CIFOR World Agroforestry	**SOP 002**	**Date: 28.02.2022** **Author:** Lukelysia Mwangi **Authorizer:** David Lelei

STANDARD OPERATING PROCEDURE

METHOD FOR SOIL WET SIEVING USING EJIKELKAMP APPARATUS

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1. Inclusion of workflow
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ABBREVIATIONS

CIFOR-ICRAF - Center for International Forestry Research - World Agroforestry

MSDS - Material Safety Data Sheet

HMP - Sodium hexametaphosphate

1. INTRODUCTION

Soil aggregates are soil particles held together by cohesive forces, secondary particles and organic matter more strongly than the surrounding mass. Whilst soil aggregate stability is the ability of soil aggregates to resist stress such as tillage, swelling and shrinking process and fast wetting raindrops which cause aggregate disintegration. Soil aggregates are arranged to form soil structure. Soil structure is defined by the combination or arrangement of primary soil particles into compound elements, which are separated from adjoining structural elements by surfaces of weakness. Thus, a properly structured soil allows gaseous, water movement and storage, biological activity and stability which are important for plant growth.

Aggregate sizes and distribution are important parameters for soil porosity and pore size, and this affects water and air movement within the soil matrix.

Some aggregates readily succumb to disruptive forces such as the water entry into the soil matrix breaking the cohesive forces leading to the disintegration of the aggregates into primary particles. Such aggregates are held together by weak forces and therefore give way easily to the disruptive forces. On the other hand, stable soil aggregates are held by strong cohesive forces and resist disintegration. The smaller aggregates are more stable than the larger one and hence a lot of care is required while maintaining the larger aggregates. The important factors for stabilizing the soil aggregates includes biological and physicochemical processes. Soils high in organic matter are much more stable than those with low OM.

The wet aggregate stability is determined on the principle that unstable aggregates will break down more easily than stable aggregates when immersed into water. The most common method used for aggregate stability measurement is wet sieving. Soil structure is one of the main factors controlling plant growth by its influence on root penetration, soil temperature and gas diffusion, water transport and seedling emergence and therefore it is an important soil characteristic for farmers. Soil texture, soil structure, and the type of clay mineral, organic matter content and type, cementing agents and cropping history influence the aggregate stability. Among the

mechanical destructive forces are soil tillage, impact of heavy machinery, treading by animals and raindrop splash. Physico-chemical forces are e.g., slaking, swelling and shrinkage, dispersion and flocculation. Slaking is the process of structure breakdown under the influence of wetting of soil aggregates, due to swelling of clay minerals, dissolving of cementing agents, air explosion or reduction in pore water suction.

The purpose of this SOP is to give detailed instructions to ensure replicability, consistency and data accuracy during soil aggregate analysis process in space and time while assessing the health of the soil.

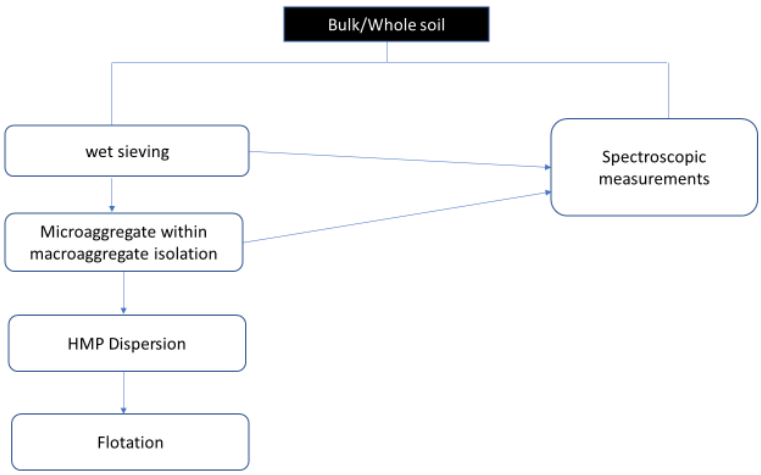
2. SCOPE AND APPLICATION

Due to the impact of aggregate stability on plant growth and soil loss, the wet sieving process is applied in agriculture and land conservation. This method of determining aggregate stability is useful for researchers and scientists on soil erosion, land degradation and conservation, agriculture, sustainable agriculture domains. Determining aggregate stability will give information on the sensitivity of soils to water and wind erosion, which might be prevented by practicing farm management practices such as mulching, planting of cover crops, and conservation agriculture. Information on soil aggregate stability will improve tillage programs, adapted to specific soil type and crop demands.

3. PRINCIPLE

The wet aggregate stability is determined on the principle that unstable aggregates will break down more easily than stable aggregates when immersed into water. To determine the stability, 8 sieves of 2.00 mm each are filled with a 4.00 gm of soil. These sieves are placed in a can filled with water, which will be moved up and downward for 3 minutes. Unstable aggregates will fall apart and pass through the sieve and are collected in the water-filled can underneath the sieve. After 3 minutes, the cans are removed and replaced by new water filled cans. Now, all aggregates will have been separated. After drying the cans with the aggregates, the weight of both stable and unstable aggregates can be determined. Dividing the weight of stable aggregates over total aggregate weight gives an index for the aggregate stability. To prevent slaking of the aggregates when putting the filled sieves into the water filled cans, the aggregates are pre-moistened with water vapour, using a humidifier or a very fine plant sprayer.

Workflow



4. PROCEDURE

4.1 TOOLS AND EQUIPMENTS

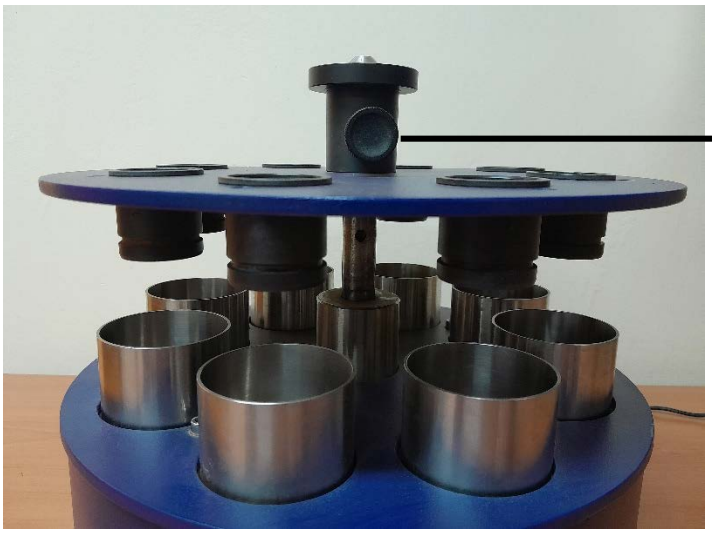
a) Wet sieving apparatus
b) oven
c) Beakers
d) khaki bags
e) Wash bottles
f) Distiller
g) Mark pens
h) Spatula
i) Weighing Balance
j) Dust coat, nose masks and gloves
k) Wooden Trays

4.2 SETTING UP THE EJIKELKAMP APPARATUS

Determining aggregate stability using the wet sieving apparatus:

- 32g of air-dried soil is weighed in a digital balance, from these, place 4g into each of the 8 sieves each 2000 µm opening
- Place the weighed (numbered) cans.
- Place the sieve holder on the build-in stop.
- Place enough distilled water into the cans to cover the soil. The water can be put into the cans through the special can-fill openings in the sieve holder. During the sieving it is important that the samples are moved under water (so add enough water to the cans).
- Slaking is done for a maximum of 5 minutes

- Check if the mains switch is in the “Off” position
- Put the Adapter into a wall plug
- Start the motor by putting the mains switch into “3 min” position and allow it to raise and lower the sieve holder for 3 min. ± 5 s.
- Machine automatically move the sieves up and down 100 times over 3 minutes. At the end of this time the motor will stop automatically.
- Raise the sieve holder out of the water and place it in the leak out position, by putting the sieve holder in the sieve holder in the first hole on the shaft. When there is no water leaking out of the sieves anymore, then place the (numbered) cans on a tray.



First hole on the shaft

Second hole on the shaft

- Place the sieve holder in the working position by putting the sieve holder in the second hole on the shaft
- Soil in each sieve holder is gently backwashed in to a beaker and the same process is repeated with 250µm sieve and 53µm sieve
- The content in the beaker taken from the suspension containing the <53 µm silt and clay sized are oven dried at 60°C and weighed
- The weight of the materials in each can is then determined by weighing the can, plus contents on a digital balance, and subtracting the weight of the can to obtain the net aggregate weight

- After the samples are weighed, they are then transferred in to zip locks awaiting further analysis
- Sand correction: to be done following the sand correction protocol
- The data of the dry weights is recorded in soft and hard copies.

4.2.1 SAND CORRECTION FOR SOIL AGGREGATE FRACTIONS

Sand of the same size as the aggregate is usually not part of an aggregate and should not be weighed as an aggregate. Thus, weights of macro- and microaggregates to be corrected for the sand content of the same size as that of the aggregates.

4.2.2 PROCEDURE

- Take 5g subsamples of the aggregate fraction (macro- & microaggregates) in pre-weighed beakers and dry overnight in the oven.
- Take the fractions out of the oven and let them cool off in the desiccator and weigh the sample and transfer to centrifuge tubes.
- Add 20 ml 0.5% (5 g/L) sodium hexametaphosphate (NaHMP) to the aggregate fraction in the centrifuge tube and shake on a reciprocal shaker for 18 hours (overnight).
- After dispersing the aggregate fraction in 20 ml of sodium hexametaphosphate, sieving through 53 µm sieve.
- The weight of sand that will remain on top of 53µ m sieve (from macro- and microaggregate fractions) to be oven dried and dry weight of each sand fraction to be determined.
- The weights of macro- and microaggregates to be corrected for the sand content of the same size as the aggregates:
- The proportion of microaggregate (53-250 µm) weight within macroaggregates (250-2000 µm) to be calculated as:

$$\frac{\text{(microaggregate weight - weight of 53-250 mm sized sand)}}{\text{(macroaggregate weight - weight of 250-2000 mm sized sand)}}$$

After this process, soil will be separated into four water stable aggregate size fractions:

l) Large macroaggregates (>2000 µm, LM),

m) Small macroaggregates (250 µm-2000 µm, SM),

n) Microaggregates (53-250 µm, mi)

o) Silt and clay sized particles (< 53 µm, S+C)

5. MAINTENANCE

The following signs should be followed keenly:

When the symbol shown on the left is placed before a piece of text, this means that an important instruction follows.

When the symbol shown on the left is placed before a piece of text, this means that an important warning follows pointing out a risk of injury to the user or damage to the device. The user is always responsible for its own personal protection.

Text Text in italics means that the actual text is shown on the display screen or instrument.

Note: Servicing of the wet sieving apparatus to be done twice annually.

6. OCCUPATIONAL HEALTH AND SAFETY

- All activities performed under this SOP comply with the recommendations of ICRAF Health and Safety policy
- Laboratory dress code: clean laboratory coats and low-heeled closed shoes worn at all times while performing the procedure.

7. REFERENCES

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8. ANNEX

1. Manufacturer manual link.

https://www.royaleijkelkamp.com/media/0v3hahtq/m-0813e-wet-sieving-apparatus.pdf

1. Detailed workflow.