Tanzania Agronomic Panel Survey 2017

This version: 20180417

I. Overview

The agronomic panel survey (APS) is a multi-component farm household survey designed to collect detailed and spatially-explicit agronomic management data from maize farmers, as well as other information about the geographic-, household- and plot-level contextual conditions which are relevant for understanding smallholder farm management decisions and their outcomes at the plot and household level.

The purpose of this survey is to collect data that will enable us to do the following:

a) To describe spatial and temporal patterns in maize yields and the agronomic practices that condition those yields
b) To better understand the contribution of alternative agronomic practices and other management decisions on land productivity, after controlling for soil, terrain and weather conditions
c) To measure costs of inputs (using actual prices for purchased inputs, and imputed prices for unpaid household resources) at the farm gate (i.e. net of transfer costs from local markets) and thereby measure profitability of maize production at the plot and household levels
d) To have a baseline dataset in place for measuring impacts (on yields and profitability) of project interventions to be developed over the next year (assuming that we can randomly distribute these interventions or "treatments" to the surveyed sample)

II. Sample size and design

Spatial sample design

Survey households are randomly selected using a stratified spatial sampling frame designed to be broadly representative of the main maize producing areas of each country. The APS sampling procedure built on work previously done by AfSIS for their national soil sampling campaign. The sampling procedure was as follows:

(i) The Area of Interest (AOI), defined as maize-producing areas with at least moderate human population density and relatively good accessibility to markets
   a. maize producing areas were defined using the AfSIS cropland map
   b. the population density criterion was >25 persons/km^2, using data from WorldPop
   c. the market access criterion was 4 hours to the nearest town of 50,000 or more people

(ii) Within this AOI we randomly selected 75 of AfSIS's 10x10km soil sampling grids, approximately 3 per district, which met the criterion of having maize as a major crop and not being deemed too inaccessible or outside the current operational domains of our partners (Selian and Uyule)

(iii) Within each of these 10x10km grids, AfSIS had previously randomly selected 16 1km2 grid cells to target soil sampling activities. Of these 16 grid cells, 3 were randomly chosen for field activities.

(iv) This final set of sample locations was evaluated for representativeness across four soil characteristics: OC, pH, CEC and % sand. Results of this analysis (found where?) indicate that the final set of 75 survey locations is adequately representative of the ranges of these characteristics within the AOI.

(v) Within each of the 75 selected survey locations, we traveled to the centroid of the grid cell with the DA and local village representatives, and listed all the farm households operating within than grid cell. Of the resulting lists, we randomly selected 8 households for inclusion in the APS survey sample.

Sample size and distribution

The final APS sample consists of 580 households, distributed across the 25 districts as shown in the table below.

zone	region	district	nobs
Northern	Arusha	Arumeru	23
		Karatu	24
		Monduli	22
	Kilimanjaro	Hai	24
		Moshi	24
		Mwanga	24
		Rombo	24
		Siha	24
	Manyara	Babati	24
		Hanang	22
		Kiteto	19
		Mbulu	24
Southern Highlands	Iringa	Iringa Rural	24
		Kilolo	24
		Mufindi	23
	Mbeya	Mbeya Rural	24
	Njombe	Ludewa	21
		Njombe Urban	21
		Wangingombe	24
	Rukwa	Nkasi	23
		Sumbawanga Rural	22
	Ruvuma	Namtumbo	22
		Songea	25
	Songwe	Mbozi	25
		Momba	24
total			*580*

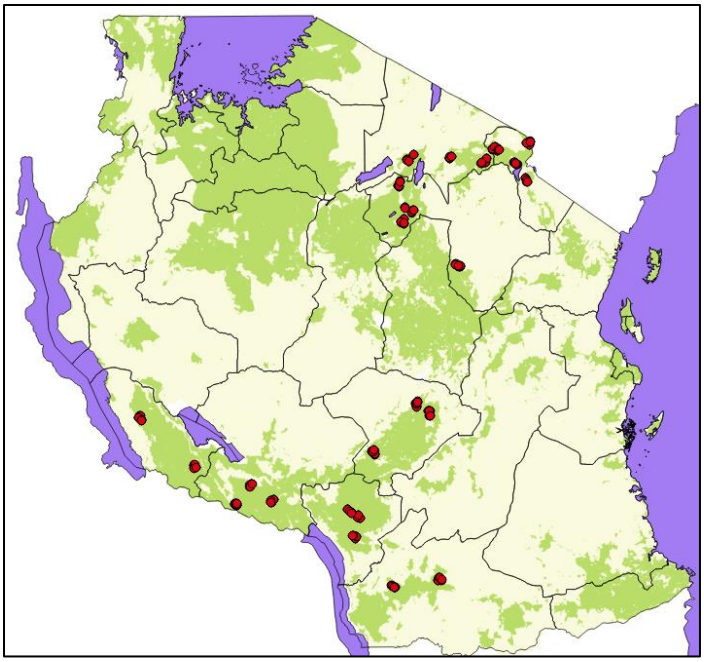


Figure 1: Distribution of APS sample

III. Survey components

The APS consists of several components:

a) The household questionnaire – containing questions on household demography, agricultural landholdings, farm management, non-farm income sources, and other factors.
b) The plot questionnaire – containing detailed agronomic management questions for the maize focal plot.
c) The crop cut and soils data form – in which the enumerator records barcodes for the physical samples, as well as observations from the crop cut protocol
d) The physical soil samples (from 0-20 cm and from 20-40 cm)
e) The physical grain sample
f) The community questionnaire – containing questions about prices and market access conditions.

IV. Focal plot identification

The focal plot is identified by the enumerator in the field, early in the interview process, immediately following the farm sketch in which all the fields controlled by the household are described. The identification of the focal plot is based on the following criteria:

a) The plot has maize
b) If multiple maize plots, the plot which is "most important" in an economic sense, at the household level. The criteria to include:
    a. Size of the plot (i.e. the most important plot is probably relatively large compared with less important maize plots)
    b. Location of plot (i.e. the most important plot is probably neither adjacent nor very far from the house; we are not interested in maize grown as part of home gardens, nor in maize fields which are so remote as to be seldom visited)
    c. Intensity of management (i.e. the most important plot probably receives more and/or greater value of inputs than less important plots)

A working assumption at the time of survey design is that in most cases the focal plot will be easily identifiable on the basis of the farm sketch. Most farmers have relatively few plots, and are able to subjectively identify the maize plot they consider most important. If the enumerator is in doubt as to the most appropriate selection, she or he is to communicate with the survey supervisor for assistance, as well as to note any comments in the survey form itself.

Focal plot identification in subsequent years

In subsequent visits (i.e. waves 2 and 3), if the focal plot identified in the previous wave is no longer under maize, we still repeat our observation of that plot, recording soil conditions, but not conducting a crop cut (as there is no maize to cut).

In the case where a previously-identified focal plot is no longer under the control of this household, a new focal plot is identified, using the same criteria outlined above.

V. Soil sampling & crop cut protocols

The workflows for soil and yield are given below. In both cases it is generally best to work through local extension agents, both to help find the designated sampling point and to help explain to the farmer the purpose of the survey. The SOPs detail what equipment and preparation is needed, all of which except 'smart phones' in some places, should be readily available (see Table below). It is best to start with the soil sample and then collect the yield sample.

Soil SOP	Yield SOP
• An Android phone or tablet. • A GPS device (either a phone or a separate device). • A soil auger marked with colored tape at 20 and 50 cm from the tip. • Two, 20-liter plastic buckets (two different colours, permanently marked 0-20 and 20-50 respectively) • A 5-liter plastic jerry can for water. • A rope marked with colored tape or knots at 2.9, 4.0 and 5.6 meters. • Sturdy, ~2-3 liter plastic bags, 2 bags for each soil sample. • Sticky labels (ideally QR codes), 2 for each soil sample.	• An Android phone or tablet. • A GPS device (either a phone or a separate device). • Wooden stakes • A balance (spring-loaded or electronic capable of weight to 10g accuracy). • A 20 m length of rope marked with colored tape or knots at 5.0 m intervals. • Sturdy, ~2-3 liter plastic or cloth bags, one bags for each yield (cob) sample. • Sticky labels (ideally QR codes), 2 for each yield (cob) sample

Soil sampling

Tools needed: String or rope marked at 2.8, 4.0 and 5.6 m, wooden peg, shovel or augur for soil sampling, two different coloured buckets, sampling bags, QR labels, ODK forms & GPS, weighing scales

Place a peg in the center of the sampling (quadrat) area

Collect 0-20 cm sample & place in labeled bucket

Collect 20-50 cm sample & place in labeled bucket

Move to next sampling position

Collect 0-20 cm sample & place in labeled bucket with first sample

Collect 20-50 cm sample & place in labeled bucket with first sample

Move to next two sampling positions & repeat; return to center (GPS) stake

Thoroughly mix soil in (i) 0-20 cm bucket

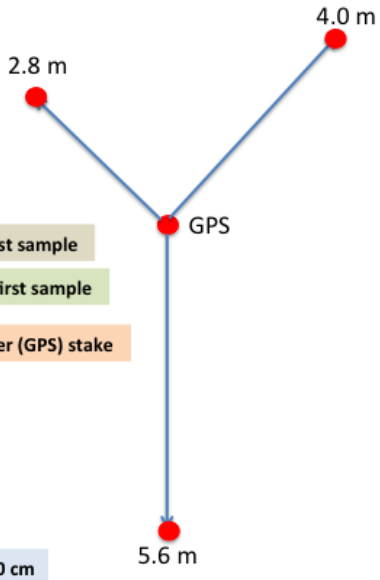
Take roughly 500g sub-sample & place in plastic bag

Label with a QR code

Start ODK Soil sample form

Select 0-20 cm soil depth

Repeat for 20-50 cm



Workflow – Yield at harvest/maturity

Tools needed: 20 m length of string or rope marked at 5m intervals, wooden stakes, sampling bags, QR labels, ODK forms & GPS, weighing scales

For each quadrat:

Mark out 5 x 5m roughly square quadrat (around the soil sampling GPS point)

Take the GPS reading in middle of plot;

Count the number of plants; record in ODK

Harvest all the cobs with grains

Layout all the cobs on the ground & count the number of cobs; record in ODK

Pick up every 10th cob; place in a bag; label with a QR-code; scan in ODK

Weigh the sub-sample: record in ODK

Keep the sub-sample for air-drying at office or laboratory

Bag the remaining cobs, take the fresh weight; record in ODK

Return cobs to farmer

Soil sample SOP

Equipment & materials

You will need the following equipment & materials:

- An Android phone or tablet.
- A GPS device (either a phone or a separate device).
- A soil auger marked with colored tape at 20 and 50 cm from the tip.
- Two, 20-liter plastic buckets (two different colours, permanently marked 0-20 and 20-50 respectively)
- A 5-liter plastic jerry can for water.
- A rope marked with colored tape or knots at 2.9, 4.0 and 5.6 meters.
- Sturdy, ~2-3 liter plastic bags, 2 bags for each soil sample.
- Sticky labels (ideally QR codes), 2 for each soil sample.

Before you go into the field

1. Install Android software and ODK forms

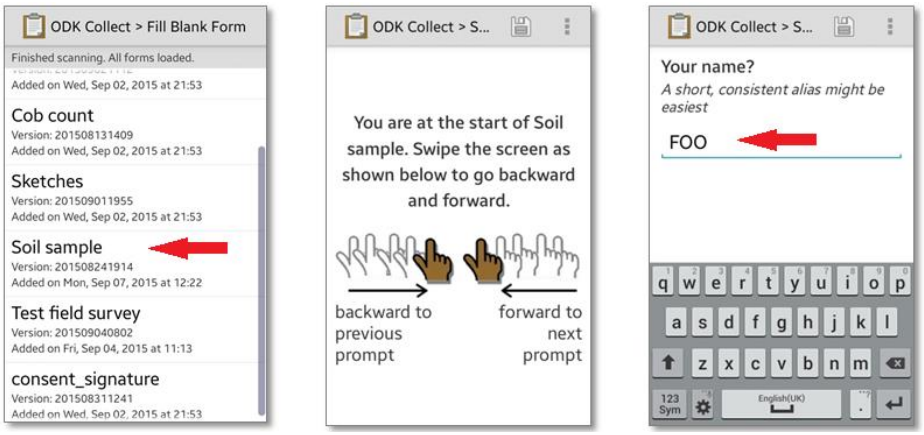
To use the AfSIS/TAMASA ODK soil sample login form you initially need to install the following applications on your Android device (tablet or phone):

- ODK Collect (to georeference, time stamp, and log in your soil sample)
- XZing barcode scanner (to read QR code labels)
- GPS Essentials (if you are going to be using your phone or tablet for field navigation rather than a separate GPS unit).

You can locate the applications on Google Play by searching for them by name. Note that you will need an Internet connection for this.

Once you have installed the software on your Android device: start ODK Collect and then set the server address that will link you to the "Soil sample" form:

- General Settings > Configure platform > URL. The General Settings menu can be accessed by tapping the <left> menu button on your device.
- Don't worry about entering a Username or Password. They are not needed.
- Set the URL field to: https://ona.io/cimmyt_gcap/
- This allows you to download blank forms for use on your Android device. It also allows you to save any completed forms to a database on the server. To download the blank ODK Soil sample form to your device, follow these 3 steps:



2. Print SSID sample bag labels

You will need to print soil sample labels. These are generated as machine-readable QR code on the basis of a SSID (or unique soil sample ID). The reason for having a unique machine-readable label is to be able to decisively track any given soil sample that is collected from the field, through the subsequent laboratory processes, and into the corresponding databases. Batches of QR code labels (below) can be generated for printing at: http://tag.kutabiri.com (please use Chrome browser to achieve the best layout).

Duplicate SSID labels should go onto every soil sample bag that is collected. We recommend that the labels be applied to the sampling bags before going to the field. If you are double-bagging your samples (recommended), apply the first label on the outside of the first bag, and the duplicate label on the inside of the second bag. This should prevent labels from being damaged during transport to the lab.

If you are only using a single bag per sample (optional, but not recommended), both labels should be placed on the outside of the bag. Also remember to recycle the sampling bags

whenever possible, but please make sure that the old SSID labels are removed before any new ones are applied.

3. Upload your sampling locations as navigation waypoints to your GPS

If you are ampling from pre-defined locations (i.e. a designed 1000 point survey), then you can upload sampling locations as waypoints in advance to help navigation to these points.

This procedure depends on which type of GPS setup you are using for field navigation. We recommend using a separate GPS unit for field navigation rather than using your Android device. This is because of the inherent battery limitations of Android phones and tablets when their internal GPS is switched on. However, if you are using a vehicle you can keep the phone charged; or carry several phones.

Many GPS devices and Android applications, including GPS Essentials, can read GPX waypoint files. GPX files can be produced with a software package called GPSBabel, which you should install on your computer. It's free, works on both Windows machines and Macs, and converts files to a wide variety GPS formats.

The simplest way of using GPSBabel is to convert a comma separated values (*.csv) file, which contains values of decimal Latitude and Longitude and a waypoint label, to a GPX (and/or other) file. An example R-script, which does grid ID labeling and format conversion, can be found here. The GPX file can then be loaded into GPS Essentials on your Android device, and/or onto a stand-alone GPS unit for navigation. We will provide additional procedures for field navigation in the near future.

In the field

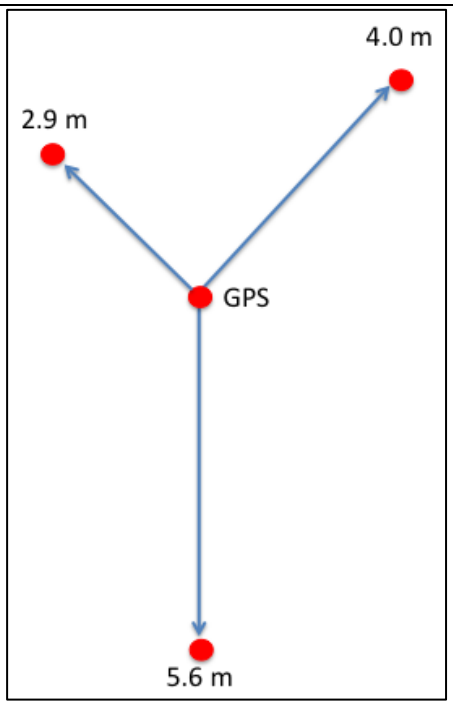
4. Do a reconnaissance drive/walk through your sampling area

Before collecting any soil samples, familiarize yourself with you overall sampling area and the people living there. In most instances it will be really helpful to introduce yourself to the local authorities and communities to inform them about the purpose of the soil survey you are conducting. It is also generally helpful to assess how close you can get to any particular sampling location by car (safely), because this will affect how quickly surveys can be conducted.

5. Layout your sampling plot and collect your samples

Once you arrive at a sampling location, lay out a plot as shown in the diagram below, using the marked rope, and placing the actual sampling locations on (roughly) the red dots, at the specified distances from the center of the plot.

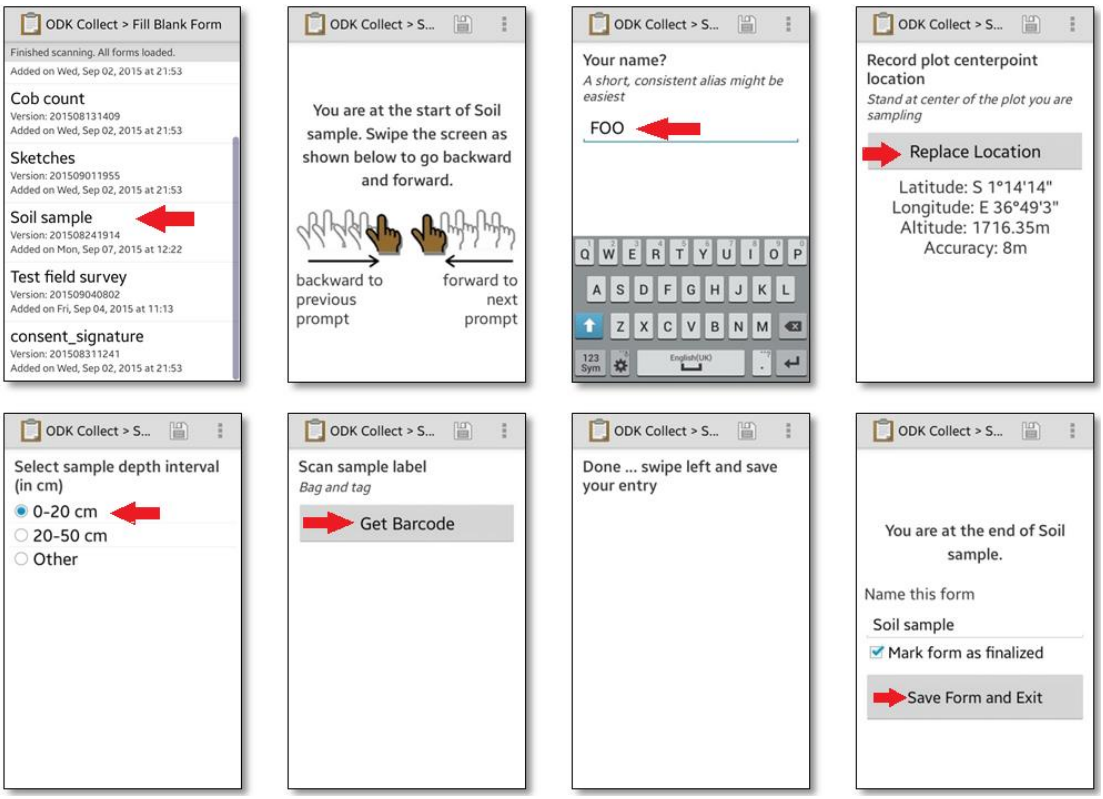
At each of the (red dot) locations use your marked soil auger to collect soil samples to both 20 cm (topsoil) and then to 50 cm (subsoil) depths. The reason for using this particular sampling pattern is to obtain composite samples that are representative of a 100 m^2 area, for both topsoils and subsoils. You will need to:

• Place all of the (0-20 cm) topsoil sub-samples into the same plastic bucket and mix them thoroughly. • Do the same for the (20-50 cm) subsoil samples, in a separate bucket. • Place ~500 grams of well-mixed (0-20 cm) topsoil soil into a pre-labeled bag. • Place ~500 grams of well-mixed (20-50 cm) subsoil soil into a pre-labeled bag. • Do not seal the 2 (top & subsoil) sample bags just yet, as the QR code labels will need to be scanned in with the Soil sample ODK form (see below).	

Note that in collecting the samples with a soil auger it is often useful to wet the auger location with a small amount of water. Depending on soil texture and the moisture of the soil being collected, wetting can be repeated as soil is recovered from an auger hole.

6. Record your samples using the "Soil sample" ODK form

The soil sample ODK form is intended to allow you to record a uniquely identified, georeferenced, and time stamped soil sample into the AfSIS and/or into your own database. The main steps for completing this form are summarized in the diagram below.



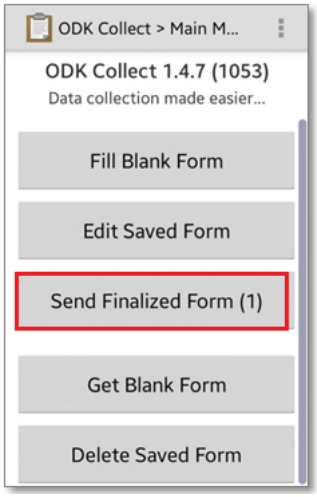
Once you try out the form, you will notice that each individual soil sample requires a separate blank form. When filling out the form please be sure to stand at the center of the 100 m^2 plot, at the location marked “GPS” in the figure, then:

- Tap Fill Blank Form. This will prompt you to select the *Soil sample* form.
- Once the form is loaded you will be prompted through the different questions by swiping toward the left on the screen.
- When you get to the part where it asks you to Record Location please make sure that you are standing at the center of the plot and that the GPS on your phone or tablet is turned on. Note that this step can take a bit of time as a GPS fix is established.
- Select the 0-20 cm depth interval for the bag containing the topsoil sample.
- When you get to the part where it asks you to Get Barcode, scan the topsoil sample label.
- At the end of the form there is a Save Form and Exit button. Please make sure to save and exit, because otherwise the data will be lost.
- Finally, repeat the entire procedure (above) for the 20-50 cm (subsoil) sample. Take care to indicate that this is a 20-50 cm sample in the depth interval section of the form.

Back in the office

7. Login your samples to the database

Once you are back from the field or at a place with an Internet connection, you should upload all of your saved forms to the server. All you need to do is to open ODK and then select Send Finalized Form from the main screen of ODK. This will prompt you to upload the saved forms on your device. Our recommendation is to upload your saved forms as regularly as your Internet access in the field/office permits.



Select the finalized surveys to send and click on Send Selected

That is pretty much all there is to collecting composite soil samples in the field.

The next step is to analyze those samples in the lab, and we will be posting a separate procedures document for those processes, including shipping instructions etc., soon.

Yield measurement SOP

You will need the following equipment & materials

- An Android phone or tablet.
- A GPS device (either a phone or a separate device).
- A balance (spring-loaded or electronic capable of weight to 10g accuracy).
- Wooden stakes
- A 20 m length of rope marked with colored tape or knots at 5.0 m intervals.
- Sturdy, ~2-3 liter plastic or cloth bags, one bags for each yield (cob) sample.
- Sticky labels (ideally QR codes), 2 for each yield (cob) sample.

Before you go into the field

1. Install Android software and ODK forms

To use the TAMASA ODK yield measurement login form you initially need to install the following applications on your Android device (tablet or phone):

- ODK Collect (to georeference, time stamp, and log in your soil sample)
- XZing barcode scanner (to read QR code labels)
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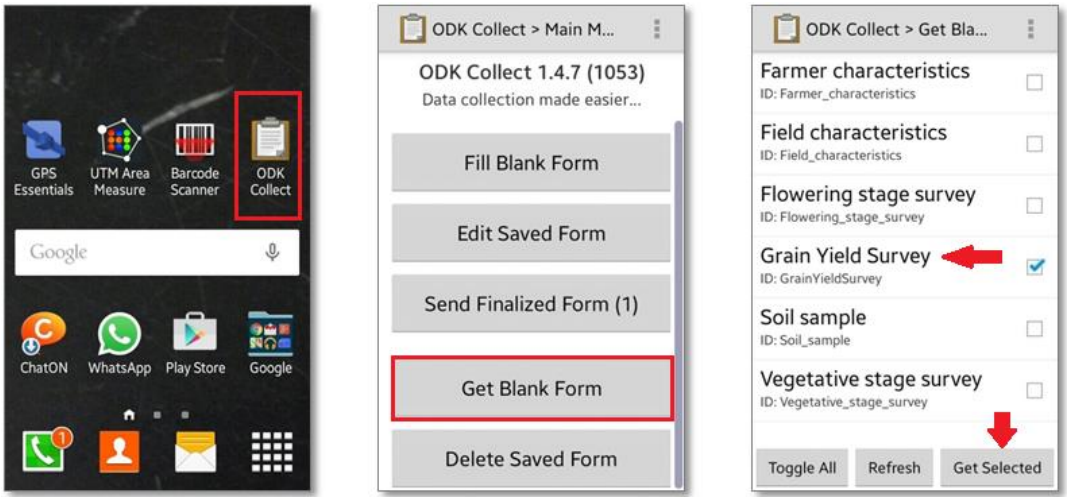

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Duplicate SSID labels should go onto every yield (cob) sample bag that is collected. We recommend that the labels be applied to the sampling bags before going to the field. If you are double-bagging your samples (recommended), apply the first label on the outside of the first bag, and the duplicate label on the inside of the second bag. This should prevent labels from being damaged during transport to the lab.

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In the field

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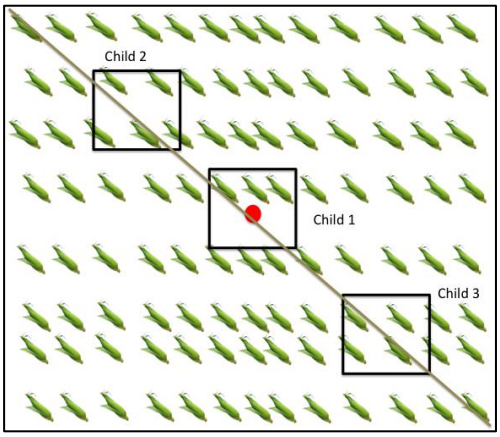
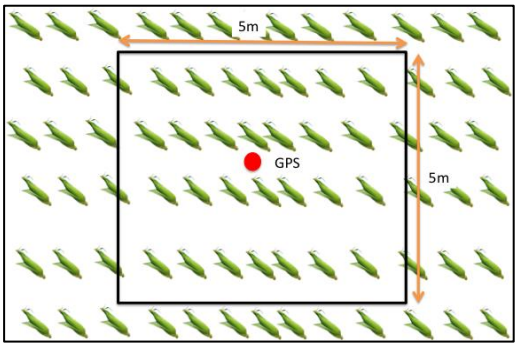
Before collecting any yield (cob) samples, familiarize yourself with you overall sampling area and the people living there. In most instances it will be really helpful to introduce yourself to the local authorities and communities to inform them about the purpose of the yield survey you are conducting. It is also generally helpful to assess how close you can get to any particular sampling location by car (safely), because this will affect how quickly surveys can be conducted.

5. Layout your sampling plot and collect your samples

Once you arrive at a sampling location, lay out a plot as shown in the diagram below, using the marked rope. Please note that in each field we recommend three (3) quadrats are sampled to capture the variability within fields. We suggest placing the first quadrat (note in ODK these are called *Child1*) roughly in the center of the field and the other two on a diagonal line between the corners. The process is:

- Mark out the 5 x 5 m quadrat around the GPS point used for soil sampling.
- Quadrat 1 (*Child1*) should be roughly in the middle of the field
- The quadrat should be aligned in the direction of the rows and start between rows, not on a row
- Take the GPS reading in the middle of the plot and record in ODK.
- Count all the plants within the quadrate and record in ODK.
- Harvest all the cobs with grains and layout in a row. Count and record the number of cobs in ODK.
- Select every 10th cob, bag, label with a QR code. Weigh the cobs, and scan the code in ODK. Keep for dry weight measurement.
- Bag the remaining cobs, weigh and record in ODK. Return cobs to farmer.
- Repeat for quadrates 2 and 3

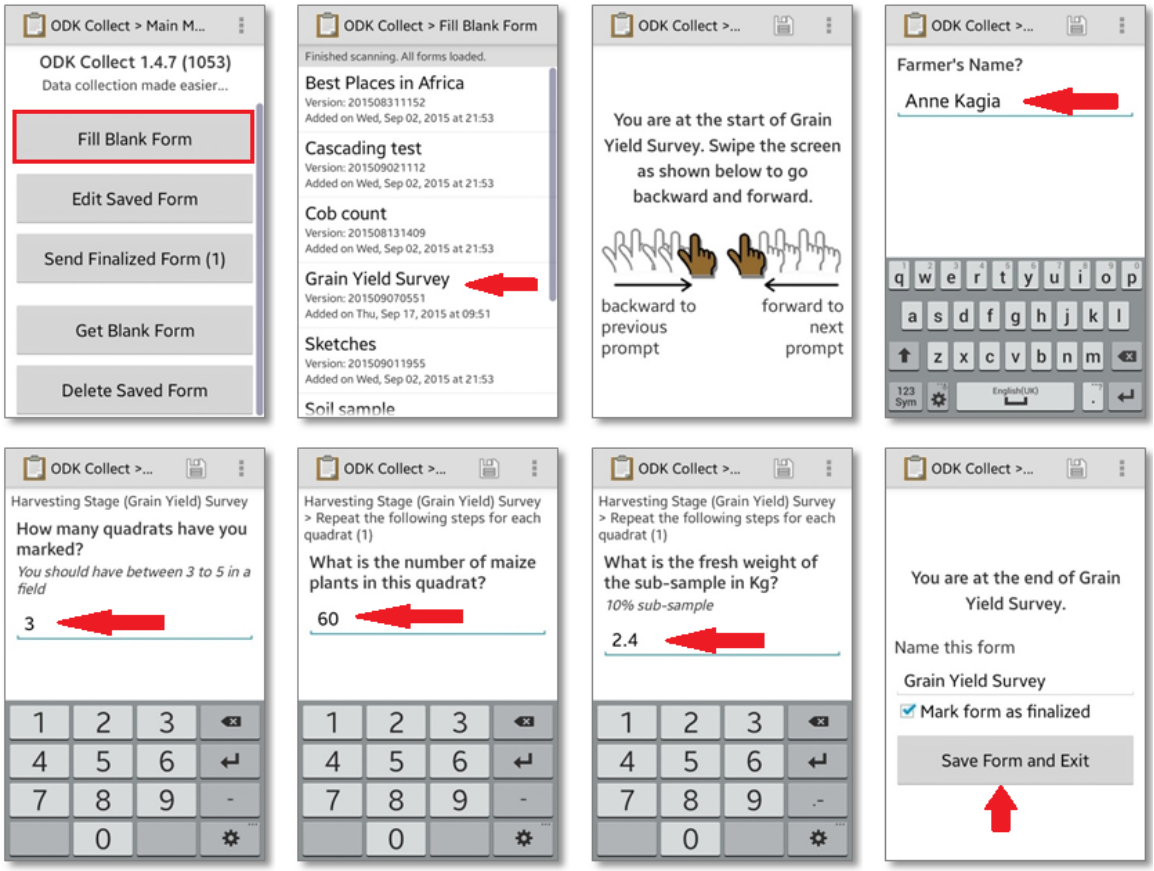




Repeat for quadrats 2 and 3.

6. Record your samples using the "Grain Yield Survey" ODK form

The yield sample ODK form is intended to allow you to record a uniquely identified, georeferenced, and time stamped yield sample into the TAMASA and/or into your own database. The main steps for completing this form are summarized in the diagram below.



In the ODK form, quadrats are labeled/named as *Child1, Child 2* and *Child3*

VI. Grain yield estimation

One thing missing in the above yield SOP is a description of what the physical sampling procedure is. This is my best attempt:

Grain yield estimates are made on the basis of a cob sample taken from each field. Within each field, three 5x5 meter quadrants are established as follows:

1) Navigate to the center of the field, and mark out the first 5x5 meter quadrant
2) From the center quadrant, along the longest axis, move to a point midway between the center and one edge; mark the second quadrant here.
3) Returning to the center quadrant, again along the longest axis, move to a point midway between the center and the edge opposite to the side previously traversed; mark the third quadrant here.

Within each of these quadrants, do the following:

1) Count all stands
2) Count all cobs
3) Take a 10 percent sample of cobs (e.g. if cob count is 91, take 9)
4) Weigh this sub-sample, record the weight, and put in bag

Combine all cob sub-samples from the three quadrants in a single bag, provide and record a bar code identifier.