview still cannot be secured, then the participant should be labeled as a "non-respondent" and sample weight adjustments must be made after fieldwork to compensate for the data relating to the missing respondent. Recall that when the sample size was calculated, the initial sample size was inflated to compensate for anticipated individual non-response, i.e., to compensate for the fact that not all interviews in the field would be secured as planned.
2. For systematic sampling only, it is possible that the total number of survey respondents will not be achieved, and that more (or fewer) participants will be interviewed in the survey than originally planned. This is illustrated in the example above, where eight participants were targeted for interviewing in a particular sampled cluster, but nine were ultimately selected in sample 1 for that cluster. On average, the total sample size target for the survey across all sampled clusters will be met (barring individual non-response), but in some clusters the exact sample size target may not be met.
3. It was previously noted that when using systematic PPS sampling at the first stage of sampling, it is possible to select the same cluster more than once. Although this is rare, when this happens, the two (or more) selections of the same sampled cluster should be treated separately. In this case, at

[50] Note that in the above example, one of the three possible samples produces more than the targeted number of sampled participants per cluster (i.e., 9 instead of 8). However, there are also examples where some samples produce fewer than the targeted number of sampled participants. For example, if $B = 25$, $b = 9$, then $k_{rounded} = 3$. In this case, there are three possible samples, but only one of them will have nine participants selected (i.e., the targeted number); the other two will have eight participants selected (i.e., fewer than the targeted number.)

the second stage of sampling, the treatment within sampled clusters depends on which method is used at the second stage of sampling: fractional interval systematic sampling or systematic sampling.

When the same cluster is selected twice at the first stage of sampling and fractional interval systematic sampling is used at the second stage of sampling, the list of participants in the cluster should be divided in two equal parts, and separate sampling using fractional interval systematic sampling should take place in each half of the cluster. This is to ensure that there will not be any overlap in the two samples of participants within the same sampled cluster. In this case, there will be $B / 2$ participants in each of the two parts and $b / 2$ participants should be sampled in each of the two parts.

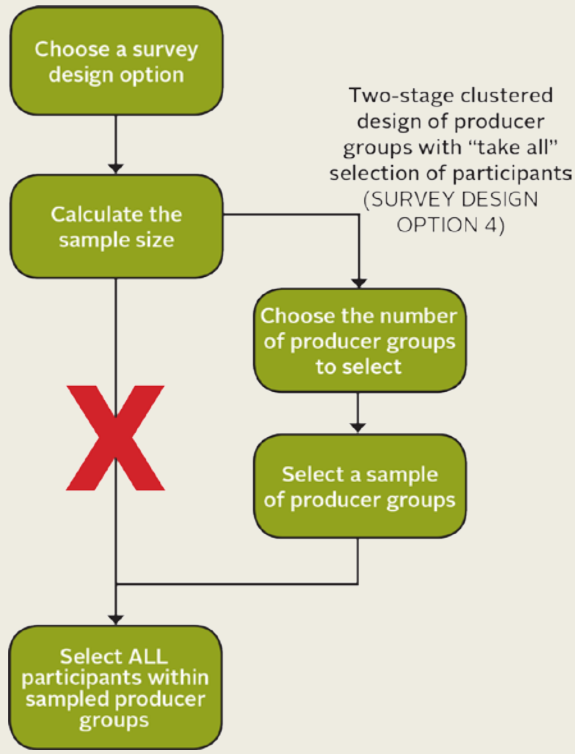
When the same cluster is selected twice at the first stage of sampling and systematic sampling is used at the second stage of sampling, two distinct random starts should be chosen for the sampled cluster, and, on this basis, two distinct samples of participants will be chosen from within the same cluster. The use of two distinct random starts ensures that the two samples of participants within the same sampled cluster will not overlap. Note by way of illustration that in the above example, samples 1, 2, and 3 are distinct samples with no overlap of participants.

CHAPTER

# 10. The Producer Groups Approach (Approach 2)

This chapter provides details on how to implement the PGs approach. This approach uses the same survey design steps as the household survey approach, that is to say: choose a survey design option (although there is only one option for this approach), calculate the sample size, choose the number of clusters (PGs) to select, select a sample of clusters (PGs), and select the survey respondents. The specifics of each of these steps are described in the following sections.

**Figure 3f. Steps in the Approach**




## 10.1 Choose a Survey Design Option

For the PGs approach, a new survey design option is used.

- **Survey design option 4:** Two-stage cluster design of PGs, with "take all" selection of participants within sampled PGs at the second stage of sampling.

One basic difference between this survey design option and the first two of the three survey design options using two-stage sampling discussed under the household survey approach is that PGs rather than villages/communities constitute clusters, and the surveys take place at the same time as project implementation with the PGs. Another difference is that "take all" selection of participants, rather than a sample selection of participants, is used at the second stage of sampling.

At the first stage, a sample of PGs (clusters) is selected from the first stage frame of all PGs using **fractional interval systematic sampling**. After PGs are selected from the sampling frame, the sampled PGs are visited during the next PG meeting. At the second stage, a comprehensive list of all participants within the selected PGs is used to ensure that all participants have a chance to be interviewed. Any participants who are absent from the PG meeting should be treated as non-respondents and sample weight adjustments should be made to compensate for the missing data. See Chapter 11 for more details.

## 10.2 Calculate the Sample Size

For the PGs approach, the overall number of participants to sample in the survey, $n_{final}$, is calculated the same way that it is in the household survey approach described in Section 9.2.

## 10.3 Choose the Number of Producer Groups to Select

To determine the number of PGs (clusters) to select, the same approach is followed as was used in Section 9.3. However, because clusters are PGs (rather than villages or communities) and because *b*, the number of participants per PG, tends to fall in the 15–30 range for Feed the Future IPs, it is not necessary to calculate minimum and maximum values for *b*. The exploratory work undertaken by the USAID-funded Food and Nutrition Technical Assistance Project (FANTA) prior to drafting this guide revealed that most projects tend to choose a roughly fixed size for their PGs (e.g., 20), and, therefore, when using PGs as clusters, *b* is roughly constant. As a result, the following formula can be used to determine the number of PGs ($m$) to select based on $n_{final}$ and the roughly constant value for *b*:

$$m = round(\frac{n_{final}}{b})$$

## 10.4 Select a Sample of Producer Groups

The next step in the survey design process is to randomly select a sample of clusters, which in this case are PGs, from the sampling frame of all the PGs in which the project is implemented. Note that it is important for survey implementers who wish to use the PGs approach to maintain a complete and comprehensive list frame of active PGs from which to sample at the first stage.

To select a sample of PGs, survey implementers should use **fractional interval systematic sampling**, as described in Section 9.4.2, rather than systematic PPS sampling. This is because most PGs are of approximately the same size, and therefore there is little benefit to using systematic PPS sampling. Recall that for systematic PPS sampling, clusters with a greater number of project participants have a greater chance of being selected from the frame, while clusters with a fewer number of project participants have a smaller chance of being selected from the frame. However, survey implementers should use systematic PPS sampling only if PG sizes vary widely.

## 10.5 Select All Participants within Sampled Producer Groups

The final step in the survey design process for the PGs approach is to select the survey respondents. It is key that survey implementers maintain a complete and comprehensive second stage frame of all participants within all active PGs. Because there is only a small number of participants in a typical PG (typically 15–35), the recommendation is to interview all participants in a sampled PG. This approach is called **"take all" sampling**. If some of the participants within a sampled PG do not participate in a PG meeting where data are being collected, a sample weight adjustment for participant non-response should be made to compensate. See Chapter 11 for more details.

Note that, under the PGs approach, it is important to interview selected participants individually rather than in a group. Group interviews could induce response biases stemming from the propensity toward social desirability outcomes and potential competition between participants. In addition, because of the sensitivity of the data collected (i.e., value of sales, volume of production, etc.), group reporting could be considered an infringement of individual confidentiality protection. However, interviewing 15–35 participants in a PG during one session can be time-consuming for participants, particularly if they are interviewed individually, given the need for each participant to "wait for his or her turn." One potential way of minimizing the waiting time for participants is to establish a dedicated PG meeting for the sole purpose of data collection and to ensure that there are sufficient interviewers so that the ratio of participants to interviewers is no more than 3 or 4 to 1. Another potential way to mitigate this problem is to introduce a second stage of sampling within each selected PG so that only a subset of the 15–35 participants in a sampled PG is interviewed. However, this means that additional PGs need to be sampled at the first stage to maintain the original sample size. This solution is complex to implement in the field and so should be considered only as a last resort solution.

One of the potential disadvantages to the PGs approach (assuming a "take all" sampling approach) is that the final sample size may deviate somewhat from the target sample size because the approach is dependent on the participation of **all** participants for the selected PG meeting(s) where data are collected. However, if attendance at PG meetings is known to be low, it is still possible to safeguard against a shortfall in the sample size. To do so, one can use a larger adjustment for anticipated individual non-response when computing the sample size. See Section 9.2.3 for more details. Another disadvantage to this approach is the potential for bias in the results, because participants who attend PG meetings may be more likely to apply new management practices and technologies or may be more likely to have higher yields than those farmers who do not attend PG meetings.

# PART 6

# DATA ANALYSIS: SAMPLE WEIGHTING AND THE CONSTRUCTION OF INDICATOR ESTIMATES AND THEIR CONFIDENCE INTERVALS AND STANDARD ERRORS

## CHAPTERS

CHAPTER

# 11. Sample Weighting

After data collection is completed, there are a number of post-fieldwork activities that typically take place prior to and in support of data analysis. First, the data are entered or uploaded into a database. If paper questionnaires were used, then double data entry[51] is typically used to help minimize errors in data entry. The data are then "cleaned." This usually means that the data entry software was designed to allow only valid data ranges (e.g., participant ages must be between 15 and 80 years), to check that questionnaire logic has been adhered to (e.g., skips and filters respected), and to flag for resolution of any logic inconsistencies in the data (e.g., a 4-year-old married participant).[52] After data cleaning, a check is typically performed to make sure that there are no "outlier" values (e.g., a producer with sales of US$1 million). Sampling weights are then constructed to reflect the various stages of sampling. A sampling weight is attached to each of the respondents on the cleaned data file. Finally, data analysis, which includes the production of estimates of the annual monitoring indicators and their associated confidence intervals and standard errors, takes place.

This chapter and the next two chapters address the three topics of sample weighting, producing estimates of indicators, and producing confidence intervals and standard errors associated with the indicators.

The first step to take before data analysis is to calculate the sample weights associated with each of the participants who have been randomly selected in the PaBS and who have responded to the survey interview questions. Sample weights for selected participants are calculated and applied to corresponding individual survey data record(s) to inflate the participant data values up to the level of the population of participants. In essence, sample weights are a means of compensating for having collected data on a sampled subset of the participant population, instead of having conducted a full "census" of all the project participants.

For the survey design options discussed in earlier chapters, sample weights should be calculated and used in the construction of estimates of each indicator to account and compensate for the following:

- Probabilities of selection at each stage of sampling
- Non-response at the participant level

## 11.1 Calculating Sample Weights to Reflect Probabilities of Selection

All participants included on a sampling frame have an underlying chance or probability of being included in the sample. For example, if 1 participant is randomly selected from among 10 possible participants on

[51] Double data entry is a data entry quality control method, where, in the first pass through a set of records, an operator enters data from all records. On the second pass through the batch, a verifier enters the same data. The contents entered by the verifier are compared with those of the original operator. If there are differences, the data fields or records where there are differences are flagged for follow-up and reconciliation.

[52] In the case where paper-based questionnaires were not used, and some form of computer-assisted personal interviewing (e.g., using tablets) were used instead, error checks are often programmed into the tablets so that validity and logic errors can be detected automatically and rectified while still in the field.

a sampling frame, the probability of that respondent being selected is 1 in 10 and the associated sampling weight is 10. One interpretation of a sample weight is that the selected participant represents all 10 participants—himself or herself, along with 9 other participants who were not selected in the survey. The individual sample weight of each respondent is multiplied by each value of the respondent's data before the quantity is summed across all respondent participants to form an estimate of a total. When the survey data on participants are used to make inferences about the entire participant population, the survey-weighted data from the participant used in the example above will have the effect of "being replicated" 10 times.

### 11.1.1 Overview of How to Calculate Sample Weights to Account for Probabilities of Selection

For survey design options 1, 2, and 4, where there are two stages of sampling, the sampling weight associated with the probabilities of selection for each sampled participant is calculated (in general terms) using the steps outlined below. The specifics of the general set of steps in relation to each of the survey design options are mapped out in the sections that follow.

**STEP 1.** Calculate the probability of selection at the first stage of selection (this corresponds to the selection of clusters, i.e., villages, communities, or PGs). This is done for each cluster.

$$probability\ of\ selection\ of\ cluster\ i\ at\ the\ first\ stage = f_{1i}$$

**STEP 2.** Calculate the probability of selection at the second stage of selection (this corresponds to the "conditional" selection of survey participants, assuming that the cluster in which the participant resides has been selected at the first stage of sampling). This is done for each participant who has been randomly selected for inclusion in the sample, regardless of whether or not he or she has responded. It is important to keep track of all survey participants who have been selected for inclusion in the sample at this stage; an adjustment for the non-responding participants in the sample is made later.

$$probability\ of\ selection\ of\ participant\ j\ at\ the\ second\ stage, assuming\ cluster\ i\ selected\ at\ first\ stage = f_{2ij}$$

**STEP 3.** To calculate the overall probability of selection for each participant selected for inclusion in the sample, $f_{ij}$, multiply the probability of selection at the first stage (for the cluster from which the participant was selected) by the conditional probability of selection of the participant at the second stage.

$$f_{ij} = f_{1i} * f_{2ij}$$

**STEP 4.** To calculate the overall sample weight that reflects the probabilities of selection at each stage, take the inverse of the quantity calculated in step 3:

$$overall\ sample\ weight = w_{ij} = \frac{1}{f_{ij}} = \frac{1}{f_{1i} * f_{2ij}}$$

For survey design option 3, there is only one stage of selection and it corresponds to a single stage of selection of participant *j*:

$$overall\ sample\ weight = w_j = \frac{1}{f_j}$$

Note that for survey design option 3, $w_{ij} = w_j$ and $\frac{1}{f_{ij}} = \frac{1}{f_j}$. This is because there is no stage of sampling for clusters, and therefore the subscript *i* is dropped from the notation.

For survey design option 3, although all of the sample weights are identical given that all sampled participants are selected with the same (equal) probability, it is still necessary to compute and use the sample weight in the associated analyses. This is because the indicators to be estimated are totals, and therefore the sample-weighted estimates of the totals must be appropriately inflated to reflect all participants in the population.

Lastly, for all survey design options (1–4), a non-response adjustment needs to be made to the overall sampling weight to compensate for the selected participants who did not respond to the survey. More details on this are provided in the sections that follow.

The previous section provides general formulas for computing sample weights at each stage of sampling. In the following sections, specific formulas are provided for each of the four survey design options that are used in this guide. **Table 5** provides a summary of the types of sampling recommended for each of the four survey design options at each stage of sampling. See Sections 9.1 and 10.1 for more details.

### Table 5. Summary of Types of Sampling for Each of the Survey Design Options

| | Survey design option 1 | Survey design option 2 | Survey design option 3 | Survey design option 4 |
|---|---|---|---|---|
| Sampling of clusters (at first stage) | Systematic PPS | Systematic PPS or fractional interval systematic | Not applicable | Fractional interval systematic |
| Sampling of participants (at first or second stage) | Fractional interval systematic | Systematic | Fractional interval systematic | Take all |

### 11.1.2 Calculating the Probability of Selection at the First Stage

For survey design options 1, 2, and 4 (the options where clustering is used), the probability of selection at the first stage, that is, the probability of selection of a cluster, is calculated differently depending on which of the selection methods is used—systematic PPS sampling or fractional interval systematic sampling.

When **systematic PPS sampling** is used at the first stage of sampling (survey design option 1 or 2), the probability of selection of the *ith* cluster is calculated as follows:

$$f_{1i} = \frac{(number\ of\ clusters\ to\ be\ selected * total\ number\ of\ participants\ in\ selected\ cluster\ i)}{total\ number\ of\ participants\ in\ all\ clusters} = \frac{m * B_i}{N}$$

In the above formula, *m* is the number of clusters selected (computed in Section 9.3) and $B_i$ is the total number of participants in selected cluster *i* (computed through a count from the sampling frame). The following illustrates the calculation of the probabilities of selection for systematic PPS sampling, continuing the example from Section 9.4.1.

| | | | |
|---|---|---|---|
| Population of participants | $N$ | 350 |
| Number of clusters to select | $m$ | 4 |
| Sampling interval | $k = N/m$ | 87.50 |
| Random start | $RS = rand()*k$ | 62.53 |

| Cluster number | Region | Cluster name | Number of participants per cluster ($B_i$) | Cumulative total of participants | Probability of selection (first stage) ($f_{1i} = (m*B_i)/N$) | |
|---|---|---|---|---|---|---|
| 1 | Central Region | Kvothe | 6 | 6 | | |
| 2 | Central Region | Gumbo | 13 | 19 | | |
| 3 | Central Region | Pancho | 27 | 46 | | |
| 4 | Central Region | Glokta | 22 | 68 | 0.2514 | = (4 * 22) / 350 |
| 5 | Shattered Plains | Rainbow's End | 21 | 89 | | |
| 6 | Shattered Plains | Furculita | 27 | 116 | | |
| 7 | Shattered Plains | Stanka | 25 | 141 | | |
| 8 | Shattered Plains | Stormlight | 26 | 167 | 0.2971 | = (4 * 26) / 350 |
| 9 | Shattered Plains | Deepness | 26 | 193 | | |
| 10 | The North | Black Dow | 9 | 202 | | |
| 11 | The North | Logan | 12 | 214 | | |
| 12 | The North | Tul Duru | 33 | 247 | 0.3771 | = (4 * 33) / 350 |
| 13 | The North | Bast | 34 | 281 | | |
| 14 | The North | Kaladin | 34 | 315 | | |
| 15 | The North | Arya | 35 | 350 | 0.4000 | = (4 * 35) / 350 |
| | | | **350** | | | |

When **fractional interval systematic sampling** is used at the first stage of sampling (survey design options 2 or 4), the probability of selection of the *ith* cluster is calculated as follows:

$$f_{1i} = \frac{number\ of\ clusters\ or\ PGs\ to\ be\ selected}{total\ number\ of\ clusters\ or\ PGs\ on\ frame} = \frac{m}{M}$$

Note that in this case, the probability of selection is the same for all clusters and so does not depend on which cluster it is (i.e., on *i*.) The following example illustrates the calculation of the probabilities of selection for fractional interval systematic sampling, continuing the example from Section 9.4.2.

| | | |
|---|---|---|
| Total number of clusters on frame | *M* | 15 |
| Number of clusters to select | *m* | 4 |
| Sampling interval | *k = M/m* | 3.75 |
| Random start | *RS = rand()*k* | 1.18 |

| Cluster number | Region | Cluster name | $f_{1i} = m / M$ Probability of selection (first stage) | |
|---|---|---|---|---|
| 1 | Central Region | Kvothe | | |
| 2 | Central Region | Gumbo | 0.2667 | *= 4 / 15* |
| 3 | Central Region | Pancho | | |
| 4 | Central Region | Glokta | | |
| 5 | Shattered Plains | Rainbow's End | 0.2667 | *= 4 / 15* |
| 6 | Shattered Plains | Furculita | | |
| 7 | Shattered Plains | Stanka | | |
| 8 | Shattered Plains | Stormlight | | |
| 9 | Shattered Plains | Deepness | 0.2667 | *= 4 / 15* |
| 10 | The North | Black Dow | | |
| 11 | The North | Logan | | |
| 12 | The North | Tul Duru | | |
| 13 | The North | Bast | 0.2667 | *= 4 / 15* |
| 14 | The North | Kaladin | | |
| 15 | The North | Arya | | |

### 11.1.3 Calculating the Probability of Selection at the Second Stage

The three methods used for selecting participants at the second stage are **fractional interval systematic sampling** (for survey design option 1 or 3), **systematic sampling** (for survey design option 2), and **take all sampling** (for survey design option 4). For the first two methods, the formula to use to calculate the conditional probability of selection for the *jth* participant in cluster *i* at the second stage under survey design option 1 is the following[53]:

$$f_{2ij} = \frac{total\ number\ of\ participants\ selected\ for\ sampling\ in\ cluster\ i}{total\ number\ of\ participants\ in\ cluster\ i} = \frac{b_i}{B_i}$$

[53] Strictly speaking, for the systematic sampling variant, the denominator should include a small adjustment due to the rounding of the sampling interval, but this can be ignored for simplicity sake because it makes very little difference to the overall probability.

For **take all sampling**, because the number of participants selected for sampling in any cluster is always the same as the number of participants in that cluster, $f_{2ij}$ always equals 1.

In the above formula, $b_i$ is the total number of participants to be selected in cluster *i*, as computed in Section 9.3. The value for $b_i$ is not always the same for all selected clusters (particularly with systematic sampling) and therefore the value of $b_i$ depends on *i*. For instance, in the illustrative example in Section 9.5.3, where survey respondents in the field are selected using systematic sampling under survey design option 2, the different samples (1, 2, and 3) result in somewhat different values for $b_i$. The value of $B_i$, the total number of participants in cluster *i*, will rarely be the same for all selected clusters, and therefore the value of $B_i$ again depends on *i*.

The calculation of the probabilities of selection at the second stage is illustrated below, continuing the example from Section 9.5.1, where fractional interval systematic sampling is used at the second stage of sampling.

| | | |
|---|---|---|
| Number of participants in cluster i | $B_i$ | 22 |
| Number of participants to select in cluster i | $b_i$ | 8 |
| Sampling interval | $k = B_i / b_i$ | 2.75 |
| Random start | $RS = rand()*k$ | 1.77 |

| Participant number | Participant name | $f_{2ij} = b_i / B_i$ Probability of selection (second stage) | |
|---|---|---|---|
| 1 | L. Popescu | | |
| 2 | G. Grafiti | 0.3636 | = 8 / 22 |
| 3 | J.J. Abramov | | |
| 4 | K. Blessed | | |
| 5 | G. Smithy | 0.3636 | = 8 / 22 |
| 6 | B.B. Gigi | | |
| 7 | C. Shmaltz | | |
| 8 | Ch. Shaltitch | 0.3636 | = 8 / 22 |
| 9 | Sh. Choopah | | |
| 10 | B. Jobonei | | |
| 11 | W. Zebreeks | 0.3636 | = 8 / 22 |
| 12 | Th. Stankulets | | |
| 13 | V. Augustus | 0.3636 | = 8 / 22 |
| 14 | E. Starck | | |
| 15 | D. Targanovitch | | |
| 16 | R. Hornshnutz | 0.3636 | = 8 / 22 |
| 17 | P.O. Buxitz | | |
| 18 | Fh. Furbenty | | |
| 19 | Du. Poonts | 0.3636 | = 8 / 22 |
| 20 | R. Shteingartz | | |
| 21 | Q. Berts | | |
| 22 | M.N. Shevitz | 0.3636 | = 8 / 22 |

An example of systematic sampling at the second stage of sampling is not provided here, but the calculation would be similar to that in the example given above.

### 11.1.4 Calculating the Overall Probability of Selection

Once the probability of selection at the first and second stages of sampling is calculated, the overall probability of selection for a participant in the sample can be calculated by multiplying the probability of selection at the first stage by the probability of selection at the second stage.

$$f_{ij} = f_{1i} * f_{2ij}$$

When **systematic PPS sampling** is used in the first stage (survey design option 1 or 2), and either **fractional interval systematic sampling** (survey design option 1 only) or **systematic sampling** (survey design option 2 only) is used at the second stage (see Table 5), the formula for the overall probability of selection for a participant *j* in cluster *i* is the following:

$$f_{ij} = f_{1i} * f_{2ij} = \left(\frac{m * B_i}{N}\right) * \left(\frac{b_i}{B_i}\right) = \frac{m * b_i}{N}$$

The following illustrates the calculation of the overall probabilities of selection, continuing the examples above where systematic PPS sampling is used at the first stage of sampling and fractional interval systematic sampling is used at the second stage of sampling (survey design option 1). The calculation is performed for one of the sampled first stage clusters (Glokta) only.

| | | |
|---|---|---|
| Number of clusters selected | $m$ | 4 |
| Total number of participants | $N$ | 350 |
| Number of participants in cluster i | $B_i$ | 22 |
| Number of participants to select in cluster i | $b_i$ | 8 |

| Cluster number | Region | Cluster name | Number of participants | $f_{1i} = (m*B_i)/N$ Probability of selection (first stage) | Participant number | Participant name | $f_{2ij} = b_i/B_i$ Probability of selection (second stage) | $f_{ij} = f_{1i} * f_{2ij}$ Probability of selection (overall) |
|---|---|---|---|---|---|---|---|---|
| 4 | Central Region | Glokta | 22 | 0.2514 | 2 | G. Grafiti | 0.3636 | 0.0914 |
| | | | | | 5 | G. Smithy | 0.3636 | 0.0914 |
| | | | | | 8 | Ch. Shaltitch | 0.3636 | 0.0914 |
| | | | | | 11 | W. Zebreeks | 0.3636 | 0.0914 |
| | | | | | 13 | V. Augustus | 0.3636 | 0.0914 |
| | | | | | 16 | R. Hornshnutz | 0.3636 | 0.0914 |
| | | | | | 19 | Du. Poonts | 0.3636 | 0.0914 |
| | | | | | 22 | M.N. Shevitz | 0.3636 | 0.0914 |

When **fractional interval systematic sampling** is used in the first stage, and **systematic sampling** is used at the second stage (survey design option 2 only; see Table 5), the formula for the overall probability of selection is the following:

$$f_{ij} = f_{1i} * f_{2ij} = \left(\frac{m}{M}\right) * \left(\frac{b_i}{B_i}\right)$$

For survey design option 3, when **fractional interval systematic sampling** is used to select participants directly (the only stage of sampling; see Table 5), the formula for the overall probability of selection for participant *j* is the following:

$$f_j = \frac{b}{B}$$

In this case, because there are no clusters, neither *B* nor *b* depends on *i,* and therefore, both are constants.

For survey design option 4, when **fractional interval systematic sampling** is used at the first stage of sampling and a **take all** strategy is used at the second stage of sampling (see Table 5), the formula for the overall probability of selection is the following:

$$f_{ij} = \frac{m}{M}$$

### 11.1.5 Calculating the Sampling Weights to Account for Probabilities of Selection

At the final step, the sampling weights to account for the probabilities of selection are calculated by taking the inverse of the total probability of selection. For survey design options 1, 2, and 4, the formula is given by:

$$w_{ProbSelection} = w_{ij} = \frac{1}{f_{ij}} = \frac{1}{f_{1i} * f_{2ij}}$$

For survey design option 3, the formula is given by:

$$w_{ProbSelection} = w_j = \frac{1}{f_j}$$

The following illustration demonstrates the computation of the sample weights, continuing the example above where **systematic PPS sampling** is used at the first stage of sampling and **fractional interval systematic sampling** is used at the second stage of sampling (survey design option 1).

| | | |
|---|---|---|
| Number of clusters selected | $m$ | 4 |
| Total number of participants | $N$ | 350 |
| Number of participants in cluster i | $B_i$ | 22 |
| Number of participants to select in cluster i | $b_i$ | 8 |

| Cluster number | Region | Cluster name | Number of participants | $f_{1i} = (m*B_i)/N$ Probability of selection (first stage) | Participant number | Participant name | $f_{2ij} = b_i / B_i$ Probability of selection (second stage) | $f_{ij} = f_{1i} * f_{2ij}$ Probability of selection (overall) | $w = 1/f_{ij}$ Sampling weight |
|---|---|---|---|---|---|---|---|---|---|
| 4 | Central Region | Glokta | 22 | 0.2514 | 2 | G. Grafiti | 0.3636 | 0.0914 | 10.94 |
| | | | | | 5 | G. Smithy | 0.3636 | 0.0914 | 10.94 |
| | | | | | 8 | Ch. Shaltitch | 0.3636 | 0.0914 | 10.94 |
| | | | | | 11 | W. Zebreeks | 0.3636 | 0.0914 | 10.94 |
| | | | | | 13 | V. Augustus | 0.3636 | 0.0914 | 10.94 |
| | | | | | 16 | R. Hornshnutz | 0.3636 | 0.0914 | 10.94 |
| | | | | | 19 | Du. Poonts | 0.3636 | 0.0914 | 10.94 |
| | | | | | 22 | M.N. Shevitz | 0.3636 | 0.0914 | 10.94 |

## 11.2 Adjusting Survey Weights for Non-Response

It is to be expected that some percentage of participants randomly selected for the survey will be unreachable, unavailable, or unwilling to respond to any or all of the survey questions; this is called "individual non-response." The recommended survey protocol is that interviewers return to households up to three times to complete an interview with the selected participants who reside within. Despite the best efforts of interviewers, however, there will always be some residual non-response that remains even after three attempts to complete an interview with the respondent. When non-response happens, adjustments to the sample weights need to be applied to compensate for the non-response.[54]

To calculate the weight adjustments for non-response, the survey must track both the selected participants who do not respond and the selected participants who do respond. Both respondents and non-respondents have probabilities of selection. But because no interview has taken place for the non-responding selected participants, the sample weights of the responding selected participants are inflated to compensate for those who did not respond.

The weight adjustment for non-response for survey design options 1, 2, and 4 is calculated as:

$$w_{non\text{-}response} = \frac{sum\ of\ w_{ProbSelection}\ over\ participants\ selected\ to\ be\ interviewed\ (in\ a\ sampled\ cluster)}{sum\ of\ w_{ProbSelection}\ over\ participants\ actually\ interviewed\ (in\ a\ sampled\ cluster)}$$

For survey design options 1, 2, and 4, a weight adjustment for non-response should be calculated individually for each sampled cluster. The weight adjustments for non-response will vary among clusters given that clusters will likely experience different non-response rates. However, for all survey respondents in a particular sampled cluster, the same weight adjustment for non-response can be used. After the weight adjustment is made, the records for the non-responding sampled participants can be dropped for the purposes of analysis.

For survey design option 3, a similar adjustment to the one above is made, but at the overall level instead of at the cluster level.

[54] Note that sometimes a sampled participant may provide data for some of the indicators and not for others. In this case, the participant is deemed a "partial respondent" and the missing data points are called "item non-responses." Sometimes the missing data points for the participant are "imputed" using special statistical methods. However, if the number of missing data points is not large, a common practice is to leave the missing data points blank and to compute the indicators without the inputs from the missing respondent(s). Because a discussion on methods of imputation is beyond the scope of this guide, it is assumed that the latter strategy will be adopted for implementers of PaBSs.

The following illustrates this, continuing the above example where clustering is involved.

| | | | |
|---|---|---|---|
| Number of participants in cluster i | $B_i$ | 22 | |
| Number of participants selected to be interviewed in cluster i | $b_i$ | 8 | |
| Number of participants who do not respond (not found, not present or who refuse) | NR | 1 | |
| Number of participants interviewed | $b_i$ - NR | 7 | |
| Weight adjustment to compensate for non-response | $w_{non\text{-}response}$ | 1.143 | = (8*10.94) / (7*10.94) |

## 11.3 Calculating the Final Sampling Weights

For all four survey design options, the final sample weights to be used in all data analysis are calculated by multiplying the sample weights (inverse of the probabilities of selection) by the weight adjustment for non-response:

$$w_{final} = w_{ProbSelection} * w_{non\text{-}response}$$

The illustration below demonstrates this computation, using the example above where systematic PPS sampling is used at the first stage of sampling and fractional interval systematic sampling is used at the second stage of sampling (survey design option 1). In this example, of the eight participants selected for sampling, one does not respond (participant #5, G. Smithy), and the non-respondent record is dropped. After the non-response adjustment is made, the resulting final sample weight is applied to each responding participant who was sampled and only the results of responding participants are used in the analysis of the data.

| | | |
|---|---|---|
| Number of clusters selected | *m* | 4 |
| Total number of participants | *N* | 350 |
| Number of participants in cluster i | $B_i$ | 22 |
| Number of participants selected in cluster i | $b_i$ | 8 |
| Number of participants who did not respond in cluster i | *NR* | 1 |
| Number of participants interviewed in cluster i | $b_i$ - *NR* | 7 |

| | | | | $f_{1i} = (m*B_i) / N$ | | | $f_{2ij} = b_i / B_i$ | $f_{ij} = f_{1i} * f_{2ij}$ | $w = 1 / f_{ij}$ | $w_{non\text{-}response}$ | $w_{final}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cluster number | Region | Cluster name | Number of participants | Probability of selection (first stage) | Participant number | Participant name | Probability of selection (second stage) | Probability of selection (overall) | Sampling weight for probabilities of selection | Sampling weight for non-response | Final sampling weight |
| 4 | Central Region | Glokta | 22 | 0.2514 | 2 | G. Grafiti | 0.3636 | 0.0914 | 10.94 | 1.143 | 12.50 |
| | | | | | ~~5~~ | ~~G. Smithy~~ | ~~0.3636~~ | ~~0.0914~~ | ~~10.94~~ | ~~1.143~~ | ~~12.50~~ |
| | | | | | 8 | Ch. Shaltitch | 0.3636 | 0.0914 | 10.94 | 1.143 | 12.50 |
| | | | | | 11 | W. Zebreeks | 0.3636 | 0.0914 | 10.94 | 1.143 | 12.50 |
| | | | | | 13 | V. Augustus | 0.3636 | 0.0914 | 10.94 | 1.143 | 12.50 |
| | | | | | 16 | R. Hornshnutz | 0.3636 | 0.0914 | 10.94 | 1.143 | 12.50 |
| | | | | | 19 | Du. Poonts | 0.3636 | 0.0914 | 10.94 | 1.143 | 12.50 |
| | | | | | 22 | M.N. Shevitz | 0.3636 | 0.0914 | 10.94 | 1.143 | 12.50 |

CHAPTER

# 12. Producing Estimates of Indicators of Totals

After producing final sample weights to be used in data analysis, the next step is to produce estimates for the agriculture-related annual monitoring indicators that are the focus of this guide, as well as for any of the other Feed the Future annual monitoring indicators for which data were collected through the PaBS. As mentioned earlier, three of the four agriculture-related annual monitoring indicators are totals: "Value of Sales," "Number of Hectares under Improved Management Practices," and "Number of Individuals Using Improved Management Practices." A description of how to produce estimates of these indicators of totals is provided in this chapter. The fourth agriculture-related annual monitoring indicator, "Yield of Agriculture Commodities," can be expressed as a ratio of totals and each of the component totals can be estimated separately, or the indicator can be treated as a mean and estimated as such. In this chapter, the yield indicator is treated as a ratio of totals and a description is provided on how to produce estimates of the component totals. In Annex 4, a description of how to produce estimates of indicators of means is provided; this method can be used if survey implementers wish to produce an overall estimate of the "Yield of Agriculture Commodities" indicator directly.

The aim of PaBSs is to facilitate the production of estimates that represent the entire population of participants, not just the participants in the survey sample. To do so, the sample weights are used to "inflate" the data from each of the sampled participants who responds, so that a sample-weighted sum of the data from the surveyed participants provides an estimate of the total (relating to the indicator in question) for the entire population of participants. The formula for an estimate of a population total is:

$$estimate\ of\ population\ total = t = sum(w_{final_i} * \ y_i)$$

where:

$w_{final_i}$ = value of $w_{final}$ (the final sampling weight) for the *ith* sampled participant

$y_i$ = the value of $y$, the contribution to the indicator (or data point), for the *ith* sampled participant

For example, to produce an estimate for the "Number of Hectares under Improved Management Practices" indicator for the entire survey population of participants, $y_i$ represents the number of hectares under improved technologies for survey respondent *i*. This value is multiplied by the corresponding final sampling weight ($w_{final_i}$) for respondent *i*. The same is done for all other survey respondents, and then these multiplied values are summed across all survey respondents to produce an estimate of the population total (*t*).

It can be complicated and time consuming to compute estimates of totals for all annual monitoring indicators required by Feed the Future, and therefore survey implementers should use a statistical software package, such as SAS, SPSS, or STATA, to generate the estimates.

## 12.1 Producing Estimates for the Four Indicators

Estimates for the "Value of Sales," "Number of Hectares under Improved Management Practices," and "Number of Individuals Using Improved Management Practices" indicators are produced by a direct application of the formula given at the beginning of this chapter, using one of the software packages mentioned earlier.

The fourth indicator, "Yield of Agricultural Commodities," includes two distinct components or data points, as defined in Section 2.1. Each of the two components that comprise the "Yield of Agricultural Commodities" indicator is itself a total, and therefore each component should be estimated using the formula that integrates the sample weights provided at the beginning of this chapter.

Once sample-weighted estimates of each of the components are produced through one of the software packages, the estimates should be individually entered into the FFPMIS or the FTFMS. Once all inputs are entered, the FFPMIS and FTFMS systems will automatically produce estimates for the "Yield of Agricultural Commodities" indicator.

It is important to note that Feed the Future FFP and non-FFP IPs are required to compute and report in the FTFMS and FFPMIS systems only on the two data points for the "Yield of Agricultural Commodities" indicator. They are not required to produce estimates of this indicator directly, but should do so for their own internal monitoring and target-setting purposes (see Annex 4).[55]

## 12.2 Comparing Indicator Values of Totals over Time

Because Feed the Future IPs tend to increase the number of participants in their projects in the first few years of project implementation, and then decrease the number of participants as they phase out the project in the last year, for most Feed the Future projects, the pool of participants for one year is not the same as the pool of participants for any other year. This introduces a challenge when attempting to compare any of the annual monitoring indicator values of totals over time.

For instance, if we observe that the "Number of Individuals Using Improved Management Practices" indicator increased from one year to the next, it is not clear whether the increase was due to an improved adoption rate among participants or to an expansion of the number of direct participants in the project between the two years. Although the underlying intention of the indicator is to be able to track increased adoption rates, it is difficult to tease out this component directly. Therefore, IPs should carefully interpret the comparison of results over time, taking into account the number of participants in any given year, to be able to identify the trend of true interest. One way of doing this is to compute the average value per participant by dividing the estimate of the total by the weighted total number of participants; the average values (which are considered indicators of means) can easily be computed and compared over time.

[55] Feed the Future IPs are required to set targets for the yield indicator in FTFMS and FFPMIS; however, they are not required to set targets for the component data points.

CHAPTER

# 13. Producing Confidence Intervals and Standard Errors Associated with the Indicators of Totals

An important step in data analysis is calculating confidence intervals and standard errors for all estimates where the data have been collected through a PaBS. A confidence interval is a measure of the precision of an estimate and is expressed as a range of numbers that have a specific interpretation. A standard error is an alternative measure of precision of the estimates of the indicators. It quantifies how precisely the true value of the indicator is known and takes into account the value of the standard deviation, as well as the values of the actual sample size and the population size.[56] Although the reporting of confidence intervals and standard errors is not required by the FFPMIS or FTFMS, Feed the Future IPs should produce them and include them in their annual monitoring documentation, to provide a measure of the level of precision of the estimates of indicators produced. This chapter focuses on the production of confidence intervals and standard errors for indicators of totals. (Annex 4 does the same for indicators of proportions and means.)

Survey implementers should use a specialized statistical software package that can take into account the complex design features of PaBSs, such as clustering and unequal probabilities of selection, to generate the confidence intervals and standard errors. The most widely used statistical software packages are SAS, SPSS, and STATA. Each of these packages has its own specialized syntax for entering information on complex survey design features (such as clustering and sample weights) that permits the production of survey-based estimates of totals, along with their associated confidence intervals and standard errors. It is critical that the correct syntax for complex survey designs be used, and therefore users should thoroughly familiarize themselves with such software before undertaking any data analysis. See Table 6 for details on some statistical software packages that can be used.

### Table 6. Statistical Software Packages for the Analysis of Complex Survey Data

| Statistical software package | For analyses of complex survey data, use… |
|---|---|
| SAS | Specialized survey procedures (e.g., PROC SURVEYMEANS) |
| SPSS | SPSS Complex Samples module |
| STATA | *svyset* and *svy:total* syntax |

[56] A distinction should be made between the standard deviation of a distribution and the standard error of an estimate. The standard deviation is defined at the level of the participant and quantifies "scatter" by describing how individual data points vary from one another across the distribution of participant values. The standard error provides a measure of precision for the estimate (of an indicator) and is a companion measure to the confidence interval.

## 13.1 Calculating Confidence Intervals and Standard Errors Associated with Estimates of Totals

The formula to calculate a confidence interval with a confidence level of 95% for the estimate of a total (denoted by $t$) is the following:

$$CI_{total} = estimate\ of\ total\ (t) \pm \left( z * \left( \frac{\sqrt{D_{actual}} * s_{actual}}{\sqrt{n_{actual}}} \right) * N \right)$$

where:

$t$ = the sample-weighted estimate of the total (discussed in Chapter 12)
$z$ = the critical value from the Normal Probability Distribution (discussed in Section 9.2.2)
$D_{actual}$ = the design effect for the survey computed from the survey data
$s_{actual}$ = the standard deviation computed from the survey data
$n_{actual}$ = the actual sample size realized after fieldwork
$N$ = the total number of participants (discussed in Section 9.2.2)

For a confidence level of 95%, the corresponding critical value, $z$, is equal to 1.96. Survey implementers should use a confidence level of 95% (and a critical value of 1.96) for calculating confidence intervals, although values for critical value based on other confidence levels can be found from tables, statistical software, and spreadsheet software (such as Microsoft Excel).

In terms of the design effect for the survey, recall that an estimate of the design effect, $adj_{design\ effect}$, is used as an adjustment in the calculation of the target sample size ($n_{final}$), as discussed in Section 9.2.3. In contrast, the design effect that should be used in the computation of the confidence interval in the formula above is one that is computed by the statistical software using data from the fieldwork; it is denoted by $D_{actual}$.

In terms of the standard deviation of the distribution, recall that an estimate of the standard deviation, $s$, used in the calculation of the target sample size ($n_{final}$) is discussed in Chapter 9. In contrast, the standard deviation that should be used in the computation of the confidence interval in the formula above is one that is computed by the statistical software using data from the fieldwork; it is denoted by $s_{actual}$.

In the above formula, $n_{actual}$ represents the actual sample size realized after fieldwork. This is in contrast to $n_{final}$, described in Section 9.2.4, which is the target sample size calculated prior to fieldwork and which takes into account the anticipated non-response. The two sample sizes—$n_{actual}$ and $n_{final}$—differ in that $n_{actual}$ will typically be somewhat lower than $n_{final}$ given that some non-response may be encountered in the field.

The formula to calculate the standard error associated with the estimate of a total, $t$, is the following:

$$standard\ error(t) = SE(t) = \left( \frac{\sqrt{D_{actual}} * s_{actual}}{\sqrt{n_{actual}}} \right) * N$$

Both the confidence interval and the standard error associated with the estimate of the total should be reported as measures of precision of the estimate. As discussed in the previous chapter, estimates of the confidence intervals and standard errors should not be computed using formulas found in spreadsheet software, such as Microsoft Excel. Rather, statistical software (such as SAS, SPSS, and STATA) should be used to produce confidence intervals and standard errors, so that elements of the complex survey design are appropriately taken into account. The formulas given above are provided to give the reader a sense of the computations undertaken by the statistical software packages. Alternatively, users can use the statistical software to produce values for the inputs to the above formulas (i.e., $D_{actual}$, $s_{actual}$, and $t$), and then plug these inputs directly into the above formulas to obtain values for $CI_{total}$ and $SE(t)$.

## 13.2 Interpreting Confidence Intervals

The interpretation of a confidence interval is nuanced and is illustrated through the following example. Suppose the estimate for the "Number of Hectares under Improved Management Practices" indicator is 63,300 hectares and suppose that a 95% confidence interval for the estimate of the indicator is (60,622; 65,978).

The correct way to interpret the above confidence interval is as follows: If a large number of surveys was repeatedly conducted on the same participant population and if confidence intervals were calculated for each survey conducted, 95% of the confidence intervals would contain the true value of the indicator representing the entire population. The confidence interval from the given sample is one such interval.

This does **not** mean that the probability is 0.95 that the true value of the total number of hectares for the population is contained in the interval (60,622; 65,978). This is often incorrectly used as the interpretation for such a confidence interval.

## 13.3 An Example of Calculating a Confidence Interval and a Standard Error for an Estimate of a Total

The example below illustrates the computation of a confidence interval and a standard error for an estimate of the "Number of Hectares under Improved Management Practices" indicator. We assume a population of participants of size *N* = 30,000. We also assume that data from a PaBS with an actual sample size of $n_{actual}$ = 450 and a design effect of $D_{actual}$ = 2.5 is used to compute a sample-weighted estimate of total (*t* = 63,300) and an associated actual standard deviation ($s_{actual}$ = 0.611).[57] A 95% confidence interval around *t* = 63,300 is then given by (60,622; 65,978) and the standard error of the estimate is computed as 1,366.

[57] Although the figure of $s_{actual}$ = 0.611 may seem small relative to the other figures, recall that the standard deviation is defined at the level of the participant and it describes how the individual values vary from one another.

| | | | |
|---|---|---|---|
| Survey-weighted estimate of total hectares under improved management practices | t | 63,300 | *= derived from survey data* |
| Standard deviation | $s_{actual}$ | 0.611 | *= derived from survey data* |
| Total number of participants | N | 30,000 | |
| Sample size | $n_{actual}$ | 450 | |
| Confidence level | CL | 0.95 | |
| Z statistic | $z$ | 1.96 | |
| Design effect | $D_{actual}$ | 2.5 | |

**CONFIDENCE INTERVAL(CI) AND STANDARD ERROR**

CI: Lower limit = LL

$$60{,}622 = t - \left(z_{0.95} * \frac{\sqrt{D_{actual}} * s_{actual}}{\sqrt{n_{actual}}} * N\right) = 63{,}300 - (1.96 * \frac{\sqrt{2.5} * 0.611}{\sqrt{450}} * 30{,}000)$$

CI: Upper limit = UL

$$65{,}978 = t + \left(z_{0.95} * \frac{\sqrt{D_{actual}} * s_{actual}}{\sqrt{n_{actual}}} * N\right) = 63{,}300 + (1.96 * \frac{\sqrt{2.5} * 0.611}{\sqrt{450}} * 30{,}000)$$

CI: (Lower limit, Upper limit) = (LL, UL) (60,622, 65,978)

Standard Error of the Estimate

$$1{,}366 = \frac{\sqrt{D_{actual}} * s_{actual}}{\sqrt{n_{actual}}} * N = \frac{\sqrt{2.5} * 0.611}{\sqrt{450}} * 30{,}000$$

## 13.4 Calculating Confidence Intervals and Standard Errors for the "Yield of Agricultural Commodities" Indicator

Because the "Yield of Agricultural Commodities" indicator is a ratio of two components both of which are totals, the computation of associated confidence intervals and standard errors of the overall estimate of the indicator is complex. Therefore, if survey implementers desire estimates of confidence intervals and standard errors for this indicator, they should treat the indicator as a mean and follow the guidance in Annex 4 on how to do so. Note, however, that it is possible to compute confidence intervals and standard errors for each of the two component totals separately using the methods described in this chapter.

# ANNEXES

ANNEX

# Annex 1. Scope of Work Template for Participant-Based Survey

## Scope of Work for External Contractor

Participant-based survey for annual monitoring
Name of Project, Name of Country
Date of issue

## 1. BACKGROUND

**Background and objectives of project**
Provide context that covers the origin and evolution of the project, including the start and end dates and number of years in operation. Broadly state the project's goal, objectives, and expected outcomes; the strategies it is following; and the type of interventions it is undertaking to meet its objectives. Finally, include information on the donor and funding level of the project.

**Geographic scope of project**
Indicate the geographic scope of the project and how this has changed in the past or is expected to change in the future, in addition to the number of participants reached.

**Project stakeholders**
Provide background information on the respective roles of all project stakeholders.

**Previous surveys**
Identify any previous participant-based surveys, whether done internally or by other organizations, which covered the same (or similar) topics for the same (or similar) participant populations in the same (or similar) geographic area. Indicate whether reports are publicly available, and provide the title and source (including web address) of the reports.

## 2. SCOPE OF WORK

State that the survey to be conducted should be participant-based and that the contractor will be responsible for the following aspects of the survey (although this can be modified to include or exclude any of these components, should the decision be made to undertake some of these in-house instead):

a. Survey design/sampling plan
   - Sample size calculation
   - Clustering and selection of units at each stage of sampling
   - Specification of methodology for selecting participants at the final stage

b. Questionnaire development
   - Development of questionnaire instrument(s)
   - Pre-testing, finalizing, and translating questionnaire(s) into local languages
   - Printing of questionnaires

c. Equipment and logistics
    - Provision of all necessary field equipment (tablets, GPS units, etc.)
    - Securing of office and computer equipment for survey management and data entry
    - Arranging for transportation, lodging, and equipment for fieldwork

d. Data collection
    - Recruitment of fieldwork staff (interviewers, supervisors, data entry staff)
    - Development of training guide for interviewers
    - Training of interviewers and supervisors, conducting pre-test of questionnaire and pilot of field operations
    - Design and oversight of listing operations (if applicable)
    - Conducting and overseeing of data collection

e. Data entry and data cleaning
    - Development of data entry software and data entry protocols (latter only required for paper-based data collection)
    - Development of quality control measures for data entry and data cleaning
    - Data cleaning to ensure logic and consistency checks

f. Data analysis, production of estimates, and report writing
    - Calculation and use of sampling weights
    - Production of estimates and disaggregates of indicators that ensure complex sample design taken into account
    - Production of confidence intervals and standard errors of indicator estimates
    - Submission of report with findings
    - Submission of documented data sets where the identity of individual participant respondents has been anonymized or otherwise had their confidentiality protected

Also list the topics from above for which the contractor will not be responsible.

## 3. SURVEY OVERVIEW

**Survey objective(s)**
Describe the main objective(s) of the survey.

**Survey type**
It should be made clear to the contractor that this is a descriptive survey of participants in support of annual monitoring.

**Geographic scope of survey**
Provide the location names, administrative units, and other pertinent details on the geographic area that the participant-based survey will cover. Indicate if the scope of the survey differs from the scope of the project.

**Survey population of participants**
Provide a written description of the participant population (e.g., direct participants living in a particular district). Provide a total overall number for the survey population in villages, producer groups, and/or other units. Also provide the source(s) from which these totals were taken.

**List of Feed the Future annual monitoring indicators to be reported on through the participant-based survey**

A list of Feed the Future annual monitoring indicators (as well as any custom indicators) for which underlying data are to be collected through the participant-based survey should be provided to the contractor. These should include, at a minimum, the four challenging indicators that are the focus of this guide. The PIRSs associated with these indicators should be provided to the contractor as well. (The complete set of Feed the Future IM indicators and their PIRSs can be found in the publication *Feed the Future Indicator Handbook*, which is located at https://www.agrilinks.org/post/feed-future-indicator-handbook.)

**Main audience of survey**

The main intended audience for the survey report should be indicated.

**Expected dates and duration of consultancy**

The expected time frame and duration of the contract should be specified. Refer to the section on "Work Plan" in Section 7 of this scope of work.

## 4. SURVEY DESIGN/SAMPLING PLAN

**Indicators to be used as basis for sample size calculations**

Indicate the key indicators (preferably no more than five and including the three suggested earlier in this guide) that will serve as a basis for the sample size calculation. Also state if any data exist on the current value of each of the key indicators within the target populations (from a survey conducted by another organization, for example). Specify the levels of disaggregation required for which indicator estimates must be produced.[58]

**Sample size calculation**

If the sample size calculation is to be produced by the contractor, this should be stated. In this case, the project should provide to the contractor all relevant inputs for such computations (e.g., number of population participants and targets for indicators, as well as any relevant information from prior surveys [if it exists], such as values of indicators and standard deviations, the design effects, and the non-response rates/response rates). The project can opt to specify the desired level of confidence (e.g., 95%), as well as the acceptable percentage error (p) for the MOE, or the project can leave the specification of these parameters to the contractor.

**Sampling frame(s) and coverage for participant-based survey**

Describe the lists from which participants will ultimately be selected.

Frame of Clusters: If cluster sampling is to be used, describe the lists of geographic units that will be used (e.g., villages/communities or producer groups). In the case that survey design option 1 or 2 is to be used, it should be stated that a complete list of implementation clusters (villages or communities) will be provided to the contractor. If survey design option 4 is to be used, it should be stated that a complete list of producer groups will be provided to the contractor.

[58] It should be made clear to the contractor that separate sample size calculations for the various required disaggregates for Feed the Future annual monitoring indicators need not be undertaken. The one exception to this is the "Yield of Agricultural Commodities" indicator by commodity type – as noted in Section 9.2.2.

Frame of Participants: In the case that survey design option 1, 3, or 4 is to be used, then a complete, comprehensive, and up-to-date list of participants should be provided to the contractor for the second stage of sampling. If survey design option 2 is to be used, it should be stated that a complete list of participants does not exist and that a listing operation will be required to create such a list as part of survey taking.

Finally, specify whether the lists provided cover the entire participant population. If not, specify the areas/participants that are not covered by the lists.

**Sample selection**
If the contractor will be responsible for developing the sample design, state that the contractor should select units at each stage of sampling in accordance with the possible options below:

***Household survey approach***

- Survey design option 1 – two-stage cluster design with systematic selection of participants
- Survey design option 2 – two-stage cluster design with listing operation and systematic selection of participants
- Survey design option 3 – one-stage design with systematic selection of participants

***Producer groups approach***

- Survey design option 4 – two-stage cluster design with "take all" selection of participants

**Sampling weights and the treatment of non-response**
It should be specified that the contractor is expected to produce sampling weights for each participant record on the sampling file to be used in the analysis of data. In addition, the contractor should make adjustments to the final weights to compensate for any residual non-response encountered at the participant level.

**Production of indicator estimates**
The final report should include tables with the following information for each indicator:

| Indicator Name or Data Point[a] | Level of Reporting (overall or disaggregate)[b] | Value of Indicator | Standard Error of Indicator | Confidence Interval | | Design Effect | Number of Cases | | Estimated Number of Participants[c] |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Lower Limit | Upper Limit | | Number of Respondents in Survey | Number of Non-Respondents in Survey | |
| | | | | | | | | | |

[a] Both the overall indicator and associated component data points (when relevant) should be reported.

[b] Indicators should be reported at the overall level and at every required level of disaggregation.

[c] The estimated number of participants can be computed using the sample-weighted number of respondents in the survey.

## 5. SURVEY QUESTIONNAIRE(S)

**Questionnaire development**
State whether a questionnaire has already been drafted, or whether the contractor will need to develop a new questionnaire for the survey. If a questionnaire from a prior survey is to be used as a basis for development for the questionnaire, it should be provided along with details regarding estimated time per completed questionnaire module or interview. If the contractor needs to develop a new questionnaire from scratch, a list of indicators for which questions must be developed should be provided, along with their associated PIRSs.

**Translation of questionnaire**
State whether the questionnaire needs to be translated or whether a translation will be undertaken by the project. Explain who will be responsible for engaging the translation service and funding translation costs, and whether forward- and backward-translation is required. Make sure that translation time is taken into account in the work plan.

**Pre-testing and finalization of questionnaire**
State if field pre-testing is required to test the flow, filters, and skip patterns in the questionnaire. Give any known details on pre-testing: expected duration, pre-testing sites, choice of pre-test respondents, and number of pre-tests required, as well as the timeline for questionnaire finalization.

## 6. FIELDWORK OPERATIONS

**Human resources for fieldwork**
State the human resource requirements for fieldwork by position, including both those that will be provided by the organization and those that will be provided by the contractor. State the expected level of education and/or experience, as well as their employment status (volunteer, employee, etc.).

**Listing operation(s)**
Provide necessary details on expectations relating to listing operation(s) (survey design option 2 only), such as how much information on each participant should be collected and whether GPS information on the participant dwellings and/or clusters is required as well. Specify whether GPS equipment will be provided by the project or by the contractor. Indicate if the contractor will need to produce any maps during the listing exercise.

**Training of interviewers**
Provide details on the expectations relating to the training of interviewers, including expected duration and expected types of activities (e.g., piloting field operations, pre-testing of questionnaire).

**Mode of data collection**
The preferred mode of data collection should be specified in the scope of work.

- Personal interviews with paper questionnaires
- Personal interviews with PDAs (personal digital assistants) or other computer-assisted collection
- Other (please specify)

**Data entry**
If data collection is paper-based (rather than tablet-based), state whether the contractor will be responsible for providing a system to input and manage data entry, and whether there are any specific hardware or software requirements. State if double data entry is expected. State any expected quality control mechanisms that the contractor will need to put in place to ensure consistency and logical coherence of the data during data cleaning.

## 7. WORK PLAN, DELIVERABLES, AND DISSEMINATION

**Work plan**

The contractor should submit a plan of activities, the following table of which is an example. A Gantt chart can also be used in place of a table.

| Activities | Number of Days | Expected Dates | Person(s) Responsible |
|---|---|---|---|
| 1. Desk review and discussions with project staff | 2 | | |
| 2. Develop and submit an inception report for approval, which should include the following:<br>• work plan<br>• survey design/sampling plan, including sample size calculations<br>• data treatment (including quality control measures) and analysis plan | 10 | | |
| 3. Develop survey instrument(s) and translate into relevant local languages | 10 | | |
| 4. Develop data entry system designed for survey, as well as data entry protocols and specifications (in case of paper-based data collection) | 10 | | |
| 5. Recruit interviewers and supervisors | 30 | | |
| 6. Develop training agenda and materials (and translate) | 10 | | |
| 7. Train interviewers and supervisors | 5 | | |
| 8. Pre-test and finalize survey instrument(s) | 5 | | |
| 9. Oversee listing operation(s) | 5 | | |
| 10. Pilot field operations and collect data | 20 | | |
| 11. Enter, clean, and analyze data | 10 | | |
| 12. Prepare table of indicator estimates and write short report | 10 | | |
| 13. Prepare data set for submission | 5 | | |

**Deliverables**

The contractor should be given a set of expected deliverables and their deadlines. Indicate the language required for all deliverables and what role, if any, the contractor is expected to play in translations or reviews of translated text. Also state any page limitations. The following is an example of a set of deliverables:

| Deliverables | Expected Deadline |
|---|---|
| 1. Inception report (which includes the work plan, survey design/sampling plan, and data treatment and analysis plan) | |
| 2. Finalized survey instrument(s), in English and in relevant local language(s) | |
| 3. Training manual(s) for field staff, in English and in relevant local language(s) | |
| 4. All data files in SAS, SPSS, or STATA format (sampling frame[s], raw data sets, transformed data sets and syntax, edit rules, code book/data dictionary, sampling weights). The data sets must have all personally identifiable information removed. A version of the data sets must be provided in CSV format in accordance with the USAID Open Data Policy; data sets should not be provided in a format generated by proprietary software. | |
| 5. Tables of indicator estimates along with their confidence intervals and standard errors; short report | |

## 8. LOGISTICS AND REPORTING

**Logistics and administrative support**

The scope of work should indicate any requirements that have a bearing on costs (such as travel) and state who will finance them. It should be clear on the extent to which any human resources (e.g., translator, driver) or logistical support (e.g., computers, office space, vehicles) will be provided free of charge to the contractor.

**Reporting relationships**

The name and title of the designated survey manager within the Feed the Future project to whom the contractor will report should be stated.

**Language on future use of data**

Within the scope of work, language should be included to the following effect: “The completed data set will be the sole property of USAID. The contractor may not use the data for its own research purposes, nor license the data to be used by others, without the written consent of USAID.” Precise wording can be crafted in consultation with USAID.

## 9. OBLIGATIONS OF KEY PARTICIPANTS IN SURVEY

It is useful to detail the obligations of each party in the survey to set realistic expectations and accountabilities. The following is an example.

**Contractor**

a. Inform the Feed the Future survey manager in a timely fashion of progress made and of problems encountered.

b. Implement the activities as expected, and, if modifications are necessary, bring them to the attention of the Feed the Future survey manager before enacting any changes.

**Feed the Future project survey manager**

a. Ensure that the contractor is provided with the specified documents and adequate human resources and logistical support.
b. Facilitate the work of the contractor with participants and other local stakeholders.
c. Answer day-to-day enquiries, monitor the daily work of the contractor, and flag concerns.

**Feed the Future project technical staff**

a. Review and approve the proposed methodology.
b. Provide technical oversight in the review of all deliverables.
c. Provide timely comments on any draft reports.

## 10. REQUIRED QUALIFICATIONS OF CONTRACTOR

The scope of work should state the required qualifications expected for all key positions and how this information should be presented in the bid or proposal. Any language or diversity requirements that factor into the selection decision should be indicated. Illustrative examples of job descriptions for key survey team members can be found in Annex 2.

## 11. SUBMISSION OF PROPOSALS

**Proposal submission details**

The scope of work should be clear on which documents to submit, how proposals should be submitted (by email, uploading to website, regular post, etc.), and to whom to address proposal submissions. The exact date and time deadline (with time zone) for receiving bids should be given. It should be clearly specified that any bids received after the deadline will not be considered.

**Proposal outline**

A suggestive format for the proposal is outlined below:

**a. Background**: Brief background about the objectives of the study should be included in the proposal.

**b. Work plan**: The proposal should clearly mention details of each and every activity, including those mentioned in the work plan in Section 7.1 of this scope of work. The timeline and person(s) responsible for each activity should be clearly stated.

**c. Survey design/sampling plan**: The proposal should provide information on the overall survey design, covering an overview of the treatment of all of the items in Section 4 of this scope of work.

**d. Training**: The proposal should state who will be responsible for training interviewers and supervisors, and should describe the topics covered, expected duration, and logistic and administrative support needed.

**e. Field team**: There should be a clear indication in the proposal of the number of individuals needed for data collection and listing operations, by position.

f. **Quality control mechanisms during data collection**: The proposal should provide a section that details the mechanisms that will be put in place to ensure data quality, clearly specifying steps for data validation. This section may also include supervisory mechanisms for data quality and the role of field editors.

g. **Data entry and processing plan**: This section of the proposal should clearly state details on data entry (if paper-based data collection is used), validation (logical and consistency) checks, and other data-processing activities.

h. **Data analysis and report writing**: The proposal should provide details on the analyses that will be carried out and the person/people responsible for data analysis and the writing of the summary report.

i. **Contractor division of labor**: There should be a section of the proposal that provides information on key professionals and their level of effort for the different activities of the survey. An illustrative matrix is provided below:

| | Level of Effort (number of days) | | | | | | |
|---|---|---|---|---|---|---|---|
| Name | Sampling Plan | Instrument Development | Training | Data Collection | Data Entry and Cleaning | Data Analysis | Short Report (including tables of indicator estimates) |
| | | | | | | | |

j. **Contractor Expertise**: This section of the proposal should highlight past experience of the contractor in conducting similar surveys, preferably with complex sample designs and in developing countries. The section should mention names, qualifications, and experiences of all persons who would be involved in various aspects of conducting the survey.

k. **Progress updates:** This section of the proposal should clearly indicate the mechanism that will be used to communicate with the Feed the Future survey manager in providing regular updates on field activities, coverage rate, data entry status, etc.

**Detailed Budget**: There are three approaches that can be taken concerning the budgeting of the evaluation:

- No budget is specified and bidders are requested to provide both technical and financial proposals. In this case, bidders can specify a preferred methodology, estimate its costs, and have control over their ability to meet the deliverables.
- The project specifies a maximum budget in the scope of work and the bidders are requested only to provide technical proposals. Bidders are expected to match their proposed methodology and work plan to the budget.
- The project specifies a maximum budget in the scope of work and invites both technical and financial proposals to see if the contractor has a good understanding of how much it will cost to carry out the needed tasks and if funds can be economized. However, bids will not usually come in for much less than the maximum budget specified, and selection will usually be on the basis of the quality of the technical proposal.

Under the first option, a wider range of proposed methodologies may be received, although some may exceed the maximum amount budgeted for the survey. Under the second and third options, the Feed the Future IP can more directly control the budget, but in some cases this approach may lead to a lower number of proposals and/or proposed methodologies that are suboptimal in terms of rigor or scope.

If a budget is required as part of the proposal, it should provide the estimated budget for each activity, clearly mentioning rates and how rates are estimated. Possible line items are suggested below:

a. Daily rate of key professionals
b. Travel costs
c. Training costs
    i. Listers/mappers, supervisors, interviewers, data editors
    ii. Instrument pre-testing and field operations piloting costs
    iii. Other costs
d. Field expenses
    i. Payment of field staff (e.g., listers/mappers, supervisors, interviewers, data editors)
    ii. Travel cost of field staff during data collection (e.g., accommodations, per diems)
    iii. Other costs (e.g., printing of questionnaires, vehicles, GPS equipment, PDAs/tablets)
e. Data entry (including laptops and computer software)
f. Data cleaning, analysis, and report writing
g. Preparation of data sets for sharing
h. Other costs

## 12. SELECTION PROCESS

The selection process and the criteria (along with relative weightings of each of the criteria) that will be used should be described.

**Questions from bidders**

Before the deadline for receiving bids has passed, a clear protocol should be developed on how to accept and respond to questions from potential bidders. Answering questions from potential bidders will likely increase the quality of received proposals. Typically, a clear deadline is specified by which any questions must be submitted (and to whom they should be addressed), and an indication is also given regarding when responses will be provided. A specified process should be put in place through which questions are collected during a certain time period, typically using an online mechanism where bidders do not need to reveal their identities to other bidders. Answers should then either be posted online or sent by email to all bidders.

# Annex 2. Illustrative Job Descriptions for Key Survey Team Members

## SURVEY TEAM LEADER

1. Postgraduate degree from a recognized university in development studies, project management, project monitoring and evaluation, or other relevant field of study
2. Minimum of 5 years of experience in a *senior* management position for an international development organization
3. Prior experience leading at least two large-scale, complex participant-based or household surveys (preferably in resource-constrained environments)
4. Demonstrated expertise in managing budgets, staff, logistics, contracting, and other support staff issues
5. Strong experience in partnering and interacting with international multinational donors and in-country governmental authorities
6. Excellent interpersonal, presentation, and communication skills, and a demonstrated ability to deliver a high-quality product
7. Prior professional experience in country or region preferred
8. Fluency in English (or French for Francophone countries or Spanish for Spanish-speaking countries, etc.) required; fluency in relevant local language(s) an advantage

## SENIOR SURVEY SPECIALIST

1. Postgraduate degree from a recognized institution relating to survey methodology, statistics, monitoring and evaluation, or social sciences research
2. Experience designing and leading the implementation of large-scale, clustered, multistage participant-based or household surveys (preferably in resource-constrained environments)
3. Experience developing survey inception reports and work plans, and in managing the administrative, logistical, and budgetary functions of large-scale surveys
4. Experience developing, overseeing translations of, pre-testing, and finalizing survey instruments
5. Experience in developing survey training materials and data collection manuals (for supervisors and interviewers)
6. Experience in overseeing data entry (for paper-based data collections) and editing processes
7. Expertise analyzing complex survey data (including calculating sampling weights); strong knowledge of at least one statistical software package (SAS, SPSS, STATA, etc.)

8. Experience presenting survey results to high-level project stakeholders
9. Prior experience with surveys with similar purpose, mode, and populations strongly preferred
10. Prior professional experience in country or region preferred
11. Fluency in English (or French for Francophone countries, or Spanish for Spanish-speaking countries, etc.) required; fluency in relevant local language(s) an advantage

**FIELD OPERATIONS MANAGER**

1. Undergraduate degree from a recognized institution
2. Experience supervising fieldwork for large-scale participant-based or household surveys (preferably in resource-constrained environments)
3. Experience recruiting, training, and managing field supervisors and interviewers
4. Experience coordinating field logistics, schedules, and equipment
5. Experience managing data quality control in the field during survey implementation
6. Strong interpersonal skills, ability to solve problems when confronted with roadblocks during survey fieldwork
7. Prior professional experience in country or region preferred
8. Fluency in English (or French for Francophone countries, or Spanish for Spanish-speaking countries, etc.) required; fluency in relevant local language(s) also required

# Annex 3. Checklist for Engaging External Contractors

| # | Evaluation factor | Critical | Important |
|---|---|---|---|
| 1 | Survey team leader has designed and led **a minimum of two** large-scale, complex participant-based or household surveys (i.e., clustered, multistage surveys) in resource-constrained environments **in the past 5 years** | ✓ | |
| 2 | Senior survey specialist has demonstrated expertise in calculating sample sizes, designing surveys, and analyzing complex survey data | ✓ | |
| 3 | Survey team includes, **at a minimum**, a survey team leader, a senior survey specialist, and a field operations manager | ✓ | |
| 4 | At least one member of the survey team (or local subcontracting team) speaks each local language in which the survey will be administered | ✓ | |
| 5 | Contractor proposal includes high-quality sampling plan that adheres to all requirements specified in the scope of work | ✓ | |
| 6 | Contractor proposal includes details on quality control processes to be used before, during, and after data collection | ✓ | |
| 7 | Contractor can provide contact information for professional references for whom contractor has implemented surveys in the past | ✓ | |
| 8 | Contractor has previous survey-related experience in the country | | ✓ |

# Annex 4. Participant-Based Surveys for Non-Agricultural Annual Monitoring Indicators

Thus far in this guide, the discussion has focused on PaBSs that collect Feed the Future agricultural annual monitoring indicators. However, some Feed the Future projects have interventions in other sectors as well, such as MCHN and WASH. Feed the Future IPs must collect data and report on all relevant Feed the Future annual monitoring indicators related to the sector in which there are associated interventions and to which they are contributing results. Some of these annual monitoring indicators can be collected through routine monitoring, but in some cases, it is also appropriate to use PaBSs.

This annex discusses adaptations to the approaches discussed in the main body of this guide when implementing PaBSs in relation to MCHN and WASH indicators. Many of the key adaptations stem from the fact that the indicators to be collected through such PaBSs relate to different types of indicators beyond totals, including proportions and means. Special consideration is also needed in terms of the various distinct sampling frames associated with the MCHN and WASH indicators. The annex focuses on the adaptations that must be made when using indicators of proportions and means in such PaBSs, as well as the considerations that must be made to accommodate distinct sampling frames.

## A4.1 The Two Approaches: Household Survey Approach and Producer Groups Approach

The two PaBS implementation approaches described in this guide are the household survey approach (Chapter 9) and the PGs approach (Chapter 10). Both approaches can be used for PaBSs in support of MCHN and WASH interventions, but with a few essential adjustments. For instance, although the PGs approach is applied in agriculture-related interventions where, say, FFSs are used as part of the intervention package, the approach can be adapted to analogous contexts in MCHN- and WASH-related contexts where, for example, Mother Care Groups are used as part of the intervention package.

### *A4.1.1 Calculating the Sample Size*

One of the adjustments that must be made to both approaches is the calculation of the sample size when considering key indicators that are not totals (e.g., proportions or means). Details on how to compute the sample size in such cases is provided below.

#### *Indicators to Use as a Basis for Sample Size Calculation*

Most Feed the Future indicators can be expressed as totals, proportions, or means. The Feed the Future annual monitoring indicators relating to MCHN and WASH are either totals or proportions (i.e., expressed as percentages) and are listed in Table A4.1.

In addition, Feed the Future IPs often develop their own custom annual monitoring indicators that do not have to be reported back to Feed the Future, but that are used as part of the overall monitoring process by IPs.[59] These custom indicators vary from IP to IP and can also take the form of totals, proportions, or means. An example of a custom MCHN indicator that is a mean is also included in Table A4.1; there are no Feed the Future MCHN or WASH annual monitoring indicators that are means and therefore this indicator is included in the table for illustrative purposes only.

[59] However, Feed the Future encourages IPs to upload their custom indicator reporting as part of the documentation in FTFMS. Feed the Future will be working on adjusting FTFMS to allow direct entry of custom indicators in the future.

### Table A4.1 Feed the Future and Custom MCHN and WASH Annual Monitoring Indicators

| Indicator | Type of Indicator | Sampling Group Implicated | Source of Indicator | Intervention Sector |
|---|---|---|---|---|
| 1. Number of People Gaining Access to a Basic Sanitation Service as a Result of USG Assistance | Total | Households participating in WASH interventions[a] | Feed the Future | WASH |
| 2. Percentage of Households with Soap and Water at a Hand Washing Station Commonly Used by Family Members | Proportion | Households participating in WASH interventions | Feed the Future | WASH |
| 3. Number of Children under Two (0–23 months) Reached with Community-Level Nutrition Interventions through USG-Supported Programs | Total | Children under two participating in community-level MCHN interventions | Feed the Future | MCHN |
| 4. Number of Children under Five (0–59 months) Reached with Nutrition-Specific Interventions through USG-Supported Programs[b] | Total | Children under five participating in community-level MCHN interventions | Feed the Future | MCHN |
| 5. Number of Pregnant Women Reached with Nutrition-Specific Interventions through USG-Supported Programs | Total | Pregnant women participating in community-level MCHN interventions | Feed the Future | MCHN |
| 6. Percentage of Female Participants of USG Nutrition-Sensitive Agriculture Activities Consuming a Diet of Minimum Diversity[c] | Proportion | Female participants of community-level MCHN interventions that have nutrition-sensitive agriculture activities | Feed the Future | MCHN |
| 7. Women's Dietary Diversity Score (WDDS) for Caregivers of Children under Two Participating in Community-Level MCHN Interventions | Mean | Caregivers of children under two participating in community-level MCHN interventions | Custom (example only) | MCHN |
| 8. Percentage of Participants of Community-Level Nutrition Interventions Who Practice Promoted Infant and Young Child Feeding Behaviors | Proportion | Caregivers of children under two (reported under indicator 3) participating in community-level MCHN interventions | Feed the Future | MCHN |
| 9. Number of Individuals Receiving Nutrition-Related Professional Training through USG-Supported Programs | Total | N/A[d] | Feed the Future | MCHN |

[a] Households are considered in the sampling group for this indicator, even though the indicator is expressed in terms of people. The number of people living in households are estimated using results from the survey and used as a basis to calculate the indicator.

[b] Indicator 4 may be applicable to three types of Feed the Future projects: a) those that support national public health campaigns (such as "child health days"), b) health-systems strengthening projects (that help improve facility-based nutrition-specific service delivery), and c) those implementing community-level MCHN interventions. For projects of type a) and b), data relating to indicator 3 are typically collected through routine monitoring (e.g., from ministries of health). Indicator 5 may also be applicable to project type b), with data collected through routine monitoring. This guide focuses on projects of type c) only – where data can be collected through PaBSs. Therefore, the sampling group in this table has been limited to children under five or pregnant women participating in community-level MCHN interventions.

[c] Nutrition-sensitive agriculture activities can be embedded in either agriculture interventions or community-level MCHN interventions (such as the promotion of home gardens); this annex focuses on the latter. In the cases where nutrition-sensitive agriculture activities are embedded in both, there may be participants who engage in both sets of interventions, creating an overlap in the set of participants across the two types of project interventions. Relatedly, data on this indicator can be collected through both agriculture-related or MCHN-related PaBSs. However, when participants in the agriculture and the MCHN nutrition-sensitive agriculture interventions overlap, and data related to this indicator are collected through both types of PaBSs, special methods are required to produce one overall estimate for the indicator by combining data from both PaBSs while taking into account the double-contribution to the estimate from the overlap portion. More details on this method are provided in Annex 5.

[d] The data for this indicator is collected through routine monitoring rather than through PaBSs, and therefore the concept of sampling group is not relevant here. Data on this indicator are collected on health professionals, primary health care workers, community health workers, volunteers, policy makers, researchers, students, and non-health personnel (e.g., agriculture extension workers), but not community-level participants, such as mothers receiving counseling on maternal, infant, and young child feeding.

Special attention should be given to the sampling groups associated with the indicators to be collected through a PaBS. Recall that for the set of four agriculture indicators under consideration in the main body of this guide ("Yield of Agricultural Commodities," "Value of Sales," "Number of Hectares under Improved Management Practices," and "Number of Individuals Using Improved Management Practices"), the target population definitions were intentionally limited so that the sampling frames were identical for all four indicators, and consisted of producers (both smallholder and non-smallholder) in crop, livestock, and aquaculture production systems (see Table 1b in the main body of the guide). This was important because it implied the use of **one** sampling frame that facilitated the implementation of **one** PaBS (rather than multiple PaBSs) across all four indicators.

In contrast, the sampling groups implicated by the first eight indicators in Table A4.1 span a variety of sampling groups within various interventions. For instance, for the WASH indicators, we have households participating in WASH interventions (indicators 1 and 2). For the MCHN indicators, we have children under two participating in community-level MCHN interventions (indicator 3), children under five participating in community-level MCHN interventions (indicator 4), pregnant women participating in community-level MCHN interventions (indicator 5), female participants of community-level MCHN interventions that have nutrition-sensitive agriculture activities (indicator 6), and caregivers of the children under two participating in community-level MCHN interventions (indicators 7 and 8).

It is not possible to nest the definitions of the sampling groups in Table A4.1 so that the data collection can be undertaken within **one** PaBS. For the first eight indicators in Table A4.1, there would need to be several PaBSs conducted associated with the various distinct sampling groups, although some nesting of sampling groups may be possible. For instance, it is possible to collect data on indicators 3 and 4 within the same PaBS, since the sampling group for indicator 3 is a subset of that for indicator 4. The data on indicators 1 and 2 can be collected within the same PaBS, as can the data for indicators 7 and 8, because the sampling groups are the same for the indicators in each of the pairs. Although it is possible that the participants from the various sampling groups in Table A4.1 intersect or are subsets of each other in some way, the degree of intersection will be project-specific and can be determined only through an analysis of the participant lists of the various interventions of IP projects.

Therefore, as an overall strategy, survey implementers should list the MCHN and WASH annual monitoring indicators (both Feed the Future and custom) for which data must be collected. Then, indicators should be grouped together according to their common sampling groups. Indicators whose sampling groups are subsets of other sampling groups can be grouped together with the indicators whose sampling groups subsume them. The strategy implies that the list of sampling groups associated with the IP's custom indicators should be analyzed to see if any of them coincide with or are a subset of one of the sampling groups associated with the Feed the Future annual monitoring indicators in Table A4.1; if so, these indicators should be grouped together. The intention is then to conduct separate PaBSs to collect data in support of the indicators associated with each of the distinct sampling groups (including their subsets). However, when only one or two indicators fall into a specific sampling group, it may not be worth the required resources to conduct a separate PaBS, and the collection of data in support of such indicators through routine monitoring may be the preferred approach.

Regardless of how many PaBSs must be conducted, for any specific PaBS, one indicator only, from among all indicators on which data are to be collected, can determine the overall sample size for the specific survey. As previously discussed, the general recommendation is that the sample size for all **key** indicators from among the indicators being collected in a given survey be calculated and that the **largest sample size** resulting from all candidate sample sizes computed be chosen.

However, for a WASH-related PaBS based on a sampling frame that encompasses "households participating in WASH interventions," Feed the Future recommends including "**Percentage of Households with Soap and Water at a Hand Washing Station Commonly Used by Family Members"** (indicator 2) as a key indicator on which to base the sample size computation; other Feed the Future or custom indicators deemed key by the IPs can be included, as well.

Similarly, for an MCHN-related PaBS based on a sampling frame that encompasses "caregivers of the children under two participating in community-level MCHN interventions," Feed the Future recommends including "**Percentage of Participants of Community-Level Nutrition Interventions Who Practice Promoted Infant and Young Child Feeding Behaviors"** (indicator 8) as a key indicator on which to base the sample size computation; other Feed the Future or custom indicators deemed key by the IPs can be included as well.

Table A4.1 includes indicators of all three types: totals, proportions, and means. Section 9.2.2 provides guidance on how to compute sample sizes for indicators of totals. The next two sections provide guidance on how to compute sample sizes for indicators of proportions and means.

### *Formula to Calculate the Sample Size Based on a Proportion*

The formula for calculating the initial sample size for the estimation of indicators of proportions is given by:

$$initial\ sample\ size = n_{initial} = \frac{z^2 * P * (1 - P)}{MOE^2}$$

where:

*z* = critical value from Normal Probability Distribution.

*P* = an estimate of the true (but unknown) population proportion. For the first year that a PaBS is conducted, a value can be obtained from a recent external survey that collects data on the same indicator, conducted in the same country or region of the country. For subsequent years that a PaBS is conducted, the value obtained from survey results in the prior year can be used.

*MOE* = margin of error = p. The term *p* denotes an acceptable percentage error, and is typically subjectively specified to range between 5% and 10% (expressed as $p = 0.05$ and $p = 0.10$, respectively). For purposes of Feed the Future annual performance monitoring, $p = 0.10$ should be used.

The same three adjustments as those described in Sections 9.2.3 for indicators of totals should be applied here to the initial sample size to arrive at a final sample size.

### *Formula to Calculate the Sample Size Based on a Mean*

The formula for calculating the initial sample size for the estimation of indicators of means is given by:

$$initial\ sample\ size = n_{initial} = \frac{z^2 * s^2}{MOE^2}$$

where:

$z$ = critical value from Normal Probability Distribution.

$s$ = standard deviation of the distribution of participant data. A value for this can be obtained in a manner similar to that for indicators of totals, described in Section 9.2.2.

*MOE* = margin of error = p * target value of the indicator. The first term, *p*, is the same as in the formula for proportion. The second term, the target value of the indicator, is set by the IPs in their IPTTs as the target value for the indicator to be achieved in the year in which the survey is being conducted.[60]

The same three adjustments as those described in Sections 9.2.3 for indicators of totals should be applied here to the initial sample size to arrive at a final sample size.

### A4.1.2 Data Analysis

Chapter 12 provides guidance on how to compute estimates of indicators of totals, and Chapter 13 provides guidance on how to compute associated confidence intervals and standard errors for estimates of indicators of totals. The sections below provide similar guidance for indicators of proportions and means.

### Producing Estimates, Confidence Intervals, and Standard Errors for Indicators of Proportions

Three of the Feed the Future MCHN and WASH annual monitoring indicators in Table A4.1 are proportions. Producing estimates of indicators of proportions requires a formula that is different from that used in Chapter 12 to produce estimates of indicators of totals. As before, survey implementers should use a statistical software package, such as SAS, SPSS, or STATA, to generate the estimates. However, the formula is given here to provide the reader a sense of the computations undertaken by the statistical software packages. The formula for an estimate of a population proportion is:

$$estimate\ of\ population\ proportion = P = sum(w_{final_i} *\ x_i)/sum(w_{final_i} *\ y_i)$$

where:

$w_{final_i}$ = value of $w_{final}$ (the final sampling weight) for the *ith* sampled participant

$x_i$ = 1 if the *ith* sampled participant has the attribute in question (e.g., $x_i$ = 1 for the *ith* sampled caregiver of a child under two participating in community-level MCHN interventions who practices promoted infant and young child feeding behaviors, corresponding to indicator 8 in Table A4.1); 0 otherwise (i.e., if not practicing promoted infant and young child feeding behaviors)

[60] If the PaBS is being designed to establish base year values for the project, then using target values to be achieved after one year of project implementation does not make sense. In this case, it is recommended to use an estimated value of the indicator obtained through external sources instead.

$y_i = 1$ if the *ith* sampled participant belongs to the sampling group corresponding to the indicator (e.g., $y_i = 1$ for the *ith* sampled caregiver of a children under two participating in community-level MCHN interventions, corresponding to indicator 8 in Table A4.1); 0 otherwise

The formula to calculate a confidence interval with a confidence level of 95% for the estimate of a proportion (denoted by $P$) is the following:

$$CI_{proportion} = estimate\ of\ proportion\ (P) \pm \left( z * \left( \frac{\sqrt{D_{actual}} * P * (1 - P)}{\sqrt{n_{actual}}} \right) \right)$$

where:

*P* = the sample-weighted estimate of the proportion, the formula for which is given above

*z* = the critical value from the Normal Probability Distribution (use of *z* = 1.96 is recommended)

$D_{actual}$ = the design effect for the survey computed from the survey data

$n_{actual}$ = the actual sample size realized after fieldwork

The formula to calculate the standard error associated with the estimate of a proportion, *P*, is the following:

$$standard\ error(P) = SE(P) = \left( \frac{\sqrt{D_{actual}} * P * (1 - P)}{\sqrt{n_{actual}}} \right)$$

## *Producing Estimates, Confidence Intervals, and Standard Errors for Indicators of Means*

None of the Feed the Future MCHN and WASH annual monitoring indicators in Table A4.1 are means. However, IPs may choose to include custom indicators in their set of annual monitoring indicators for MCHN and WASH that are means. Producing estimates of indicators of means requires a formula that is different from that used to produce estimates of indicators of totals or proportions. As before, survey implementers should use a statistical software package, such as SAS, SPSS, or STATA, to generate the estimates. However, the formula is given here to provide the reader a sense of the computations undertaken by the statistical software packages. The formula for an estimate of a population mean is:

$$estimate\ of\ population\ mean = \bar{X} = sum(w_{final_i} * \ x_i)/sum(w_{final_i} * \ y_i)$$

where:

$w_{final_i}$ = value of $w_{final}$ (the final sampling weight) for the *ith* sampled participant

$x_i$ = the contribution to the numerator of the indicator from the *ith* sampled participant (e.g., the number of food groups consumed by the *ith* sampled caregiver of a child under two participating in community-level MCHN interventions, corresponding to the WDDS indicator in Table A4.1)

$y_i$ = 1 if the *ith* sampled participant belongs to the sampling group corresponding to the indicator (e.g., the *ith* sampled caregiver of a child under two participating in community-level MCHN interventions, corresponding to the WDDS Indicator in Table A4.1); 0 otherwise

The formula to calculate a confidence interval with a confidence level of 95% for the estimate of a proportion (denoted by $\bar{X}$) is the following:

$$CI_{mean} = estimate\ of\ mean\ (\bar{X}) \pm\ z * \left(\frac{\sqrt{D_{actual}} * s_{actual}}{\sqrt{n_{actual}}}\right)$$

where:

$s_{actual}$ = the standard deviation computed from the survey data

The formula to calculate the standard error associated with the estimate of a mean, $\bar{X}$, is the following:

$$standard\ error(\bar{X}) =\ SE(\bar{X}) = \left(\frac{\sqrt{D_{actual}} * s_{actual}}{\sqrt{n_{actual}}}\right)$$

# Annex 5. Computing Estimates of the "Percentage of Female Participants of USG Nutrition-Sensitive Agriculture Activities Consuming a Diet of Minimum Diversity" Indicator

Table A4.1 in Annex 4 includes the Feed the Future annual monitoring indicator "Percentage of Female Participants of USG Nutrition-Sensitive Agriculture Activities Consuming a Diet of Minimum Diversity." The computation of this indicator requires special methods in some cases. This is because a project's nutrition-sensitive agriculture activities can be embedded in agriculture interventions, community-level MCHN interventions (such as the promotion of nutritious crop cultivation in the context of home gardens), or both.

In the cases where nutrition-sensitive agriculture activities are embedded in one or the other type of intervention, but not both, the indicator can be computed in the usual manner, and the overall estimate from this indicator can be derived from a single PaBS (if that is the mode through which data for this indicator are collected).

However, in the cases where nutrition-sensitive agriculture activities are embedded in both types of interventions, there may be participants who engage in both sets of interventions, creating an overlap in the set of participants across the two types of interventions. In such cases, data on this indicator can be collected through two separate PaBSs: an agriculture-related PaBS in support of the agriculture interventions and an MCHN-related PaBS in support of community-level MCHN interventions. However, when data related to this indicator are collected through both types of PaBSs, special methods are required to produce one overall estimate for the indicator by combining data from both sources; such methods must take into account the potential double-contribution to the indicator estimate from the overlap stemming from the participants who are engaged in both types of interventions. This annex focuses on the case where participants are engaged in both sets of interventions, and describes a series of steps necessary to derive a combined estimate using the data from the two separate PaBSs.

**STEP 1. Identify the overlap between the agriculture intervention and the MCHN intervention using the PaBS sampling frames.** First, create the two sample frames of participants for each of the two surveys (i.e., the agriculture-related PaBS and the MCHN-related PaBS). Because the indicator "Percentage of

Female Participants of USG Nutrition-Sensitive Agriculture Activities Consuming a Diet of Minimum Diversity" relates only to females, drop any male participants from the two sampling frames.[61] [62]

Next, identify the overlap between the agriculture and MCHN interventions. This is done by matching the two (reduced) sampling **frames** of female participants (through the unique identification numbers of the participants). The matched units then define the overlap and the unmatched units define the two non-overlaps.

**STEP 2. Identify sampled participants in the overlap.** For the agriculture-related PaBS, identify each sampled participant from the survey who is a match with a participant on the overlap part of the agriculture-related sample frame. Similarly, for the MCHN-related PaBS, identify each sampled participant from the survey who is a match with a participant on the overlap part of the MCHN-related sample frame.[63] Note that although there may be many sampled participants who are in common in the overlap between the two samples, the sampled participants in the overlap may not coincide exactly because different participants may have been randomly sampled for the two surveys. However, because each subsample is representative of the entire overlap, estimates based on these subsamples must be combined in such a way as to dampen the contribution of each to avoid double representation of the overlap.

If there is no overlap between the agriculture and MCHN interventions, modifications need to be made to the steps below; they are indicated where appropriate.

**STEP 3. Generate separate and combined indicator estimates for the overlap.** Next, compute two separate estimates of the indicator using a subset of the data that is restricted to the overlap only (from Step 2)—one estimate coming from the agriculture-related PaBS (denoted $P_{overlap\text{-}AG}$), the other coming from the MCHN-related PaBS (denoted $P_{overlap\text{-}MCHN}$). The two estimates can be computed using the formula given in Annex 4 for indicators of proportions, but restricting the data set to the aforementioned subsample.

A combined estimate of the indicator for the overlap can be expressed as a weighted combination of the two separate estimates of the overlap from the two surveys:

$$P_{overlap} = \alpha\, P_{overlap\text{-}AG} + (1-\alpha)\, P_{overlap\text{-}MCHN}$$

where ∝ is a fixed constant between 0 and 1.

[61] It is assumed that the two (agriculture-related and MCHN-related) PaBSs are conducted on participants of both sexes to accommodate a variety of indicators where both sexes are implicated, and are not conducted solely to accommodate the indicator "Percentage of Female Participants of USG Nutrition-Sensitive Agriculture Activities Consuming a Diet of Minimum Diversity". For this reason, the original frames include both females and males.

[62] The removal of female participants is more relevant to the sampling frame for the agriculture-related PaBS than it is to the sampling frame for the MCHN-related PaBS, because most participants involved in community-level MCHN interventions are most often females, whereas participants involved in agriculture-related interventions can be either male or female.

[63] Note that only sampled females from each of the two (agriculture-related and MCHN-related) PaBSs will be potential matches since the frames on which matching are attempted have been restricted to include only females in Step 1.

An optimal choice for $\propto$ that maximizes the precision of the combined estimate of the indicator for the overlap is given by:

$$\alpha = \frac{\hat{V}(P_{overlap\text{-}MCHN})}{\hat{V}(P_{overlap\text{-}AG}) + \hat{V}(P_{overlap\text{-}MCHN})}$$

where $\hat{V}(P_{overlap\text{-}AG})$ and $\hat{V}(P_{overlap\text{-}MCHN})$ are variance estimates of the separate indicator estimates of the overlap, $P_{overlap\text{-}AG}$ and $P_{overlap\text{-}MCHN}$, respectively. These variance estimates can be computed using a statistical software package (such as SAS, SPSS, or STATA), and are automatically generated to accompany the estimates of $P_{overlap\text{-}AG}$ and $P_{overlap\text{-}MCHN}$ by the statistical software package being used.[64]

Because $\alpha < 1$, the contribution to the combined estimate of the indicator for the overlap ($P_{overlap}$) coming from each of the two separate estimates of the overlap ($P_{overlap\text{-}AG}$ and $P_{overlap\text{-}MCHN}$) is dampened to avoid double representation of the overlap.

Because the estimates from the two surveys are independent, the estimated variance estimator of the combined estimate of the indicator for the overlap $P_{overlap}$ is given by:

$$\hat{V}(P_{overlap}) = \alpha^2 \hat{V}(P_{overlap\text{-}AG}) + (1-\alpha)^2 \hat{V}(P_{overlap\text{-}MCHN})$$

This variance estimate is used in the next step.

**STEP 4. Identify sampled participants in the non-overlap.** Consider the sampled participants in the non-overlap for the agriculture and MCHN interventions. For the agriculture-related PaBS, identify each sampled participant from the survey who is a match with a participant on the non-overlap part of the agriculture-related sample frame (i.e., sampled participants from the non-overlap). Similarly, for the MCHN-related PaBS, identify each sampled participant from the survey who is a match with a participant on the non-overlap part of the MCHN-related sample frame (i.e., sampled participants from the non-overlap). In each case, these should constitute the complement of the sampled participants identified in Step 2 for each survey.[65]

If there is no overlap between the agriculture and MCHN interventions, the participants from the non-overlap coincide with all of the sampled participants from each of the PaBSs.

**STEP 5. Generate separate indicator estimates for each of the two surveys for the non-overlap.** Next, compute two separate estimates of the indicator using data that are restricted to the non-overlap identified in Step 4—one estimate coming from the agriculture-related PaBS (denoted $P_{non\text{-}overlap\text{-}AG}$), the other coming from the MCHN-related PaBS (denoted $P_{non\text{-}overlap\text{-}MCHN}$). The two estimates can be computed according to the formula given in Annex 4 for indicators of proportions, restricting the data set to the aforementioned subsample.

[64] Most statistical software packages in fact generate standard errors of the estimates, rather than variances. The variances can be computed as the square of the standard errors of the estimates.

[65] As in Step 2, only sampled females from each of the two (agriculture-related and MCHN-related) PaBSs will be potential matches since the frames on which matching are attempted have been restricted to include only females in Step 1.

**STEP 6. Generate a combined overall indicator estimate using the contributions from both the overlap and non-overlap.** To create a combined overall indicator estimate (denoted $P_{overall}$), we combine $P_{non\text{-}overlap\text{-}AG}$ and $P_{non\text{-}overlap\text{-}MCHN}$ (the separate estimates of the indicator for the two non-overlaps from the two surveys) with $P_{overlap}$ (the combined estimate of the indicator for the overlap) using a weighted combination given by:

$$P_{overall} = \beta_3 \, P_{non\text{-}overlap\text{-}AG} + \beta_4 \, P_{non\text{-}overlap\text{-}MCHN} + (1 - \beta_3 - \beta_4) \, P_{overlap}$$

An optimal choice for $\beta_3$ that maximizes the precision of the combined overall indicator estimate is given by:

$$\beta_3 = \frac{\frac{1}{\hat{V}(P_{non\text{-}overlap\text{-}AG})}}{\frac{1}{\hat{V}(P_{non\text{-}overlap\text{-}AG})} + \frac{1}{\hat{V}(P_{non\text{-}overlap\text{-}MCHN})} + \frac{1}{\hat{V}(P_{overlap})}}$$

and an optimal choice for $\beta_4$ is given by:

$$\beta_4 = \frac{\frac{1}{\hat{V}(P_{non\text{-}overlap\text{-}MCHN})}}{\frac{1}{\hat{V}(P_{non\text{-}overlap\text{-}AG})} + \frac{1}{\hat{V}(P_{non\text{-}overlap\text{-}MCHN})} + \frac{1}{\hat{V}(P_{overlap})}}$$

Here, $\hat{V}(P_{non\text{-}overlap\text{-}AG})$ and $\hat{V}(P_{non\text{-}overlap\text{-}MCHN})$ are estimated variances of $P_{non\text{-}overlap\text{-}AG}$ and $P_{non\text{-}overlap\text{-}MCHN}$, respectively. These variance estimates can be computed using a statistical software package (such as SAS, SPSS, or STATA) and are automatically generated to accompany the estimates of $P_{non\text{-}overlap\text{-}AG}$ and $P_{non\text{-}overlap\text{-}MCHN}$ by the statistical software package being used.

**STEP 7. Generate an associated variance estimate of the combined overall indicator estimate.** Finally, the variance of the combined overall indicator estimate, $P_{overall}$, can be estimated as follows, exploiting the fact that the overlap and the two non-overlap estimates are all independent of each other:

$$\hat{V}(P_{overall}) = {\beta_3}^2 \hat{V}\left(P_{non\text{-}overlap\text{-}AG}\right) + {\beta_4}^2 \hat{V}\left(P_{non\text{-}overlap\text{-}MCHN}\right) + (1 - \beta_3 - \beta_4)^2 \hat{V}(P_{overlap})$$

This variance of the combined overall indicator estimate should be reported as a measure of precision of $P_{overall}$.

If there is no overlap between the agriculture and MCHN interventions, set $P_{overlap} = 0$ and set $\frac{1}{\hat{V}(P_{overlap})} = 0$ in all of the above expressions.