

REFERENCE SHEET – SOIL HEALTH ASSESSMENT TOOL KIT

METHOD FOR MEASURING SOIL AGGREGATE STABILITY IN WATER

MATERIALS:

1. Water to fill tubs and rinse basins/bottles, about 7-10 L per sample.
2. Wash bottles, these can be the standard laboratory type or made from 500 mL plastic water or soda bottles, by punching 20-30 small holes in the lid with a safety pin or thumbtack.



Figure 1. Different options for coarse mesh with openings of size between 8 and 12 mm to pass coarse aggregates before drying the soil fully.



Figure 2. 2mm sieve for the first sieving step in water.



Figure 3. 0.25 mm or 250-micron sieve for the second sieving step in water, made from the top and lid of a plastic bucket, diameter between 20 and 25 cm.

3. Sieve or mesh with holes ideally between 8 and 12 mm. This is to pre-sieve the soil to a size that corresponds to the largest aggregates, before drying (Fig. 1).
4. 2 mm and 250-micron (0.25 mm; Figs. 2 and 3) soil sieves. The 250-micron sieve can be made by cutting the top of a bucket, creating a large hole in the flat part of the lid, and placing the sieve between the hole lid and the ring of the cut bucket.
5. Small cloth squares of 15x15 cm for capturing soil fractions. These can be pre-labeled with the names of the experimental soils or treatments, and weighed in grams for their tare weight, for example 3.1 g.
6. Cylinder or open tube made from a cut plastic or metal container and a rubber band to attach the cloth squares to it, to capture the washed aggregates.
7. Small tubs and/or buckets to rinse aggregate fractions and transfer them.
8. A metronome app and a chronometer app on a cellphone, ideally on two different cell phones or on a computer. The metronome should be set to 50 beats per minute. You can also download a sound file from the website, see below in step 7.

PRE-SIEVING AND DRYING OF SOIL:

1. **IMPORTANT:** when taking the sample, do not immediately sieve the soil to 2 mm, but allow it to dry slightly until it reaches a moist but workable (friable) point. Aggressive sieving destroys many of the natural aggregates we are trying to measure with this method.
2. The soil to be measured should not be extremely wet. Rather, it should be slightly moist, that is, the aggregates or soil must be dark due to humidity or at least have a dark interior when the aggregates break.
3. Working carefully and using different parts of the sample to obtain a representative subsample (i.e., not just the large, hard lumps but all possible fractions of the sample), pass 500 g or more of the sample through the large mesh with 8-12 mm holes. Any fragments that do not immediately pass through the sieve should be broken gently, using fingertips to break up large aggregates along natural planes of weakness. Discard any stones that are larger than the large mesh size.
4. Allow this sample to air dry as much as possible. It is also possible to dry it in an oven, or under cover in a paper bag in the sun, at a temperature of **no more than 60°C**.



Figure 4. Breaking large aggregates along planes of natural weakness in the soil, to make aggregates that pass the large mesh (8-12 mm)

MEASURE STABLE AGGREGATES USING WET SIEVING:

5. Fill a tub to about 5 cm with water. Place the 2mm sieve in the water. The upper rim of the sieve should still be above the water.
6. Place 70 g of soil on the sieve immersed in the water. Wait 5 minutes. During this time, the soil will absorb water and the aggregates will break down as they become wet, due to the pressure created by the absorption of water into the aggregates.

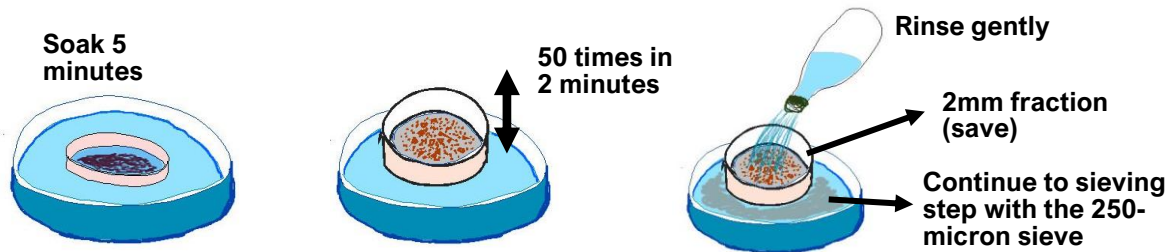


Figure 5. First steps in the wet sieving of aggregates. The washing and rinsing steps for the 2mm fraction shown here are repeated for the smaller 250mm fraction on the corresponding sieve, in step 7 below.

7. After soaking for five minutes, move the sieve out and into the water slowly, 50 times in 2 minutes. This can be done using a metronome app on a cell phone, with a rhythm of 50 beats per minute, rising and falling each beat for 25 cycles per minute. There is also an mp3 sound file available on the website (<https://smallholder-sha.org>) containing 2 minutes of this rhythm.
8. Remove the sieve from the water, then rinse it gently with the wash bottle to wash off any loose material less than 2 mm from the fraction larger than 2 mm that has remained on the sieve.
9. Set aside the 2 mm sieve with the large stable aggregates, call this the >2mm fraction.
10. Transfer what is left in the tub (aggregates smaller than 2mm, loose soil, and water) to the second smaller sieve (250 microns), which you should place in another empty tub. Add more water to the sieve, if necessary, until the sample on the sieve is covered with water (e.g. 3 to 4 cm deep) to repeat the type of washing in and out of water that was performed in step 3.
11. Repeat the washing step: raise and lower the sieve with the sample 50 times for two minutes, then rinse the aggregates on the sieve gently with a wash bottle and set the sieve with aggregates larger than 250 microns aside.
12. Discard the material in the basin that passed the 250 micron sieve. In this analysis these small particles are not part of stable aggregates. There are other methods that also consider the smallest fractions as micro-aggregates.
13. Now, with each of the fractions, perform the following action to recover the fraction on a square of fabric for drying:
 - a. Turn the sieve upside down into a larger container, which can be a tub, a large soup plate, or a small bucket, to transfer the aggregates.
 - b. Rinse the sieve, aggressively if necessary, in the tub with the sink to recover all soil particles for each fraction. It does not matter now if any aggregate breaks and that the aggregates are now suspended in water.
 - c. Pass the tub fraction, along with its water, through a square cloth that has been mounted on the end of a small plastic cylinder (a cut plastic jar, for example) or placed in a small kitchen strainer (15 cm in diameter, say).
 - d. Label the fabric square if it was not already labeled and set it aside to dry.
14. In this way, for each soil sample, you will recover the two fractions in the two cloths, one containing aggregates > 2 mm, and another with a size between 250 microns and 2 mm.

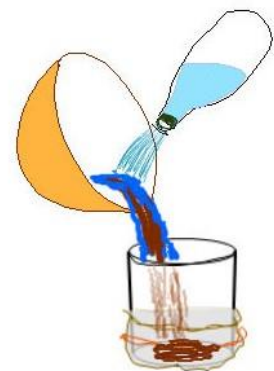


Figure 6. Cylinder with a cloth at one end to receive fractions of the stable aggregates. Each fraction is captured in a large bowl or basin before passing it through the cloth.

CALCULATION OF RESULTS:

15. When the sample is completely dry, take the >2 mm sample and remove it from the cloth to weigh it. If you have tared the fabrics, you can weigh the entire fabric plus the soil

and subtract out the tare in the calculations below. Record this total weight in grams, either along with the tare weight of the fabric, or the soil alone (different options are shown below for the calculations with and without tares). Do not throw away this fraction so that you can select or sieve out the stones >2mm.

16. Now sieve this >2mm fraction quickly through a 2mm sieve to recover only the stones and weigh them in grams. If there are only a few stones, they can be hand selected from the fraction. These stones will be subtracted in the calculations below.
17. Weigh the 250-micron fraction at 2 mm in the same way, removing it from the fabric or weighing the fabric plus the soil and subtracting the tare of the fabric (below).
18. In the case of the smaller fraction (between 250 microns and 2 mm fraction), the stones are not separated since the entire fraction is defined as soil (<2 mm) rather than stones.
19. Now you should have these 3 weights: weight of whole fraction > 2 mm, weight of stones > 2 mm and weight of whole fraction from 250 microns to 2 mm. You may also have two small tare weights of the fabric squares associated with the two fractions, which you need to subtract to find the net weight of the aggregate fractions. These can be recorded in a table like:

Sample	Initial soil weight	Weight of the fraction > 2 mm	(if present) Tare of the cloth for >2mm fraction	Weight of stones >2 mm	Weight of the fraction 250 microns to 2 mm	(if present) Tare of the cloth for 250 micron to 2 mm fraction
example	70.3	30.3	3.1	4.1	35.4	3.9
1						
2						
3						

20. You will now calculate the percentage of aggregates in the fraction >2mm, and the proportion in the fraction between 250 microns and 2 mm. Each of these is calculated as a proportion of the stone-free soil in the measurement. So, to start, calculate the initial weight of soil without stones:

(1) **Initial soil weight without stones** = 70 g – weight of stones that were sieved out

Now you can also need to subtract the stones from the weight of the fraction > 2 mm:

(2) **2 mm aggregate weight without stones** = Fraction > 2 mm – weight of sieved stones

OR, if the aggregates were weighed with the cloth, subtract out the cloth tare:

(3) **2 mm aggregate weight without stones** = Fraction > 2 mm – cloth tare for >2mm fraction - weight of sieved stones

So now finally the proportion of soil without stones that was in aggregates > 2mm:

(4) **Percentage of >2mm aggregates** = 2 mm aggregate weight without stones, from (2) or (3) / (soil weight without stones, from (1))

21. Now the proportion of 250 micron to 2 mm aggregates must also be calculated, also using the soil without stones calculated previously in (1):

(5) **Percentage of aggregates from 250 microns to 2 mm** = (weight of aggregates 250 microns to 2mm) / (soil weight without stones, from (1))

OR, if the aggregates were weighed with the cloths, subtract out the cloth tares:

(6) **Percentage of aggregates 250 to 2 mm** = [(weight of aggregates 250 microns to 2mm) – cloth tare] / (soil weight without stones, from (1))

SCORING AND INTERPRETATION TABLE FOR THE AGGREGATE STABILITY TEST:

	Score based on the sum of the percentages of stable aggregates in the 250 µm and 2mm classes			
Textural type of soil	Very low	Low	Medium	High
Soils with very coarse texture: sands and loamy sands.	<i>Stable aggregation does not develop much and is not very useful in describing soil health. Aggregation may be observed in a dry soil but is not expected to be stable in water.</i>			
Soils of coarse to medium texture: (Sandy loams, loams, silt loams, silts, with less than 35% clay)	<15%	15% - 30%	30% - 45%	>45%
Soils with fine texture: (clays, sandy clays, silty clays, silty clay loam; with greater than 35% clay)	<20%	20% - 40%	40% - 55%	>55%