YARD4ALL

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Guide for Using Mathematical Concepts on School Yard

Mathematical framework for monitoring of soil the School Garden

PROJECT

Yard4All – Using School's yard for ALL child's wellbeing and development

YARD4ALL PARTNERS

AEDCI - Agrupamento de Escolas D. Carlos I

AEA - Agrupamento de Escolas de Alfornelos

AFEJI - ASSOCIATION DES FLANDRES POUR L'EDUCATION DES ENFANTS ET ADOLESCENTS INADAPTES

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NTNU - NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU

Scoala Gimnaziala nº 28 – Romania - Scoala Gimnaziala Nr.28

AUTHOR OF THE DOCUMENT

Agrupamento de Escolas D. Carlos I

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1. INTRODUCTION

As we Know, school gardens can be help for the emergence of new approaches to teaching. The soil is nuclear in the school gardens.

When designing and planting your garden, you need to know whether the soil is acid or alkaline, as different plants thrive in different soils.

We will thus introduce the Soil theme that is relevant to have a garden at school.

Soil is a complex, living, changing and dynamic component of the agro-ecosystem. The word soil, in its broadest sense, refers to that portion of the earth crust where plants are growing.

Soil contains minerals from rock, organic matter from plants and animals and many useful living creatures such as worms, termites, bacteria and insects which help improve soil fertility. The soil stores nutrients and water in organic matter; so, the higher the organic matter content of the soil, the more nutrients and water it will contain.

Soil health is defined by the capability of the soil to sustain the productivity, diversity, and environmental services of the terrestrial ecosystems. In the agroecosystems, soil health can be maintained, promoted or recovered through the implementation of sustainable soil management practices. It is an assessment of how a soil performs all of its functions, which varies depending on inputs and soil management practices, and how these soil functions can be preserved. Because soil health is not something that can be measured directly, we need indicators that are easily measured, sensitive to changes in soil functioning and covering soil physical, chemical and biological properties. A set of soil physical, chemical and biological soil properties are used as parameters to assess soil health. The latter are relatively easy to measure in the field. (Doran et al., 2002)

Soil, like air and water, is one of the world's most important natural resources. Most of our food depends on soil - it is where we find the plants and many of the animals which make up our food, and it is home for billions of organisms. Soils provide many important functions for plants, animals and humans. The most obvious is to support the cultivation of crops, plants and trees in nature, on the farms and in gardens.

Soil types and characteristics:

Soil Type	Characteristics
Sand	Large particles, well aerated, usually yellow, orange or light brown in colour. This soil is light and easy to work but does not hold water or nutrients well
Clay	Small particles tightly packed, poorly aerated, good at holding water and nutrients. However this soil is hard to work, especially when wet, and is prone to waterlogging
Silt	Silt particles are medium-sized, somewhere in between clay and sand. Water and nutrients can move through silt particles better than in clay, but not as quickly as in sand. Even though this soil is fertile, it can't hold as many nutrients but it can retain water for a longer period of time.
Loam	Mixture of sand, silt and clay. Very fertile and easy to cultivate

Thus, when managing the soil it is important to understand that different soil types have different structure and texture.

Water:
Clings to soil particles and is taken up by the plant roots. Water is important in the soil because without it the plants and animals would die.

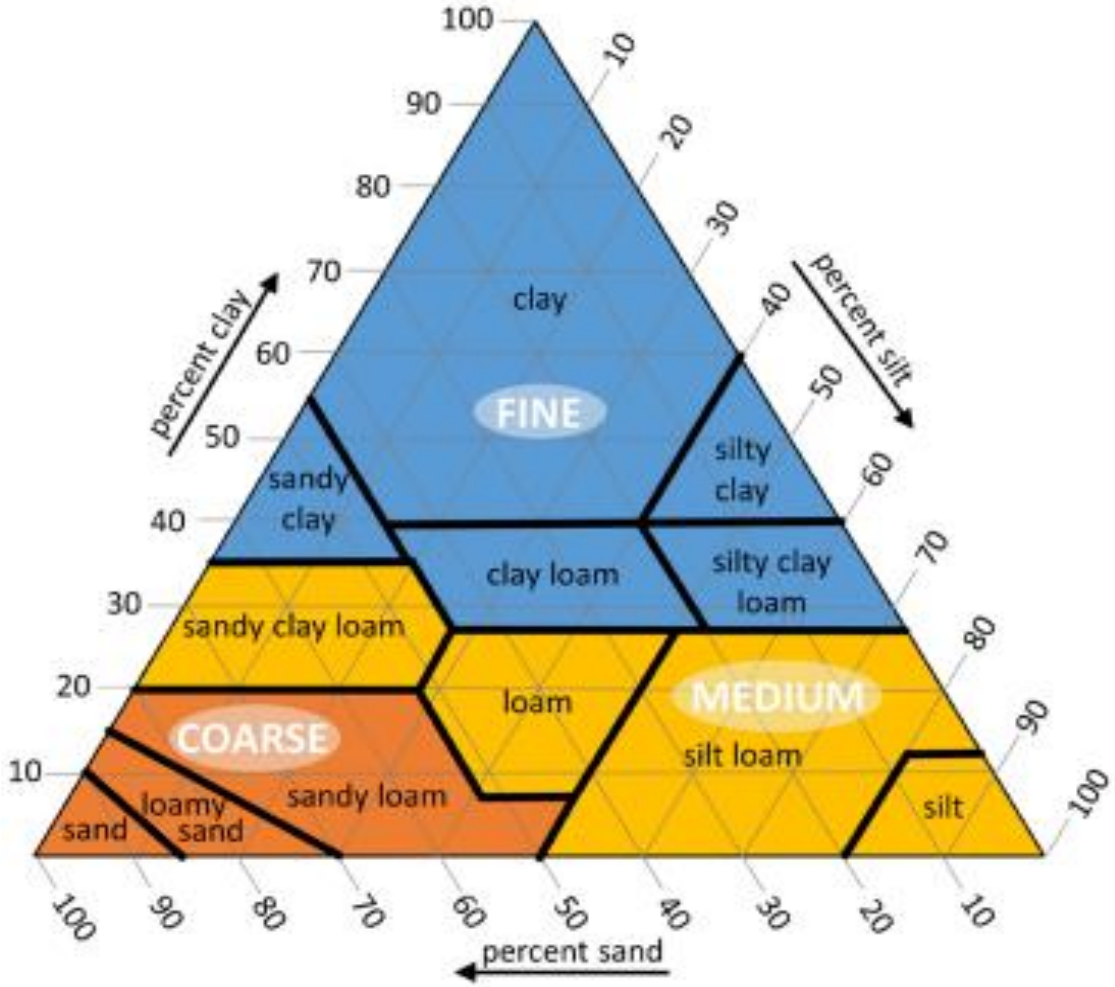
Organic matter:
Releases nutrients slowly as it rots and improves water holding. Organic matter is important in the soil because it improves water holding and helps stick the soil together.

Animals:
includes insects, bacteria and earthworms; Animals are important in the soil because they help rot down dead material.

Air: fills gaps in soil and allows the plant roots and animals 'breathe'

Just under half, about 35 to 40%, of a good soil is made up of water and air!

Textural triangle used in determining soil texture



Soils with different properties of sand, silt and clay are assigned different classes.

2. MONITORING THE SOIL

The best way to improve the long-term fertility and water-holding ability of the soil is to add organic matter.

Crops and trees need many nutrients from the soil in order to grow properly. Many soils lack some of the nutrients needed by crops and fruit trees. Chemical fertilizers can be used to supply nutrients directly to plants; however, they do not improve long-term soil fertility. In some circumstances they may be needed to address local soil deficiencies – but chemical fertilizers are expensive, hard to access and easily washed out of the soil by irrigation or rain.

Farmers can improve long-term soil fertility and organic matter content by using livestock manure or by applying compost or liquid fertilizer. The regular application of mulch also helps to maintain soil fertility, nutrient content and moisture retention.

Soil improving crops include all members of the legume family (peas, beans and groundnuts). They should be included in crop rotation and intercropped in beds with heavy feeders (such as tomatoes, cabbage and kale). Soil-improving trees such as sesbania, leucaena and pigeon pea can be planted around the edges of gardens orbetween rows of crops in fields. Pruning the leaves of soil improvers prompts the release of nutrients into the soil and ensures that crops get enough sunlight.

Manure or compost should be applied to beds every time you plant new crops at a rate of 1.5 buckets per square meter of bed. Liquid fertilizer should be applied to heavy feeder crops, especially at the flowering stage.

Livestock manure is animal waste (faeces). It contains large amounts of nitrogen, the main nutrient required for plant growth, as well as other important nutrients. It should be noted that fresh chicken manure contains such high levels of nitrogen that it can “burn” crops, so it should be added to compost heaps rather than being applied directly to beds.

Fertility trenches are large holes which are filled with organic material. The soil is replaced on top of the organic material and crops are planted in the soil. As the organic material rots, the crops take advantage of the extra fertility. Fertility trenches provide a longlasting means of improving soil fertility, but require a lot of labour to make. They can be used to dispose of material that is too rough for composting, such as thorny branches and twigs. As the material in the trench breaks down, it releases nutrients into the soil and can increase fertility for a few further years.

To make a fertility trench:
• Dig a trench about 2m long by 1m wide by 1m deep. Separate the topsoil and subsoil into piles as you dig;
• Fill the trench with organic material, e.g. food scraps, twigs and branches, leaves, grass and old bones. Avoid adding plastic;
• Replace the soil, putting the subsoil back first and then the topsoil. Mulch the bed and plant vegetables.

Liquid fertilizer is a useful means of providing heavy-feeder crops with extra nutrients and should only be applied to heavy feeders and should not be used on members of the onion family, legumes or carrots. It can be applied to any seedlings and plants which look unhealthy.

Compost is a dark, crumbly rotted material that is formed by bacteria, insects and worms. It is perfect for improving soil fertility as it stores nutrients and slowly releases them into the soil for plants to use.
Compost should be made in layers from a mixture of materials.
Thin layers of nitrogen-rich material (such as weeds, green leaves, green grass and manure) are placed between layers of carbon-rich material such as dried leaves, dried grass, waste paper or cardboard.

How to make Compost: Fork the surface of the soil where you want to make the heap. Cover the area with the first layer (made up of coarse material such as maize husks, maize stalks or dry grass). Next add a thin layer of manure or other

nitrogen-rich material, followed by a thick layer of carbon-rich material. Lightly water each layer as you add it. Keep adding layers of nitrogen- and carbon-rich material until the heap is as high as your chest. Use dry material for the last layer to keep away flies.

We should make air holes in the heap with a sharp pole and cover the heap with old bags to conserve moisture.

Compost tips:

- Once you have made the heap do not add new material to it unless it does not get hot (in which case, add more manure).
- If the heap dries out add more water.
- When using compost be sure to apply it to the soil surface as mulch. Never dig in fresh compost.
- Try to make compost four times per year.

As the compost rots it will become very hot. You will see the heap steaming and feel the heat if you put your hand inside the heap. After about a week the heap will begin to cool, indicating that it is time to mix the layers together. This will restart the heating process and should help all of the compost material to rot properly. The more frequently you turn the heap, the quicker your compost will break down. Well-made compost can be ready in six weeks.

Pest Control

Numerous factors are responsible for influencing the growth of horticultural crops, both favorably and unfavorably. Inappropriate environmental conditions are sometimes responsible for physiological disturbances that lead to poor plant growth, including a shortage or excess of water, imbalance of nutritional elements, excessive heat, inappropriate oil reactions, etc.
In addition to these environmental factors, there are five main groups of pests: viral, fungal, bacterial, insecticide and animal.

Viruses are spread by insects (aphids, leafhoppers, whitefly,thrips and nematodes) and humans (e.g. grafting with a dirty knife). All parts of the plant can be susceptible to viruses. Symptoms caused by viruses include small fruit yields and/or poor quality fruits, spotting or wilting of leaves, yellow and green discolorations on the leaves, general spotting on leaves, and dwarfed leaves or curling under of leaves.

The solution for many viruses is death. If the plants are at the seedling or very young stage, start over and make sure your seed stock is from a good source. Try weed control by removing excess debris and cleaning garden tools. Proper spacing will reduce stress on the plants and make them less vulnerable to attack. Removing the harvestable part of the plant once it is ripe and burning the infected plant material will also reduce attacks.

Fungi are spread almost everywhere. The most harmful fungi are parasites. The fungus family includes fungi, molds, mildew, rust and mushrooms (which do not harm vegetables).
Good sanitation and crop rotation can prevent most mold attacks. However, if a fungal attack does occur, you should try using a solution of bleach, garlic or soap.

Bacteria are microscopic organisms that can be found in air, water, soil and elsewhere. Some organisms are good and some are bad.
There are three main effects of bad bacteria on plants: rot, wilt and chicken. The rots attack the leaves, stems, branches and tubers of the plant. Infected parts appear to be soft and slimy. Wilt makes the plant appear to be dying. Chicken appears as an overgrowth in a specific part of the plant.

Insects can attack four main parts of a plant:

- The roots are attacked by nematodes and root larvae.
- Stems are attacked by borers, aphids, stem flies and mealy insects. The leaves are attacked by aphids, grasshoppers, thrips, caterpillars, cut worms, leaf miners and whiteflies.

- Fruit is attacked by fruit flies and fruit insects.
- Seedlings can also be attacked by army worms, leaf beetles, earthworms and furry caterpillars.

3. ACTIVITIES

School gardens provide many benefits for the school community (students, teachers, parents, …).

Now, we are specifically referring to some of the activities that the math teacher can do in the school garden, about the soil and compost, with her students:

- Count the number of ingredients by type, which are in the compost, regist and perform the statistical treatment
- Make a map of the school grounds showing buildings, paths, roads, taps, water tanks, play areas, gardens etc.
- Discuss the map and decide on the best place to locate the garden or other places to add to the main school garden, fruit trees and any other demonstration areas. Mark these on the map.

➢ Activity for know the soil type in School Garden: (*Soil Algoritm)*

Is soil sticky?

IF YES,
THEN: Roll it into a ball → Will it break easily?
IF YES,
THEN, We have Silty soil
ELSE, We have Clayey soil

ELSE, Can you roll a ball?
IF YES,
THEN, We have Loamy soil
ELSE, We have Sandy soil

- Soil pH - pH stands for potential hydrogen, and it can tell you a lot about your soil.

For your purposes think of it as potential nutrients, pH determines which nutrients are available to plants. In fact, pH affects the microorganism activity in your soil. Soil pH determines its acidity (sourness) or alkalinity (sweetness).
The lower the pH, the more acidic your soil is; the higher the pH the more alkaline it is. A pH of 7 is neutral (neither acidic or alkaline).

For gardening, most plants prefer a soil pH between 6 and 7 with **6.5** being your target soil pH. Some plants prefer more acidic (below a pH of 6) or alkaline soils (above a pH of 8), but for general gardening, all that matters is that your soil not be too acidic or alkaline unless the plants you select can tolerate these conditions. Plants are very flexible with respect to pH, so long as your site isn't near the extremes of acidity or alkalinity for the particular plants.

If your soil pH is too extreme for your plants, it creates an unhealthy environment by limiting the nourishment that is available to the plants and by weakening their natural defenses against pestilence and disease.

The pH test is a simple indicator test requiring some soil, water (use distilled water for best results), a clean cup or jar, and a pH test.

A few general facts about soil pH:

- ✓ Clay soils tend to be acidic.
- ✓ Sandy soils tend to be alkaline.
- ✓ Keeping pH at the proper level for the plants in your garden will help reduce garden pests and diseases.
- ✓ Lime helps improve the structure of the soil.
- ✓ Rather than trying to alter your soil pH with lime or sulfur, using plants suited to your soil pH can save you time, effort and money.

4. ONLINE RESOURCES

5. Growing with Nature, https://www.growingwithnature.org/observe-your-garden/
6. Leveraging Nutrition Outcomes in Schools, https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/57228/IDL-57228.pdf?sequence=2&isAllowed=y
7. Metric Conversions, https://www.metric-conversions.org/pt/tabela-de-conversao-metrica.htm
8. Model nutrition gardens, http://www.fao.org/home/en/
9. Organic Garden, https://www.gardenorganic.org.uk/
10. Project Learning Tree, http://www.plt.org
11. Schools – the beginning of the end of malnutrition, http://www.fao.org/zhc/%20detail-%20events/en/c/462548/
12. School Gardens significantly increase science achievement scores. - Klemmer, C. D., T. M. Waliczek, and J. M. Zajicek. 2005. Growing minds: The effect of a school gardening program on the science achievement of elementary students. HortTechnology15(3):448-452.
13. Soil Calculator, https://www.gardeners.com/how-to/soil-calculator/7558.html
14. Doran, J.W., Stamatiadis, S.I. & Haberern, J. 2002. Soil health as an indicator of sustainable management. *Agriculture, Ecosystems & Environment*, 88(2): 107–110. https://doi.org/10.1016/S0167-8809(01)00250-X
15. The Gourmet Garden School, https://www.facebook.com/TheGourmetGardenSchool/videos/soil-testing/184836043120692/
16. Glossary of Soil Science Terms, https://www.soils.org/publications/soils-glossary/
17. National Soil Information System https://snisolos.dgadr.gov.pt/
18. Garden Tutor, https://gardentutor.com/toolbox/ph/

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