The tasks to be performed at the Minimalistic Reference (MRS) sites

At each MRS site four (4) unit-volume composite samples should be collected. Two unit-volume composite samples representing the *surface* (0 – 5 cm) should be collected for 1.) pesticide residue and 2.) bulk density analysis. One unit-volume composite sample should be collected from the 3.) 20-50 (*subsoil*) and one unit-volume composite sample should be collected from the 4.) 0-20 cm (*topsoil*) depth interval for bulk density determination. Each sample should be a composite sample composed from three (3) subsamples collected from the soil surface, main and side walls of a mini pit that has to be excavated at the center of the sampling location. In case of favorable circumstances (eg.: non-present hard rock, plinthite, extreme compaction or cementation within the sampling depth) you need to have four (4) samples (2 *surface*, 1 *topsoil*, 1 *subsoil*) at each MRS Site.

Using the ODK Collect App for data recording

You need to follow the next steps to connect your ODKCollect app to the server established for the Reference Site activities:

1. Open the ODKCollect application
2. On the main screen select "Get Blank Form"
3. Select "Soils4Africa **Minimalistic** Reference Site description tool"
4. Click "Get Selected"
5. On the main screen select "Fill Blank Form"
6. Select "Soils4Africa **Minimalistic** Reference Site description tool"
7. You can start the data collection.

Main steps in the ODK form "Soils4Africa Minimalistic Reference Site description tool"

Entering general information

The mandatory fields are marked with a red *

1. Specification of the *unique identifier of the sampling location*. Note that you must enter the information in the given way. If you enter the information incorrectly the application will warn you and will not let you continue.
2. You need to select the date and time of the field work.
3. You need to specify the surveyor persons.
4. You need to record the coordinates of the sampling location.
5. Taking photos of the mini-profile:

The form will ask you to take or upload pictures on the mini-profile that you need to prepare for undisturbed sampling. Preferably you should take photos of the main and side walls of the mini-profile that you sample. If you would like to take or upload multiple images, you need to perform that one by one. After taking a photo, click "Next", select "Add" and take the next photo. Repeat this procedure as many times as many photos you would like to take/upload. If you are ready with taking photos select "do not add" after clicking "Next".

Record information on the sampling

You should provide information on the sampling of the *surface*, *topsoil* and *subsoil* as well.

If you haven't been able to collect the sample (either surface or subsoil or topsoil, or neither of them) you should provide information on the restrictive conditions.

Scanning the QR code for the samples

If you have been able to collect the unit-volume samples, you should scan the QR code that is the unique identifier of the samples.

Be careful not to scan the same QR code for surface/topsoil/subsoil samples!

Generating QR codes for labelling of the unit-volume soil samples

The Country Supervisor will generate labels for the soil sample ID (UDSS-ID) for all unit-volume samples to be taken on the MRS sites within the country. The steps of the QR code generation are described in "Instruction manual for Country Supervisors". The generation of the QR codes particularly for the MRS sites is the following:

- Visit the following homepage: https://tag.qed.ai/sheet/

- Leave all settings default except of:
- Margins Top: 5 mm, Bottom: 5 mm, Left: 10 mm; Right: 10 mm
- Length: 5
  - **Prefix**: u"country_code" (eg.: uDRC)
  - **No. of codes**: set a number that is ~20% higher than four times the number of the Minimalistic Reference sites in within the country (eg.: 36 sites – 4 × 36 * 1.2 = 172,8 set the No. of codes to 175
  - Columns: 6 Rows: 8
  - Code padding: 1
  - Font size: 14

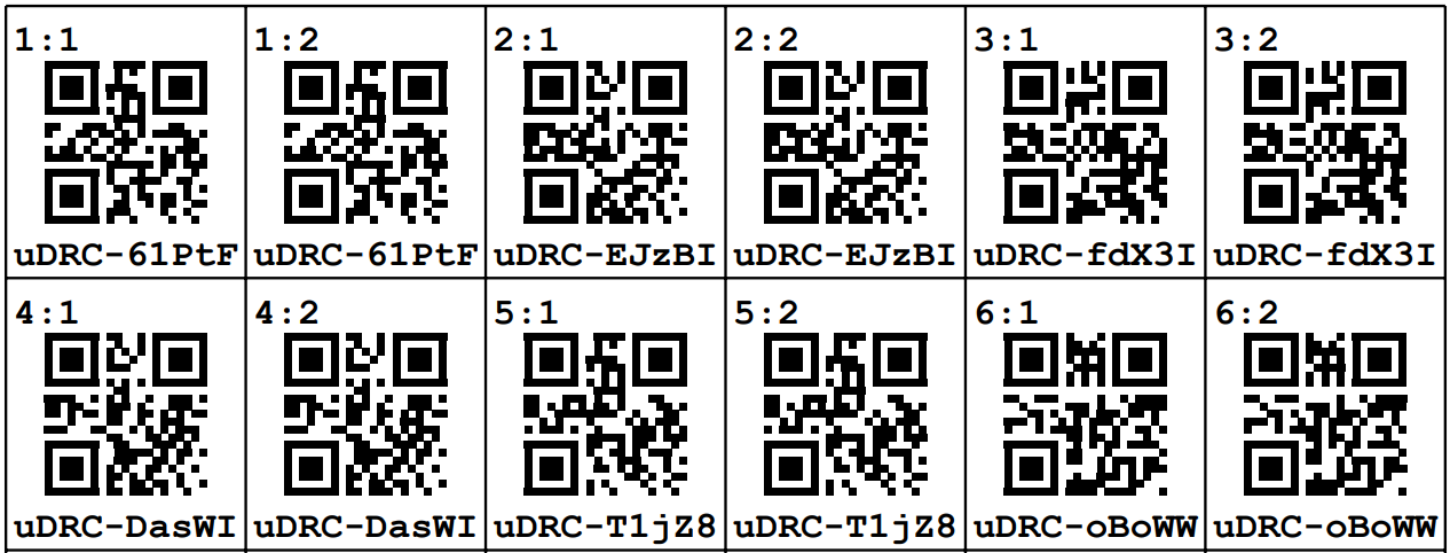

Figure 1.: Examples of QR codes for the undisturbed samples

For printing, laminating, protecting, cutting recommendations and requirements read the relevant section of the "Instruction Manual for Country Supervisors".

Tools needed for taking the undisturbed samples on MRS sites

The following tools are needed for preparing the mini-pit and taking the undisturbed samples.:

1. A spade
2. A shovel
3. A hammer or a mallet
4. An undisturbed sampler tool (optional)
5. A block of wood to protect the metallic rings
6. Short and long knives
7. At least two metallic rings of 100 cm^3 volume (seven rings are recommended)
8. A measuring tape.

Figure 2.: The tools needed on the MRS sites

Brief overview of the tasks to be performed on minimalistic Reference Sites

1. Delineate a ~70 × 90 cm area on the soil surface, at the central point of the sampling location.
2. Take three unit-volume (3 × 100 cm^3) soil sub-samples from the *surface* (0 – 5 cm depth interval). Put the three soil cores into the same *surface* plastic bag to have a composite unit-volume *surface* sample (300 cm^3) for pesticide residue analysis.
3. Repeat step 2 to collect a composite unit-volume *surface* sample (300 cm^3) for *surface* bulk density analysis.
4. Prepare a 50 cm deep mini profile with clean, straight, vertical main and side walls at the center of the sampling location
5. Take three unit-volume (3 × 100 cm^3) soil sub-samples from the *subsoil* (20 – 50 cm depth interval). Put the soil cores into the same *subsoil* plastic bag to have a composite unit-volume *subsoil* sample (300 cm^3).
6. Take three unit-volume (3 × 100 cm^3) soil sub-samples from the *topsoil* (0 – 20 cm depth interval). Put the three soil cores into the same *topsoil* plastic bag to have a unit-volume *topsoil* sample (300 cm^3).
7. Record the required information in the ODK application (take photos, provide information on any obstacles influencing the success of the sampling).
8. Scan the barcodes of the surface, topsoil, and subsoil samples.

Important remarks for the undisturbed sampling

Do not attempt to collect the samples in situations when there is a risk to damage the metallic ring. Examples of these situations:

- Hard rock or large coarse fragment content
- Extreme compaction
- Extreme cementation
- Iron pan or plinthite

Detailed protocol for performing undisturbed sampling

The preparation procedure of the mini profile for the undisturbed sampling needs the use of shovel and spade. Thus, even the taking of the standard (baseline) samples at the MRS sites is recommended by using spade (watch the relevant instruction video and read the section 6.2.2 of the Protocols of Field Survey), because the further preparation steps needed for having a proper surface for undisturbed sampling is straightforward if an already opened (however not yet prepared) pit is available.

Note: the description below describes the protocol of undisturbed sampling when full undisturbed sampling toolkit (hammer/mallet, metallic ring(s) and sampler) is not, only a hammer and one or more metallic ring(s) are available.

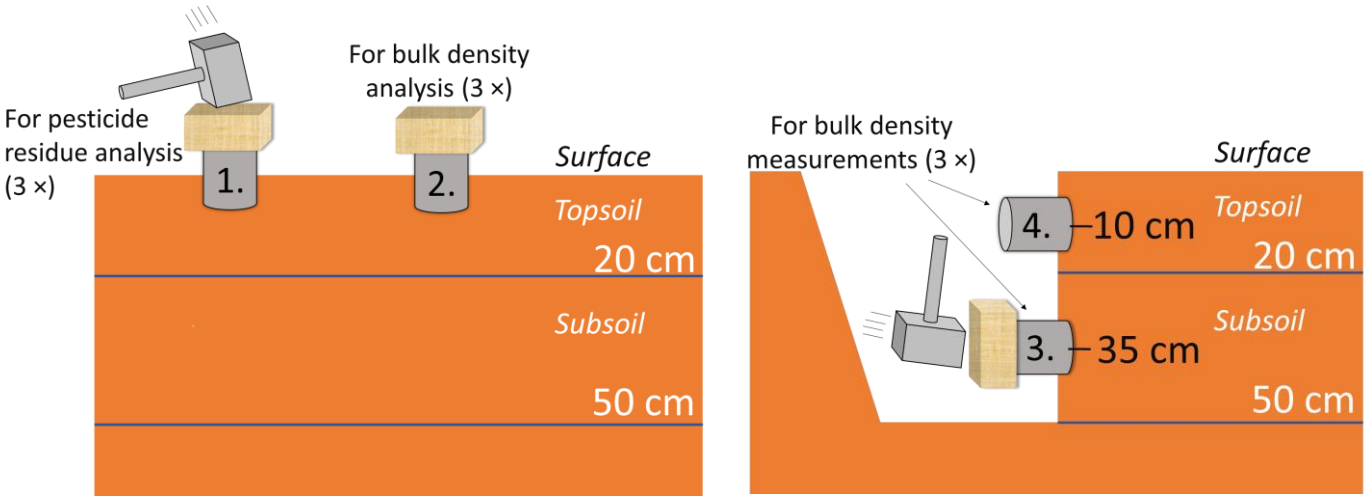

Figure 3. The layout of the sampling location. The image on the left shows the procedure of surface sampling prior opening the "mini-profile". The image of the right shows the procedure of taking the subsoil and topsoil samples from the main wall of the "mini-profile".

Taking undisturbed *surface* samples for pesticide residue analysis and *surface* bulk density

The two unit-volume samples for the 1.) pesticide residue analysis and 2.) surface bulk density should be taken from 0 – 5 cm depth interval (*surface*). For the *surface* sampling the metallic rings used for the undisturbed sampling should be used. Each sample should be a composite sample composed from the three (3) subsamples collected from the soil *surface*.

1. Prepare the tools needed for the undisturbed sampling. You will need a *hammer/mallet*, *metallic ring(s)* with the volume of 100 cm^3, and a *piece of wood* for protecting the ring.
2. Remove the vegetation residues, grass, and litter, if any, from the surface.
3. If you have at least six metallic rings you can arrange them in advance prior starting the sampling. Arrange them in 3 × 2 configuration (Figure 3.). The upper left, central right and lower left sample should be collected for pesticide residue analysis. The upper right, central left and lower right sample should be collected for bulk density analysis. You can do it in the other way around as well but be sure that samples collected from opposite sides will be put in the same bag.
4. Place the metallic ring on the soil surface, beveled edge parallel with the surface to collect the surface sample.
5. Gently press the ring into the soil with your palm if possible. Do not force it, if you are not able to push further inward, stop.
6. Gently press the metallic ring into the soil with the help of the hammer. Use a block of wood to push the ring with the hammer to avoid compaction of the soil and protect the ring. Avoid pushing the ring in too far or the soil will compact.

Fugure 4.: The procedure of cleaning the surface and hammering the metallic ring into the soil surface

7. Make four cuts with a spade at 8-10 cm from the metallic ring. Avoid to stand/step where the ring is hammered. Extract the resulting clump of soil with the spade.

If the soil is too compacted or too loose, and you can not extract a clump, excavate the ring by using knives (see Figure 7.)!

8. Excavate a little bit around the ring outside edge of the ring with a small, flat-bladed knife.
9. Fully excavate the ring by using a longer, flat-bladed knife. Remove excess soil from the bottom of the ring and around the outside edge of the ring with the knife.
10. Push the soil core into the plastic bag.
11. Repeat these steps for all the remaining 5 points.
12. **At the end you should have the <u>content of three metallic rings in one plastic bag</u>. You should have 2 plastic bags containing 300 cm^3 sample for pesticide residue analysis and 300 cm^3 sample for bulk density analysis.**

Figure 5.: Extracting of the the ring

Figure 6.: The excavation of the ring and bagging

Figure 7. The extraction and excavation of the ring in case when the soil surface if compacted or too loose to be able to extract a clump

Preparation of the "mini-pits" for subsoil and topsoil sampling

1. Prepare the mini pit. The "mini" pit should be at least 50 cm deep, and wide enough to ensure the convenient sampling. Prepare the main wall of the "mini-pit". It should be as flat as possible, and debris-free (Figure 9. right).
2. Put the measuring tape on the main wall to identify the sampling depths.
3. Take a photo in the ODK form showing the full profile (example photo can be seen on Figure8. right).

Figure 8.: the prepared main walls of the "mini-pit". You should take a photo in the ODK form like this one.

Performing the sampling of the SUBSOIL

1. Place the metallic ring on the main wall, beveled edge parallel with the main wall centered at 35 cm depth to collect the undisturbed subsoil. Try to avoid roots and cracks.
2. Gently press the ring into the soil with your palm if possible. Do not force it, if you are not able to push further inward, stop.
3. Gently press the metallic ring into the soil with the help of the hammer. Use a block of wood to push the ring with the hammer to avoid compaction of the soil and protect the ring. Avoid pushing the ring in too far or the soil will compact.
4. Excavate a little bit around the ring outside edge of the ring with a small, flat-bladed knife (See the full procedure on.
5. Fully excavate the ring by using a longer, flat-bladed knife. Remove excess soil from the bottom of the ring and around the outside edge of the ring with the knife.
6. Push the soil core into the plastic bag.
7. Repeat these steps at the two side walls of the profile as well to have the three sub-samples.
8. At the end you should have the content of three metallic rings in one bag representing 300 cm^3 subsoil material.

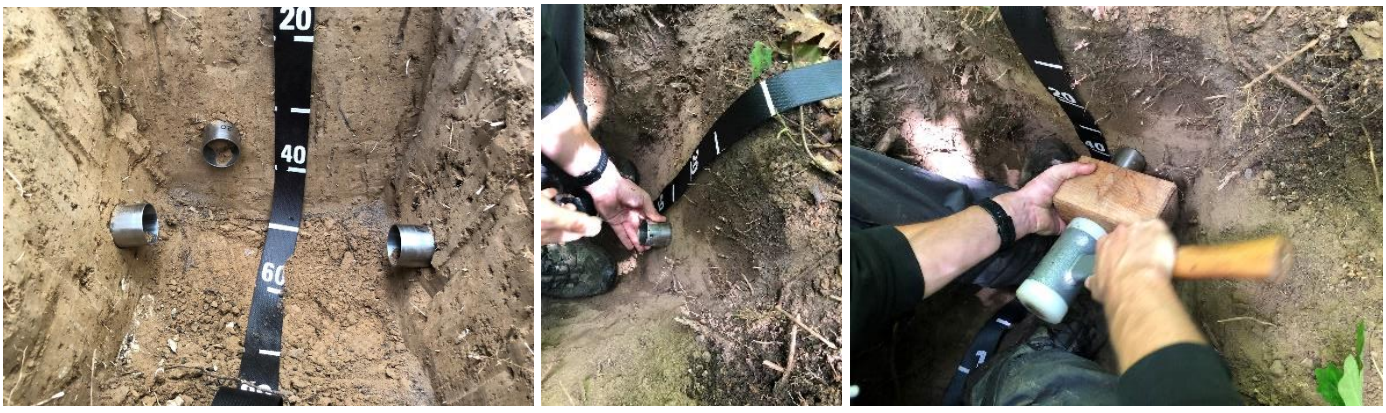

Figure 9.: First steps of pushing the metallic ring into the soil

Figure 10.: Hammering the metallic ring into the soil, and the excavation

Figure 11.: Full excavation and removing excess soil material

Performing the sampling of the TOPSOIL

1. Follow the protocols of sampling the subsoil (steps of 1 – 5) for taking the topsoil unit-volume sample. The sampling depth is preferably 10 cm.
2. Important note: if you took the subsoil sample from the left side of the "mini-profile", take the topsoil sample from the right side of the "mini-profile".
3. Put the soil core into the plastic bag.
4. Repeat these steps at the two side walls of the mini profile to have three sub-samples.
5. At the end you should have the content of three metallic rings in one bag representing 300 cm^3 topsoil material.

Figure 12.: Taking the undisturbed topsoil sample.

Bagging and labelling the subsoil, topsoil, and surface samples

The samples should be bagged and labelled the same way as the standard samples are. The differences are: QR codes starting with “u” should be used and different labelling should be indicated on the outer bag.

The samples collected should be double bagged using a plastic bag as inner bag and a cloth/paper bag as outer bag. The QR code is put between the inner and outer bag (ensure the bar code is scanned before it is put in the bag).

The first step of labelling is done in the ODK form by scanning the barcode at the appropriate section of the form. After scanning, put the QR code between the outer and inner bag.

On the outer bag, write the sampling point ID, and indicate PR_SURFACE for pesticide residue analysis, BD_SURFACE for surface, BD_TOPSOIL for topsoil, BD_SUBSOIL for subsoil bulk density analysis. Write with permanent maker.

Figure 13.: The plastic bags containing the 400 cm^3 soil samples, the QR codes that should be put into the cloth bag (left). The bagged, labelled surface, topsoil, and subsoil samples (right)

Final remarks

During the sampling keep the following questions in your mind:

Did I take a photo of the prepared, cleaned wall of the mini profile?

Did I put the three undisturbed subsoil sub-samples in the same plastic bag?

Did I put the three undisturbed topsoil sub-samples in the same plastic bag?

Did I put the three undisturbed surface samples for pesticide residue analysis in the same plastic bag?

Did I put the three undisturbed surface samples for surface bulk density analysis in the same plastic bag?

Do I have 4 bags per sampling site representing the surface (2), subsoil (1) and topsoil (1)?