



Soils: where food begins!

A collection of 10 children's stories from around the world

Required citation:

FAO & IUSS. 2023. *Soils: where food begins! A collection of 10 children's stories from around the world.* Rome. https://doi.org/10.4060/cc7127en

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) or International Union of Social Sciences (IUSS) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO or IUSS in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO or IUSS.

ISBN 978-92-5-138028-4 [FAO] © FAO, 2023



Some rights reserved. This work is made available under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 IGO licence (CC BY-NC-SA 3.0 IGO; https://creativecommons.org/licenses/by-nc-sa/3.0/igo/legalcode).

Under the terms of this licence, this work may be copied, redistributed and adapted for non-commercial purposes, provided that the work is appropriately cited. In any use of this work, there should be no suggestion that FAO endorses any specific organization, products or services. The use of the FAO logo is not permitted. If the work is adapted, then it must be licensed under the same or equivalent Creative Commons licence. If a translation of this work is created, it must include the following disclaimer along with the required citation: "This translation was not created by the Food and Agriculture Organization of the United Nations (FAO). FAO is not responsible for the content or accuracy of this translation. The original [Language] edition shall be the authoritative edition."

Disputes arising under the licence that cannot be settled amicably will be resolved by mediation and arbitration as described in Article 8 of the licence except as otherwise provided herein. The applicable mediation rules will be the mediation rules of the World Intellectual Property Organization http://www.wipo.int/amc/en/mediation/rules and any arbitration will be conducted in accordance with the Arbitration Rules of the United Nations Commission on International Trade Law (UNCITRAL).

Third-party materials. Users wishing to reuse material from this work that is attributed to a third party, such as tables, figures or images, are responsible for determining whether permission is needed for that reuse and for obtaining permission from the copyright holder. The risk of claims resulting from infringement of any third-party-owned component in the work rests solely with the user.

Sales, rights and licensing. FAO information products are available on the FAO website (www.fao.org/publications) and can be purchased through publications-sales@fao.org. Requests for commercial use should be submitted via: www.fao.org/contact-us/licence-request. Queries regarding rights and licensing should be submitted to: copyright@fao.org.

Contents

Foreword	V
Soils: where food begins Anja Weber	1
The amazing journey where food is born Juan Camilo Fontalvo Buelvas	8
Special picnic on World Soil Day Jully Gabriela Retzlaf de Oliveira	24
Soils: where food begins Maite Guardiola Claramonte	40
Soils: where food begins James Dowers	47
The amazing soil: our food and our health Marcela Bianchessi da Cunha Santino	59
Solinho in the cerrado Antonio Azevedo	75
Soils, where food begins Laura & Lea Riggi	91
Food for soul Sayba Binte Sharif	107
The beauty of a healthy soil Precious Dane Tagas	119



Foreword

On 5 December 2022, the ninth UN World Soil Day celebrations focused on the theme *Soils: Where food begins*. Since 2014, this annual event has helped to raise awareness of the importance of maintaining healthy ecosystems and human wellbeing by addressing the growing challenges in soil management and encouraging societies to improve soil health.

Our wonderful soils provide more than 95 percent of our food and are one of the most precious natural resources we have. Healthy and fertile soils provide us with nutritious and wholesome food, whether directly, through vegetables, fruits, grains, nuts and seeds or indirectly, through the consumption of livestock meat and dairy products and eggs. However, one-third of the world's soils are now degraded, through compaction, the loss of organic carbon and biodiversity, as well as through salinization and sodification, reducing our ability to provide safe and nutritious food to an ever-increasing world population.

As part of the World Soil Day 2022 campaign activities, the Food and Agriculture Organization of the United Nations (FAO), through its Global Soil Partnership, and the International Union of Soil Sciences (IUSS) launched a children's scientific book-writing competition on soils for nutrition and the positive role soil has to play for our health and wellbeing. The contest was very well received, with over thirty excellent entries received from all over the world.

The IUSS and FAO would like to warmly congratulate and thank everyone on the quality of their entries and the care and commitment they have shown in producing such wonderful books. The dedication, creativity, and passion of the authors for spreading awareness about soil and nutrition are inspiring.

It is essential to teach children about the link between healthy soil and nutritious food. This would help them to understand the vital role soil in food production and nutrition, so as cultivate new generations that value soils and cherishes the natural resources that sustain us.

We are very proud to present this collection of stories about soil and where food begins, including some of the best, regionally balanced entries from around the world.

It is our hope that these books will serve as a starting point for children and adults alike to better understand the connection between healthy soils, nutrient-rich food and our own wellbeing. We believe that they will help us to preserve the health of our soils in the future.

We hope this series will capture children's curiosity about soil and encourage them to explore its secrets. And who knows? It could also spark a deep interest in biology, soil science and the quest for a more sustainable future.

So kids, sit back with a healthy snack, relax, and read about the wonders of soils and the benefits they bring to our food and life!

Happy reading!

Mr Li Lifeng

Director Land and Water Division (NSL)
Food and Agriculture Organization of the United Nations
(FAO)

Ms Laura Bertha Reyes Sanchez

President of the International Union of Soil Sciences (IUSS)



1st classified

Soils: where food begins

A Kenyan story, the conversation about a little girl and her mother who take a walk to discover different soil types and to understand which kind of soil plants need to grow well.

Anja Weber

Development Advisor, GIZ **Kenya**





Soil: where food begins

a Kenyan story by Anja Weber



Mama why does nothing ever grow in my sandpit?



Look closely - sand is nothing but little pieces of rocks and stones.

Plants need to hold on to soil with their roots to find water and food to grow.

Sand is too loose for that.



The sand at the beach gets flooded every day, but a few hours later it is so dry again that you can play in the sand because the pieces of sand can't hold the water.

Mama, where else do plants not grow well?



For example in pure clay soil.
What is clay?
Let's visit your cousins.
Aunty Amina and uncle Vincent are repairing the old cow shed.
The walls are made of clay.



Mama, look! I can make a sausage out of clay!

Yes, this is why you can make pots and walls out of clay. Take some home to make some plates and bowls for your dolls.



The problem with clay soil is that it can be as hard as a wall. It is difficult for plants to grow their roots into such a soil. When it dries clay soil cracks.

That's why uncle Vincent needs to repair the wall.

In which soil do plants grow best, Mama?



Come! We go and have a look at Granny's garden.

Granny, everything grows so well here!



Garden soil is a nice mix of sand and clay and organic matter. It is neither too loose nor too hard. It is not too dry and not too wet. The organic matter makes the soil crumbly and dark.

Granny, your soil smells nice and sweet!



Where does the organic matter come from?

It comes from dead leaves and roots.



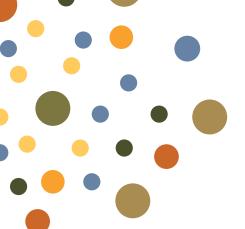
Good soil is full of little insects. Can you see the earthworms? They eat the organic matter and turn it into food for plants. That's why everything grows so well here in Granny's garden.



Mama, let's harvest some nice, fresh vegetables and invite my cousins for lunch!



Soils: where food begins
A Kenyan story by Anja Weber
2022



2nd classified

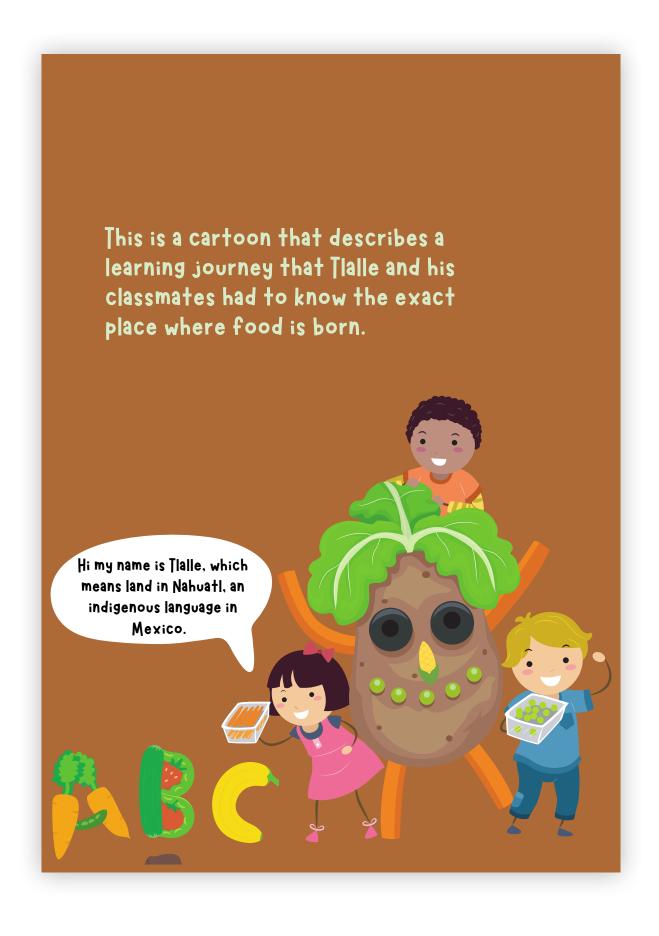
The amazing journey where food is born

This is a cartoon that describes a learning journey that Tlalle and his classmates had to know the exact place where food is born. Tlalle is a girl's name, but means land in Nahuatl, an Indigenous Peoples' language in Mexico. The story begins at breakfast with his father, with a little doubt about where the food comes from. This leads her on a series of clues that lead from the house to the ground, passing through the school, the school cafeteria, the supermarket and a visit to the field with farmers. Finally, Tllale and her classmates return to school with seeds to build a garden vegetables and continue learning about the relationship between healthy soil, healthy food, and healthy people.

Juan Camilo Fontalvo Buelvas

Universidad Nacional Autónoma de México, PhD student in Sustainability Sciences **Mexico**

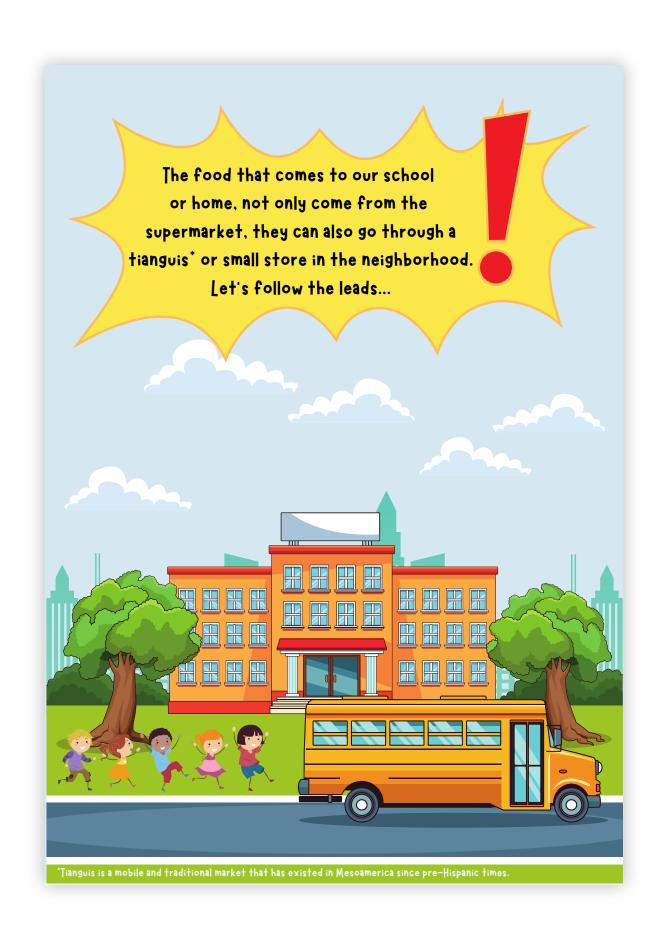














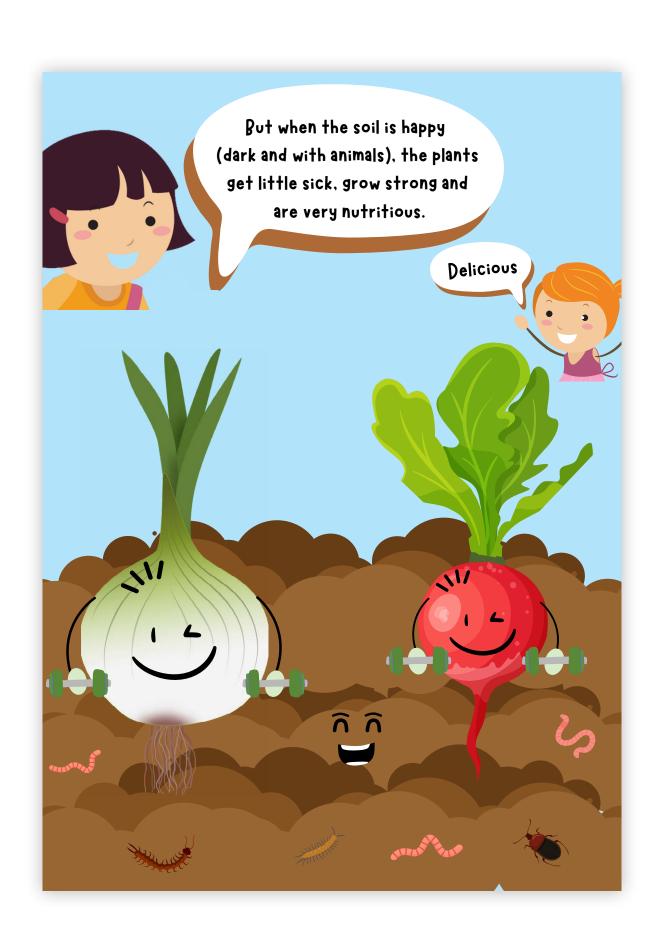






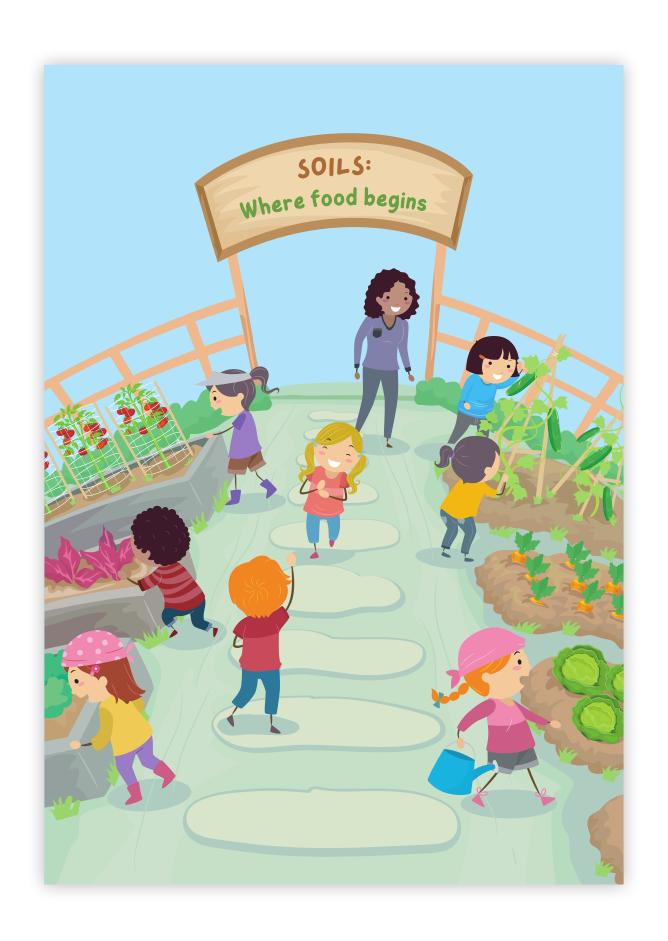














3rd classified

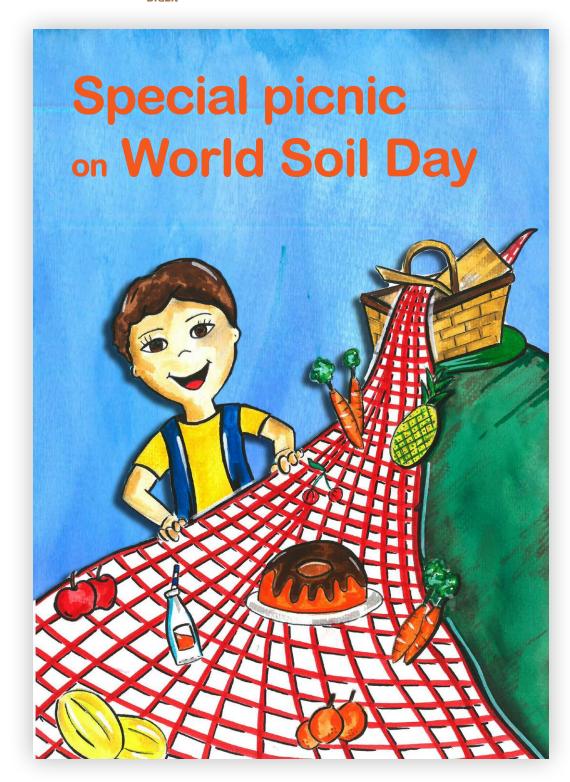
Special picnic on World Soil Day

This book aims to show children and all soil lovers, in a playful and fun way, the importance of soil as a food producer. The work highlights that, for this to happen, the soil must be healthy, conserved, and full of life, that is, rich in biodiversity, which help to maintain and replace essential nutrients for plant growth, securing food provision to animals and people.

Jully Gabriela Retzlaf de Oliveira

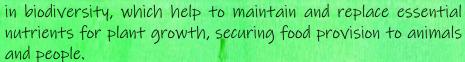
Universidade Estadual do Norte do Paraná - UENP; Professora adjunta C do colegiado de Geografia

Brazil



Tutroduction

This book aims to show children and all soil lovers, in a playful and fun way, the importance of soil as a food producer. The work highlights that, for this to happen, the soil must be healthy, conserved, and full of life, that is, rich



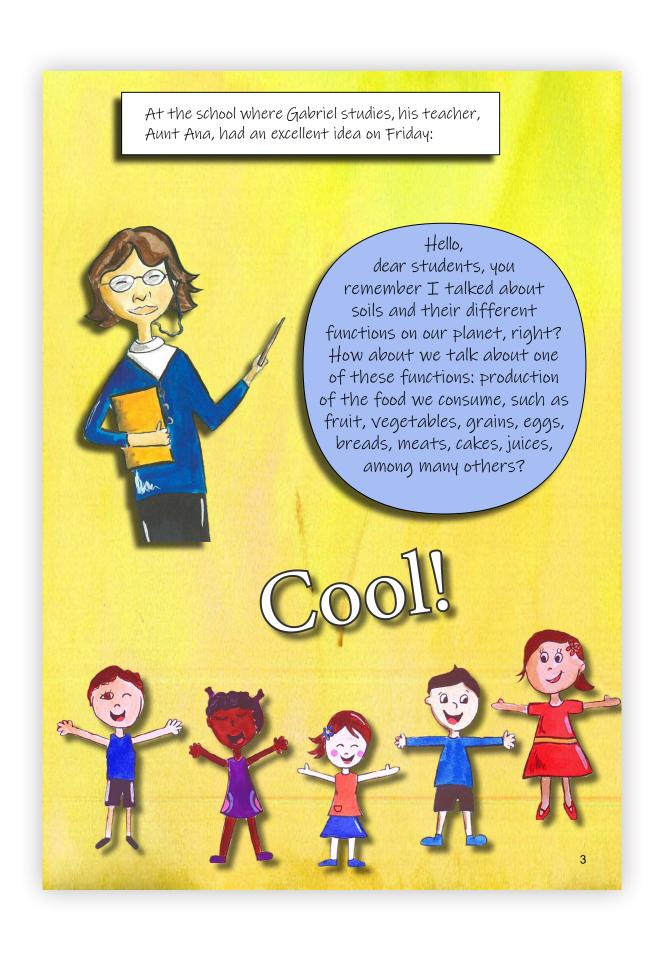
The book also addresses the commemoration of World Soil Day, December 5th, and seeks to sensitize children to the functions of the soil and its role in people's lives, as well as to act in the popularization of Soil Science among society, thus, contributing to Soil Education.

The story highlights the affectionate and educational family interaction between grandson Gabriel and his grandparents Tico and Nina, who encourage Gabriel to learn about the relationship between the soil and food origin. Another important character is the teacher at the school where Gabriel studies, Aunt Ana. It is a simple tribute to the great scientist of ecological soil management, Ana Primavesi, who has always underscored that a healthy soil generates healthy food and healthy human beings.



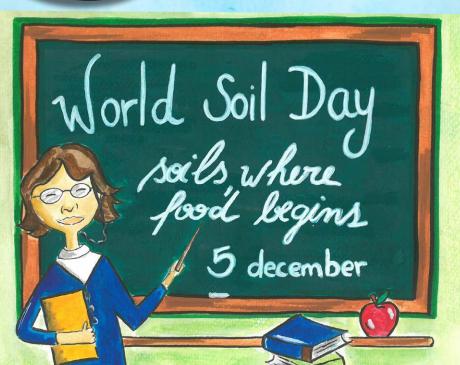
Finally, the authors wish that the book encourages readers to adopt sustainable behaviors and respect for the soil, therefore, allowing to produce healthy food, contributing to an effective reduction of hunger, malnutrition, and poverty on planet Earth.

2



How
about, then,
having a picnic in the
school garden to talk
about soils and food and
celebrate World Soil Day,
on December 5th,
next Monday?



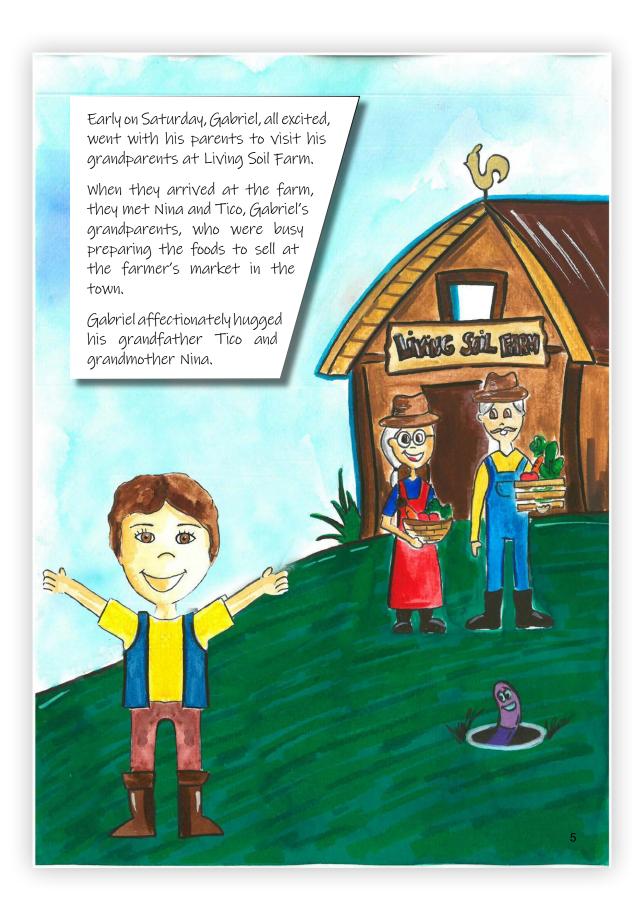


Great!! en, for our

Then, for our special picnic, I ask each student to bring some food, it can be fresh, such as a fruit, or homemade, such as bread and cake, or industrialized, such as juice, cookie, or jelly.

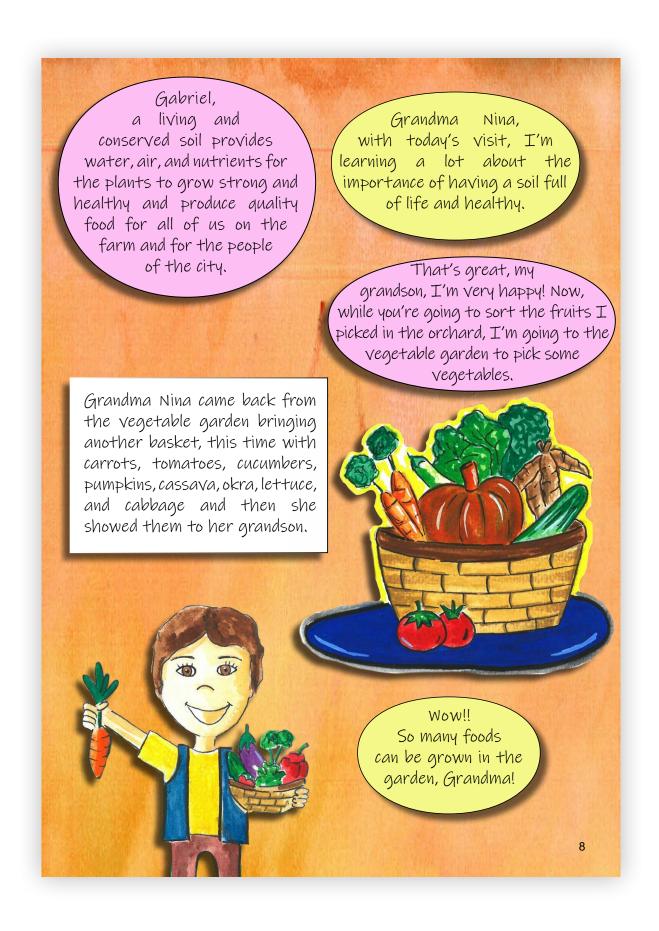
Gabriel and his friends loved the picnic idea, as they felt they would have fun playing, while eating delicious things, like Gabriel's favorite carrot cake.

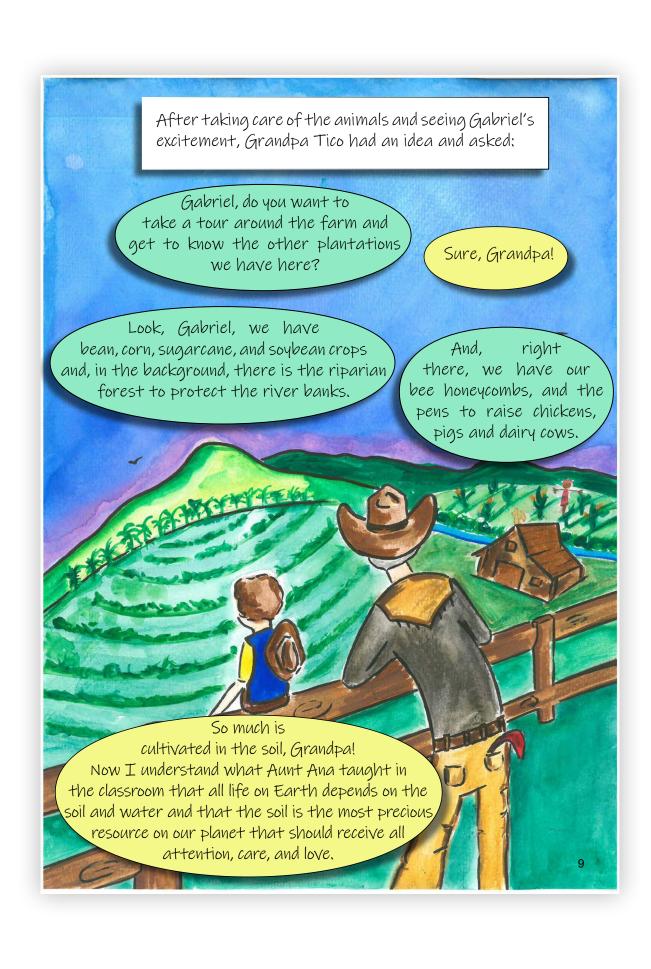
4





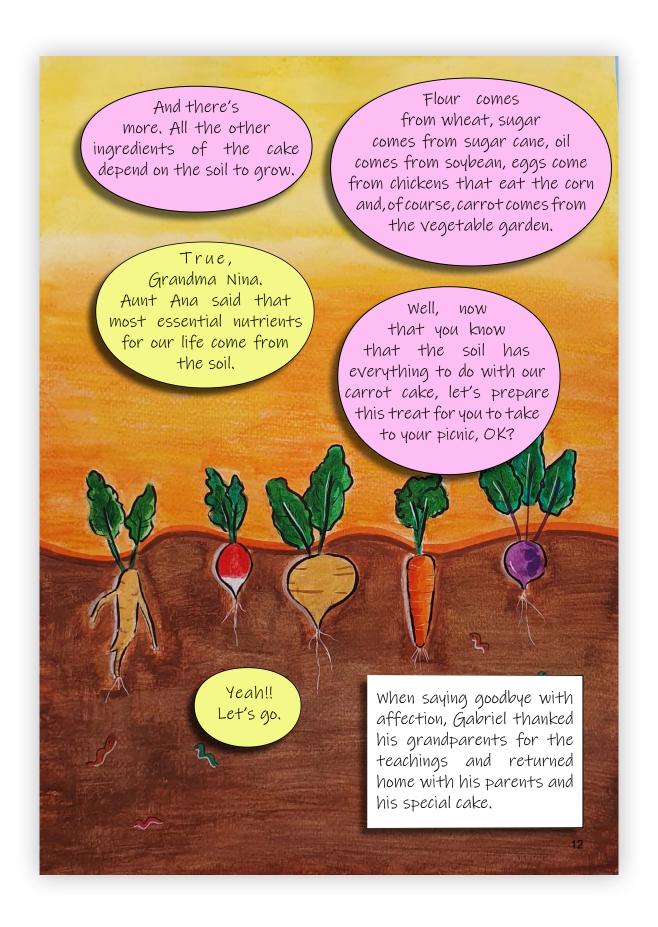


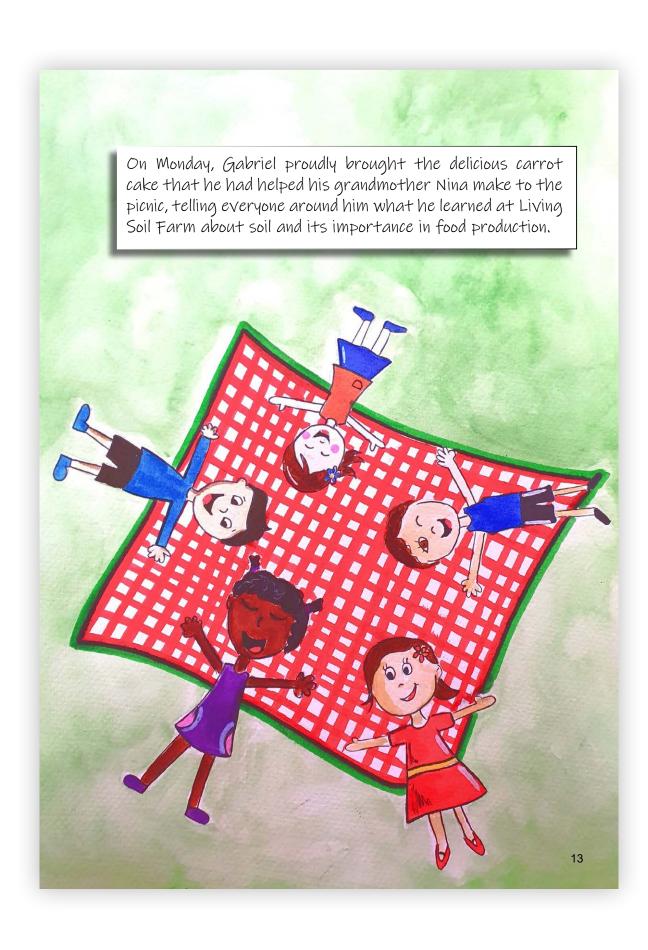












SOILS: WHERE FOOD BEGINS

Concepts of Ana Primavesi

The current decline in soils and their productivity has a common origin: soil degradation.

Soil is not an inert mass consisting of a mineral fraction serving as a simple support for vegetation, but a dynamic system similar to a living organism.

The more intense the life around the root, the greater the availability of nutrients.

Everything is interconnected: land, water, air, plants, and animals.

Healthy soil produces healthy plants and healthy humans.

https://anamariaprimavesi.com.br/2022/04/15/

RECIPE OF CARROT CAKE WITH A CHOCOLATE TOPPING

INGREDIENTS

- · 4 eggs
- 3/4 cup of soy oil (143ml)
- 2 cups of sugar (320g)
- 3 medium raw carrots (250g)
- 2 cups of wheat flour (280g)
- 1 pinch of salt (2g)
- 1 tablespoon of baking powder (15g)

PREPARATION

- 1. Add the eggs, oil, sugar, and chopped carrots in a blender and beat until creamy.
- 2. Mix the flour, baking powder, and salt in a bowl. Then add the cream from the blender and stir gently.
- 3. Grease the baking pan with butter or margarine and pour the cake dough.
- 4. Bake in the oven at medium temperature (180°C) for 35 minutes or until golden.
- 5. After removing from the oven, apply a chocolate topping.





























This book is part of the scientific book contest for children whose theme is SOILS: ORIGIN OF FOODS, which is an initiative of the Food and Agriculture Organization (FAO) of the United Nations, its World Soil Alliance (GSP) and the International Union of Soil Science (IUSS) for the 2022 commemoration of World Soil Day, December 5th.





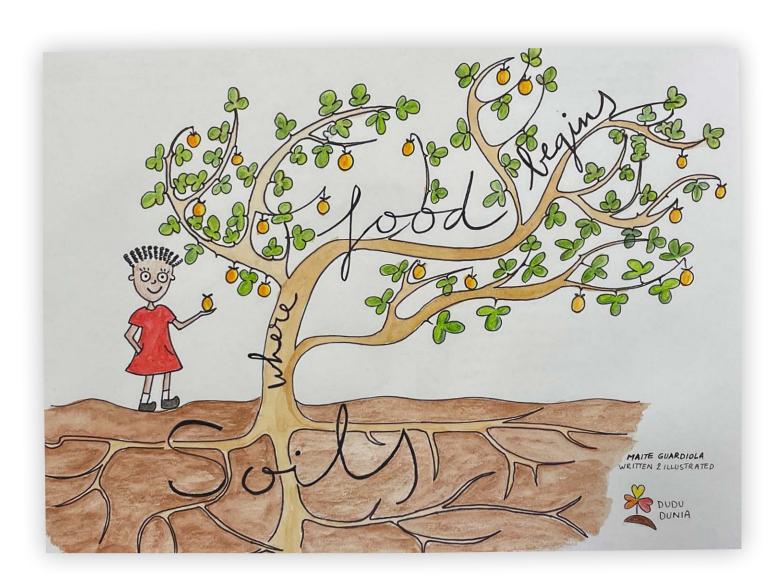


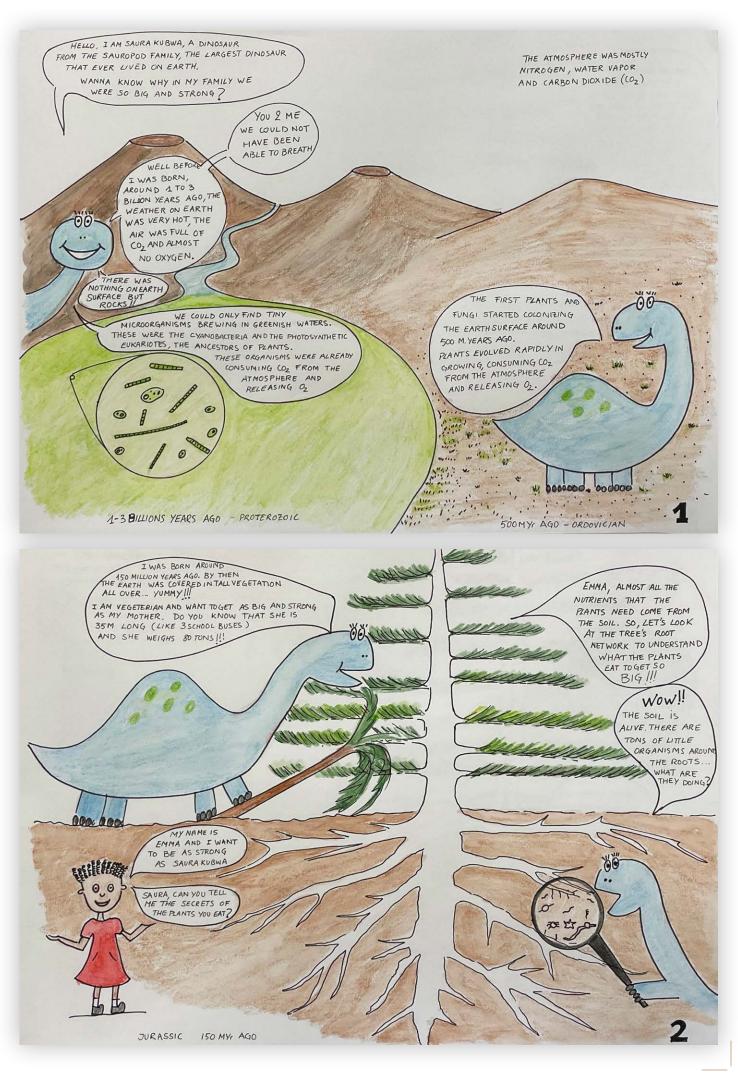
Soils: where food begins

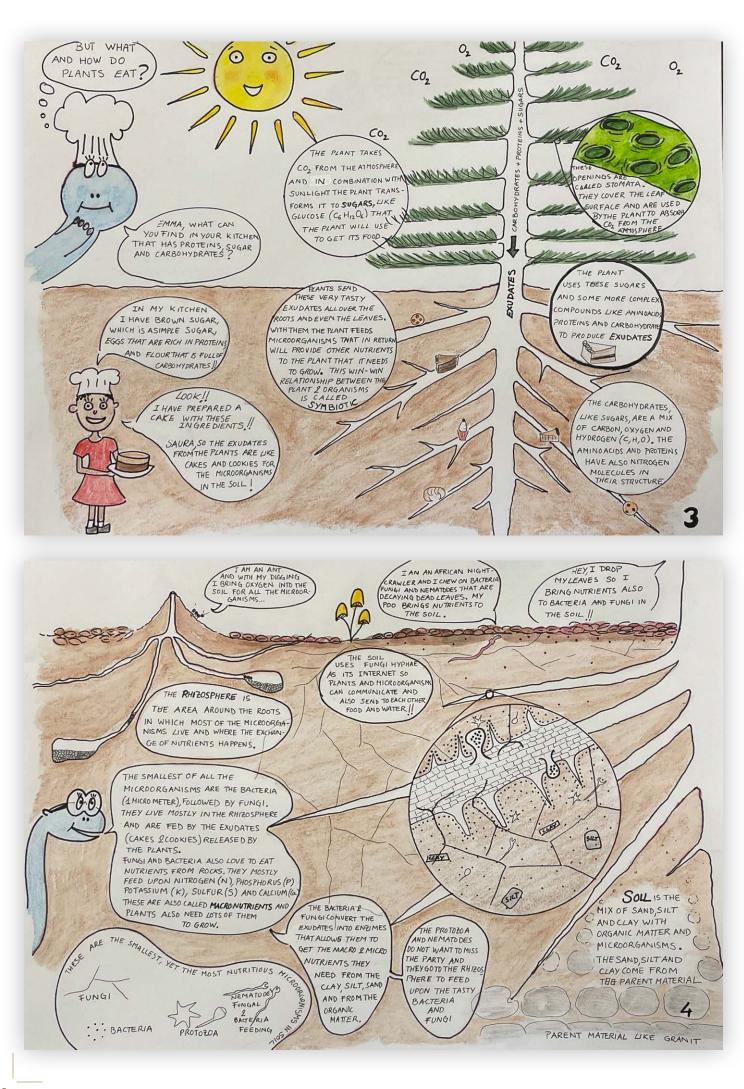
Emma is a girl that wants to get as strong as her big vegetarian dinosaur friend (Saura Kubwa). She wants to understand if the plants in her grandmother's farm will make her as strong as Saura.

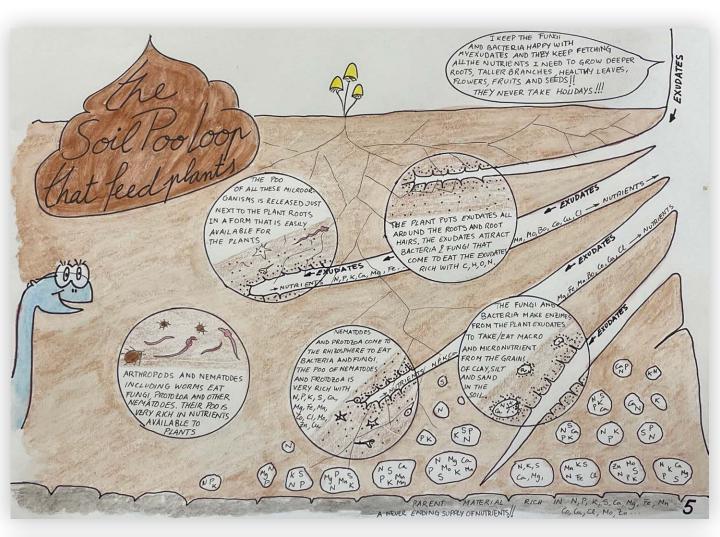
Maite Guardiola Claramonte

Water and Sanitation Advisor **Kenya**



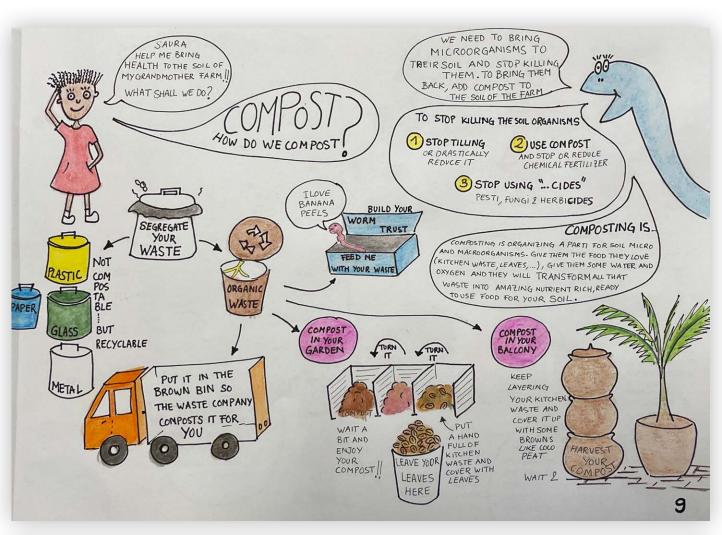


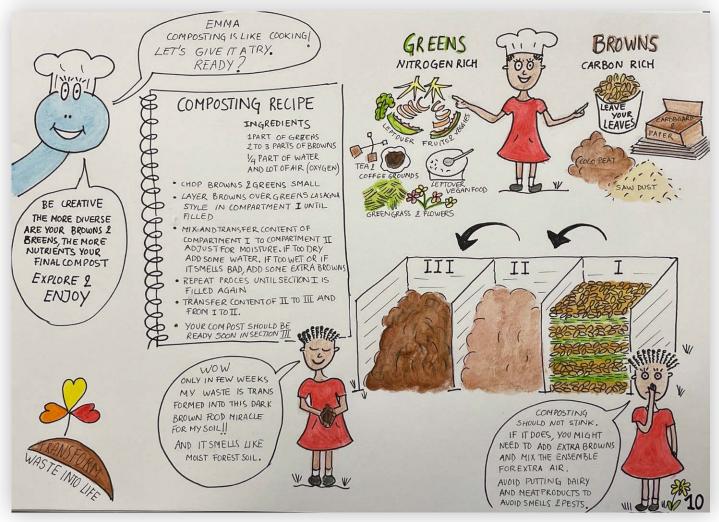


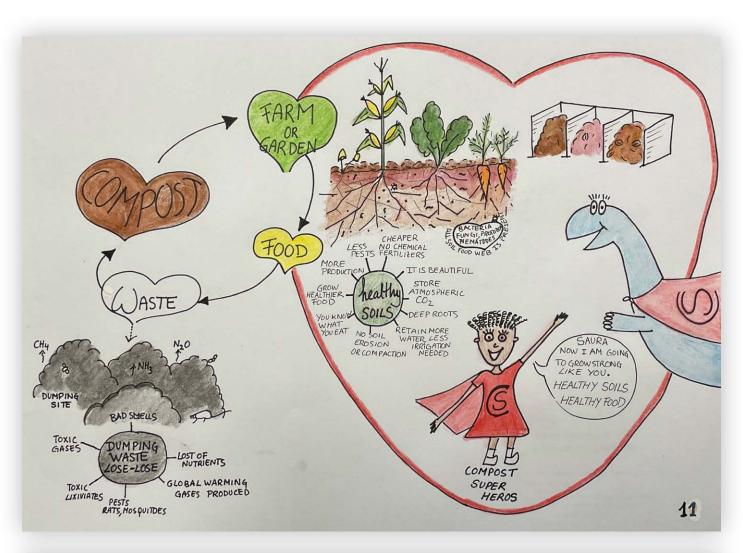














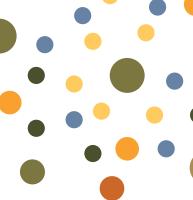
Soils: where food begins

This book follows a story that is sparked by a small child asking her father where the food on her plate comes from. It teaches about the nutrients hidden in the soils, the threats soils face globally, how important they are for feeding people, and finishes by encouraging the child to get her hands dirty, examine the soil and try planting a seed for herself.

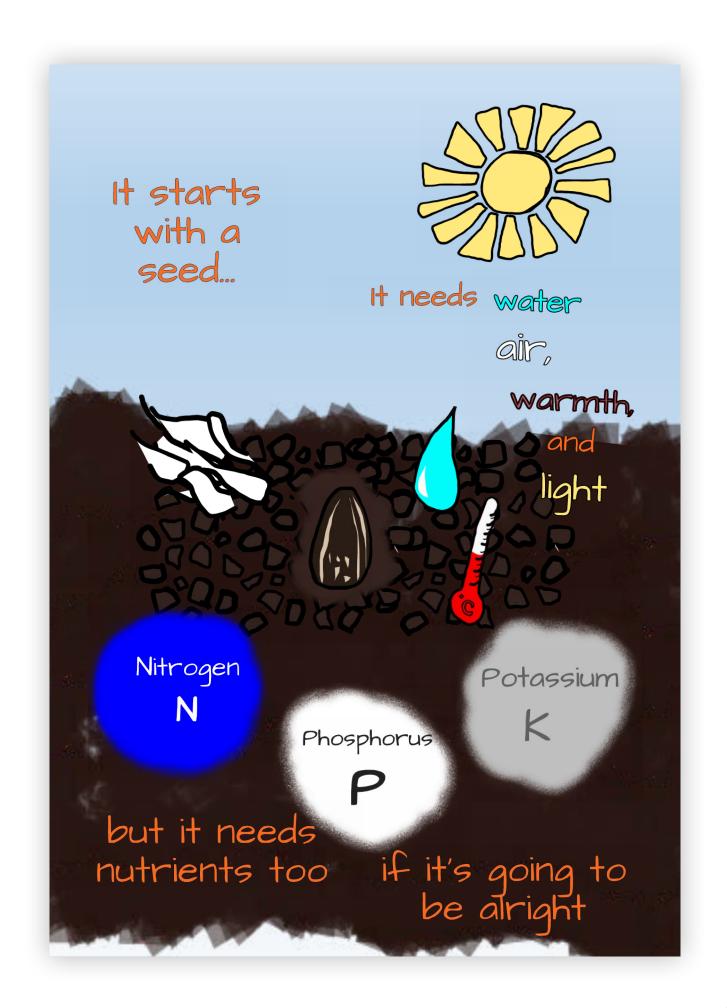
James Dowers

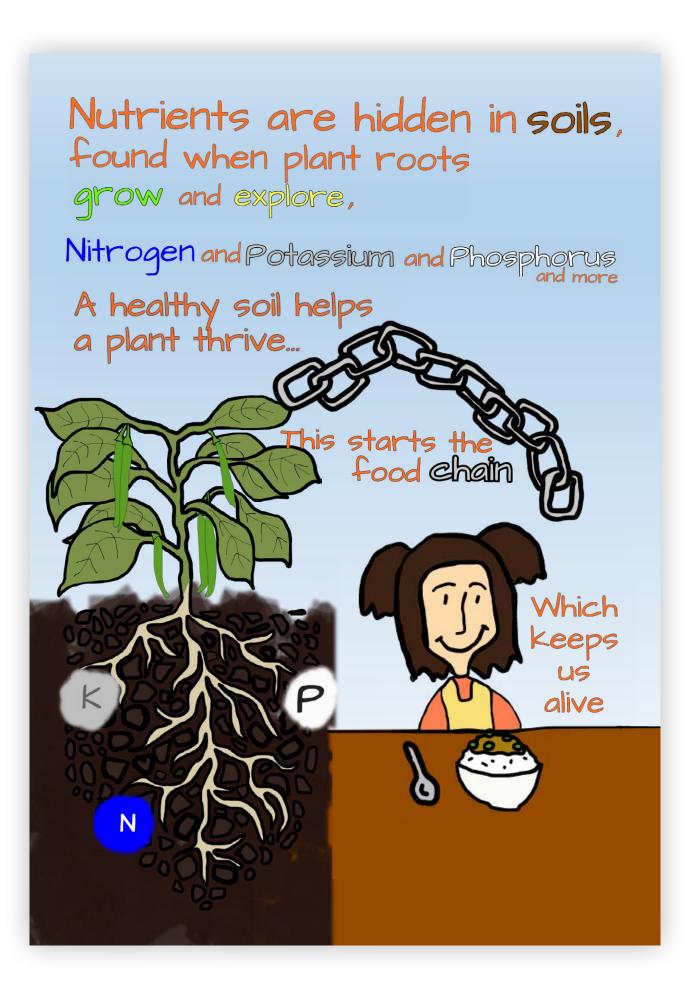
Research scientist, ADAS - United Kingdom of Great Britain and Northern Ireland

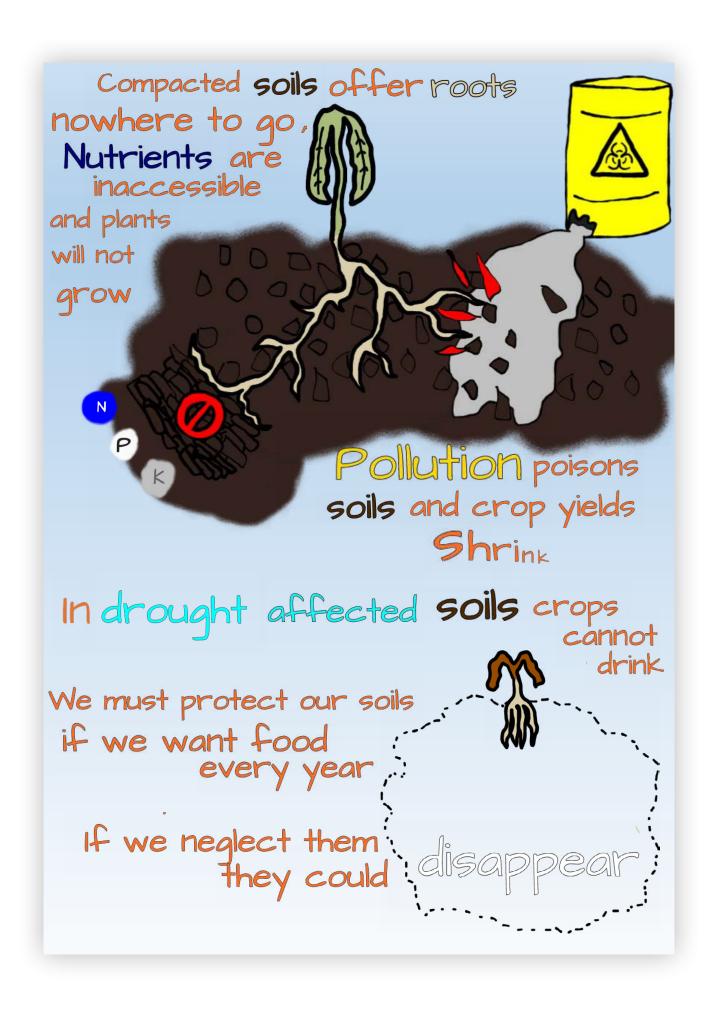














For our soils this is a threat We must act now or there will be worse yet



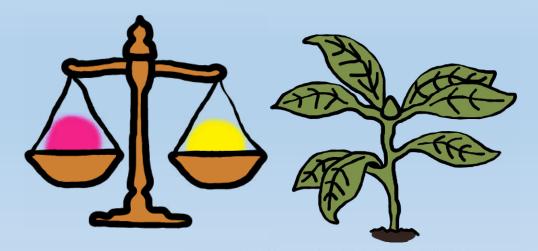
Extreme weather like flooding will take a toll



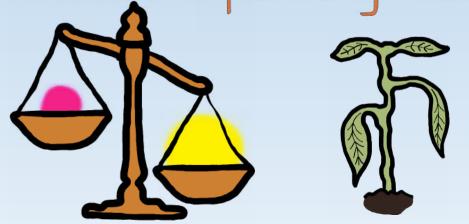


With no soil to grow crops
What will be in your bowl?

Too much of one nutrient

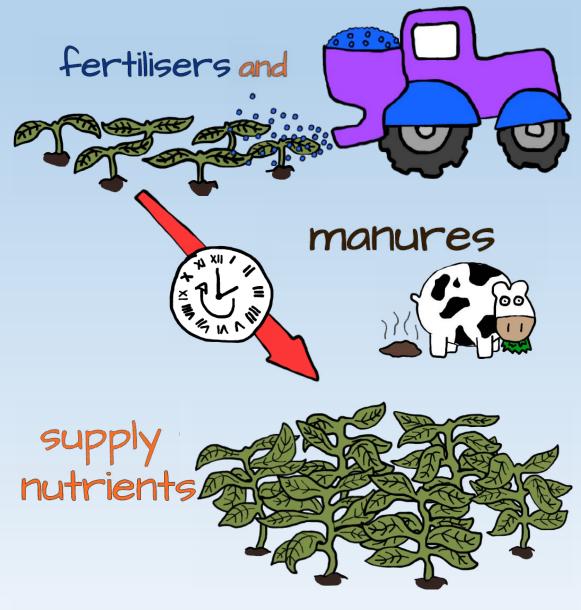


Or too little of another Can hinder a plant's growth

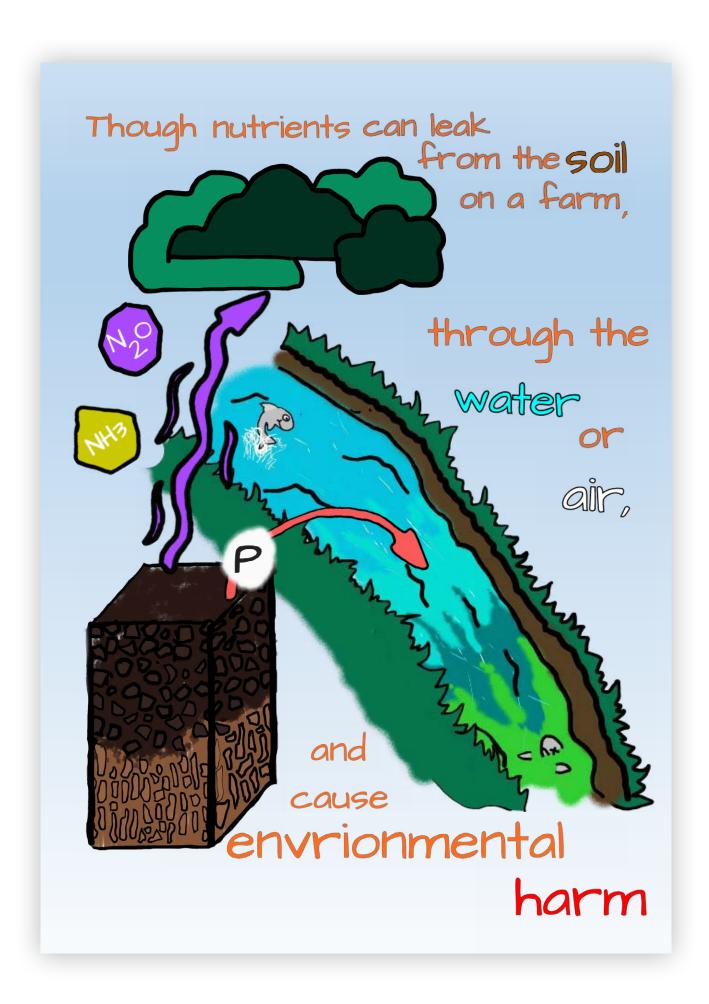


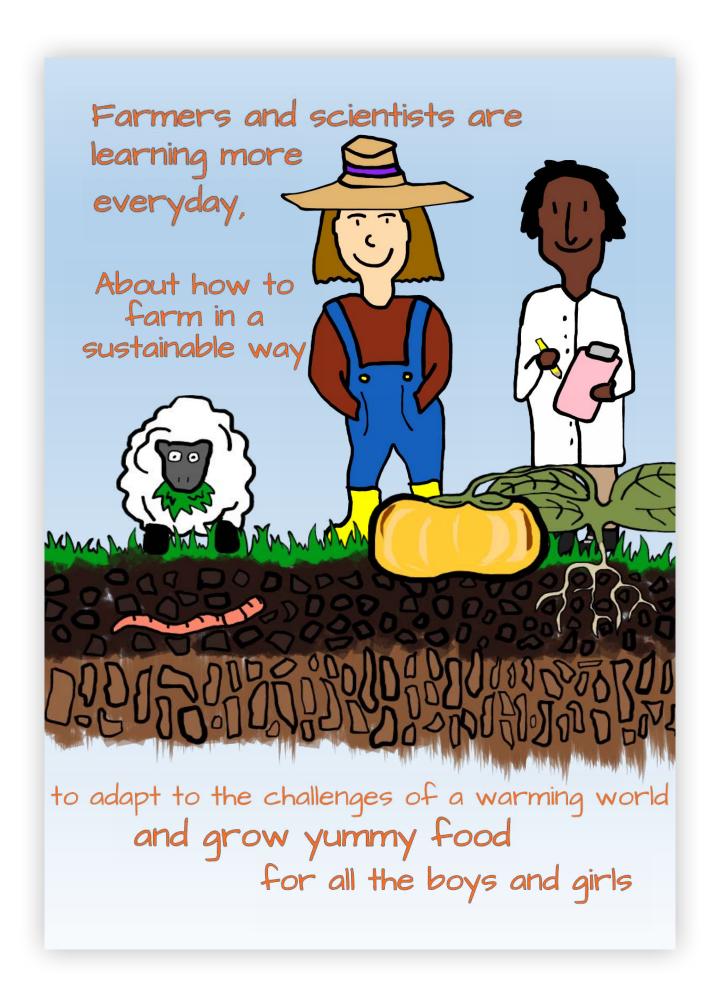
It might never recover

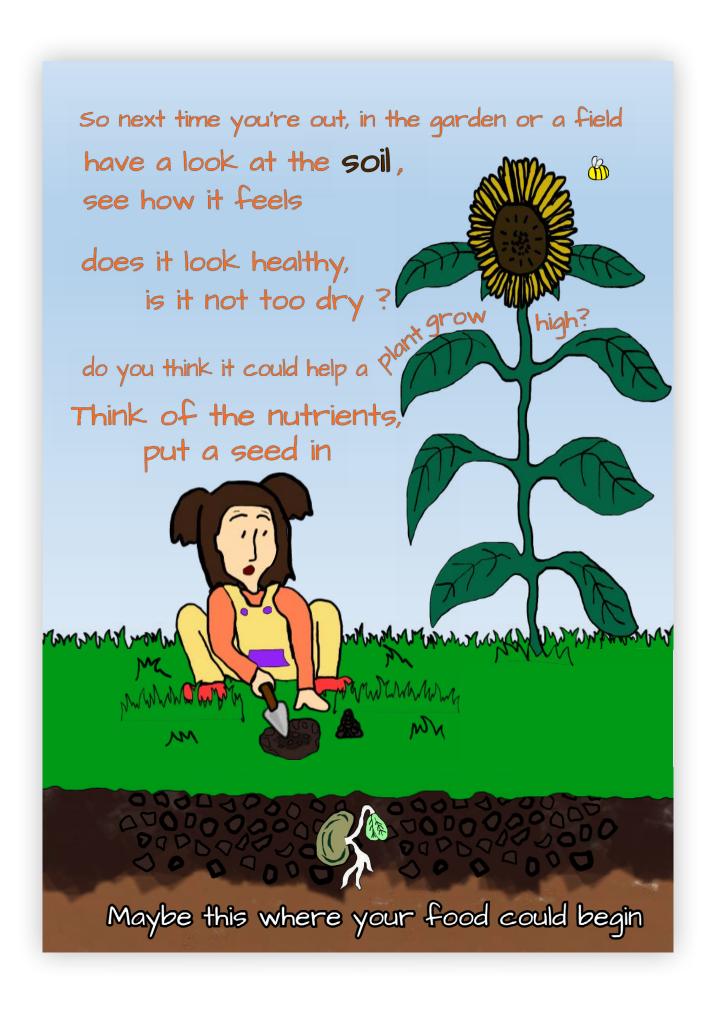
We can tinker with the balance, to give the soil exactly what it needs,



to help crops succeed







To learn more go to:

The website of the Food and Agriculture
Organization of the United Nations: https://
www.fao.org/home/en

The website of the British Society of Soil Science : https://soils.org.uk/

Or search for the soil science society in your country



The amazing soil: our food and our health

This booklet was designed to disseminate scientific knowledge about soil fertility and nutrition to children. The information was based on scientific literature. The language used was designed to be simple and fun, showing concepts about the importance of soil fertility for all living organisms. This booklet also refers to the importance of sustainable development goals in soil conservation.



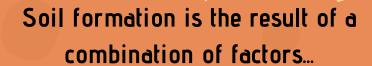
Universidade Federal de São Carlos (UFSCar), Dr., Professor, Researcher **Brazil**

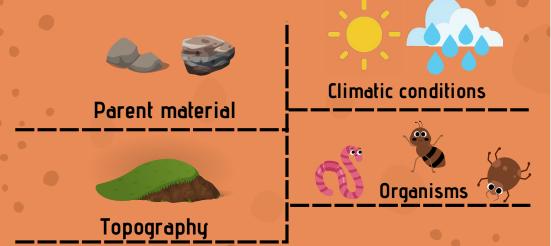


Once upon a time, a rock...



...began to form soil on a long geological journey!





...that work together over time...







...to shape the soil!







...soil is where food begins.

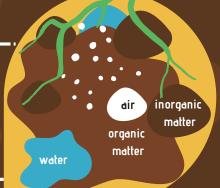
But how to ensure good production and quality food?



Soil particles are formed by inorganic and organic matter.



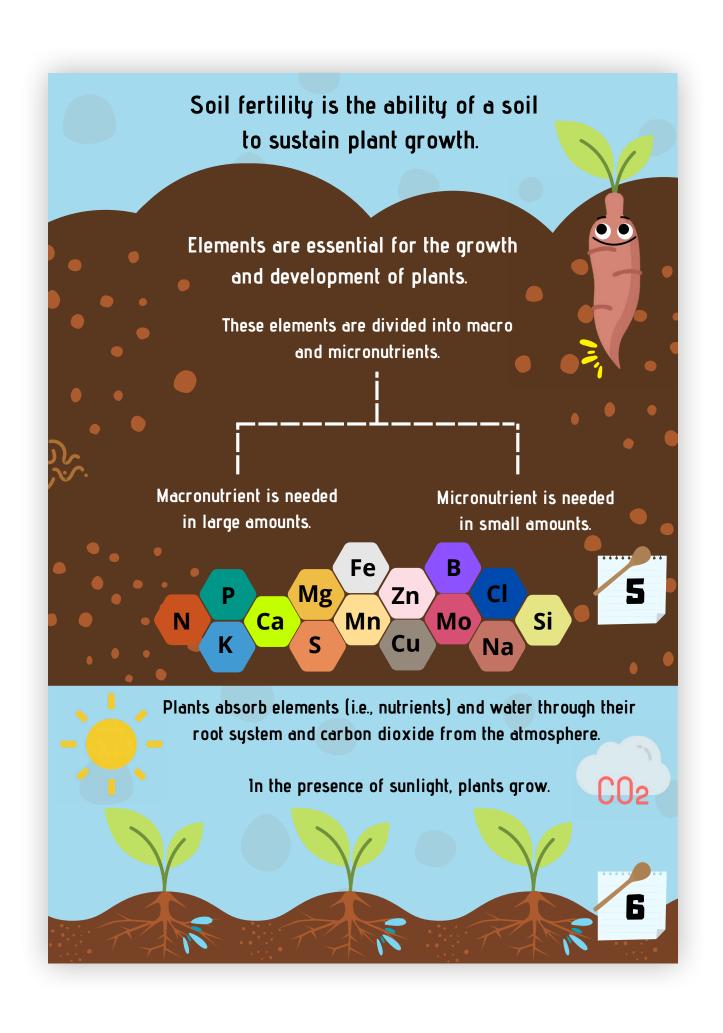
Soils supply the essential nutrients, water, air and root support for plants.



So, healthy soils are the basis for producing food!

Soil fertility is connected to food quality and quantity.





Healthy soil feeds the world



But ... Soil is a finite resource!

Many benefits provided by soils are being lost through the degradation and loss of soils.

Take a look at some examples!





Erosion

is the removal of the top layer of soil by running water, rainfall, wind or ice.

Salinization

is the accumulation of soluble salts (e.g., sodium, magnesium, and calcium) in soil.



Contamination

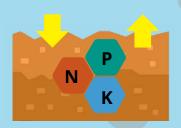
is the increase of toxic compounds (e.g., heavy metals, pesticides) in the soil.



Compaction

occurs when soil particles
are pressed together by
external forces, resulting
in loss of pore space.





Nutrient imbalance

is an excess or a lack of nutrients in the soil.

Biodiversity loss

of micro and macro organisms

present in the soil.







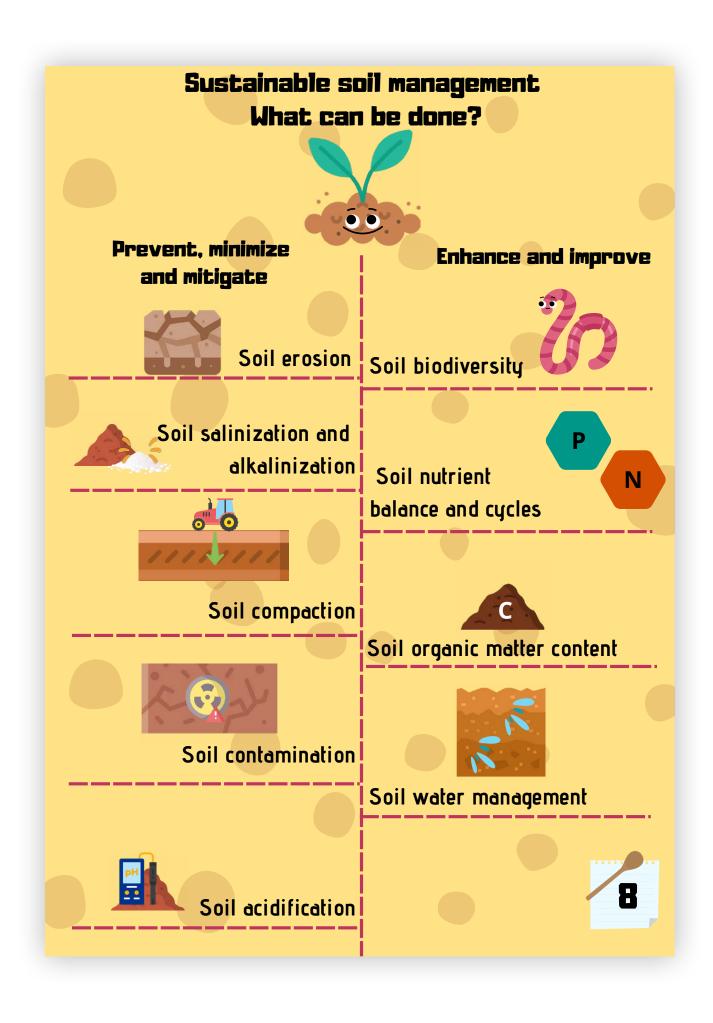
Acidification

is the lowering of the soil pH.

Organic carbon loss

is the decline of organic carbon stock in the soil.









Soil is the greatest pool of terrestrial organic carbon.

Conserving and re-storing carbon content in soil organic matter can help to mitigate climate change through carbon sequestration and reduction of greenhouse gas emissions, and also, address food security.



Have you heard about Sustainable Development Goals?

The Sustainable Development Goals (SDGs) aim to transform our world. They are a call to action to end poverty and inequality, protect the planet, and ensure that all people enjoy health, justice and prosperity.



Remember that healthy soil guarantees food security for all people on the planet!











Learning about these initiatives helps us develop insights into critical issues around the world, such as, good health and well-being, zero hunger, access to clean water and sanitation and climate action.

How about being a soil scientist?

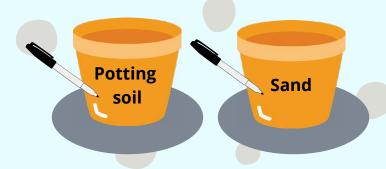
Which soil is best for growing plants?

What will you need?

Permanent marker
Potting soil
Sand
Spoon
2 small pots
6 seeds (e.g., beans)
Ruler
Watering can

How do you conduct the experiment?

Step 1: Use a permanent marker to label the pots as "potting soil" and "sand".



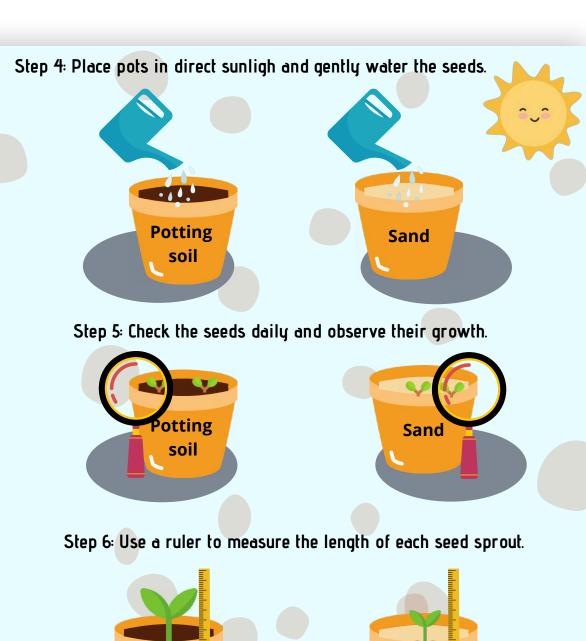
Step 2: Use a spoon to place potting soil in one pot and sand in the other pot.



Step 3: Place three seeds into each pot.









Now! Find out with your teacher!

What pot produced the seeds with the longest sprouts?

What are the key resources (e.g., nutrients, water, sunlight) to produce a healthy plant?

The conservation and restoration of soils are among the greatest challenges for us!



Healthy soils are essential for plant growth and human nutrition.

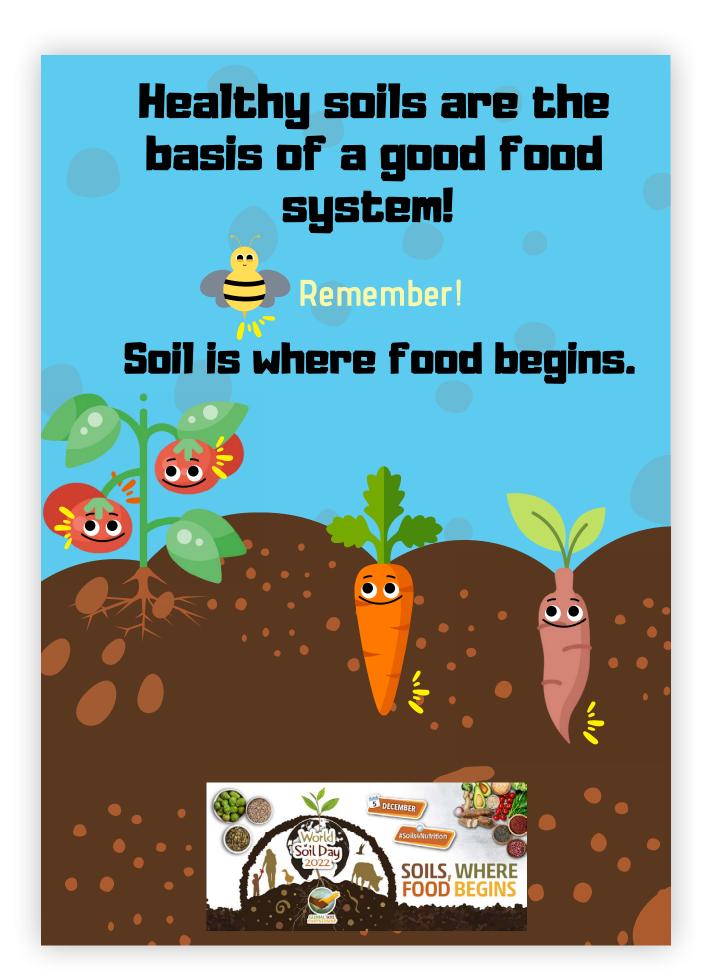




Sustainable food systems are able to feed the world population while protecting the environment.



- 1. Food and Agriculture Organization of the United Nations FAO (2019). Global Soil Partnership. What is soil? CA2214EN/1/12.19. Available at https://www.fao.org/3/ca2214en/ca2214en.pdf.
- 2. Needelman, B. A. (2013). What Are Soils? Nature Education Knowledge 4(3):2.
- 3. Food and Agriculture Organization of the United Nations FAO (2015) Soil functions Infographics. Rome: FAO. Available at: https://www.fao.org/publications/card/fr/c/0815e457-c6a4-47e9-ab6c-f23224279834.
- 4. Food and Agriculture Organization of the United Nations FAO (2015) Five reasons why soil is key to the planet's sustainable future Sustainable Development Goals. Available at https://www.fao.org/sustainable-development-goals/news/detailnews/en/c/277113/ Rome: FAO.
- 5. Parikh, S. J.; James, B. R. (2012). Soil: The Foundation of Agriculture. Nature Education Knowledge 3(10):2.
- 6. Food and Agriculture Organization of the United Nations FAO (2015). Soils are the Foundation for Vegetation Poster. Available at https://www.fao.org/documents/card/en/c/54b9410f-9bd8-40bf-8873-fd68ac316c34/ Rome, Italy.
- 7. Food and Agriculture Organization of the United Nations/ Intergovernmental Technical Panel on Soils FAO/ITPS (2015). Status of the World's Soil Resources (SWSR) Main Report. Rome, Italy.
- 8. Food and Agriculture Organization of the United Nations FAO (2017). Voluntary Guidelinesbfor Sustainable Soil Management, Rome, Italy. 16p. Available at https://www.fao.org/3/bl813e/bl813e.pdf.
- 9. World Health Organization WHO (2022). Sustainable Development Goals. Available at https://www.who.int/europe/about-us/our-work/sustainable-development-goals.
- 10. World Health Organization WHO (2022). Nutrition. Available at https://www.who.int/health-topics/nutrition#tab=tab_1.

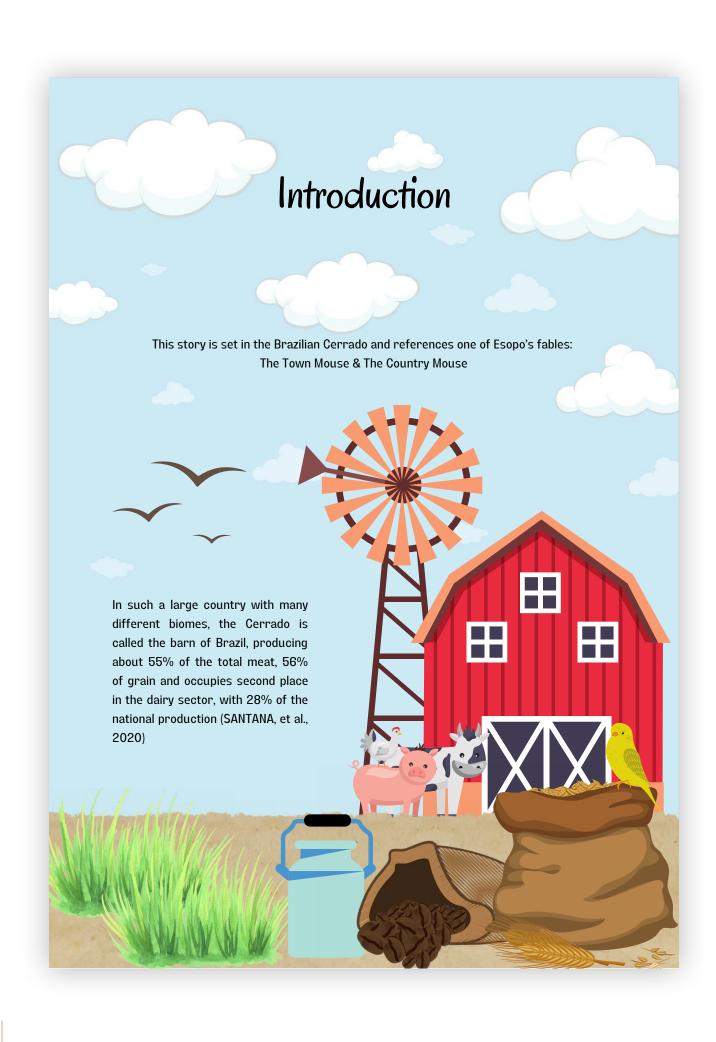


Solinho in the cerrado

Antonio Azevedo

University of Sao Paulo **Brazil**

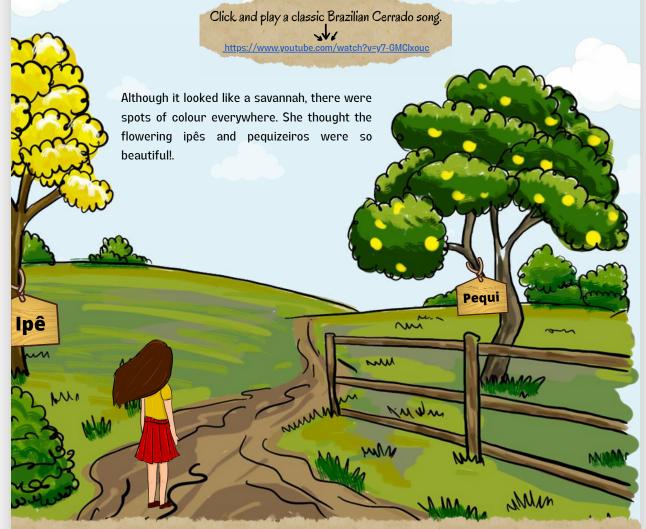




September arrived, bringing the first signs of spring to the Cerrado.

Despite the natural local abundance and living on the farm with her grandmother, Anne felt lonely, although she knew that in a few months her aunt Louise and cousin Peter would live in the countryside. It would be the first time the cousins met there, and they were both very nervous.

While waiting, Anne enjoyed the waterfall baths and the beauty of the spring landscape.



Pequizeiro (Caryocar brasiliense): typical tree of the Brazilian Cerrado, whose fruits are called "cerrado gold" because of their yellow colour.

Ipê do Cerrado (*Handroanthus ochraceus* (Cham.) Mattos): native to the Brazilian Cerrado, ipês can grow up to 14 m and bloom from July to September.

Cerrado Biome: In Brazil, the area of Cerrado, the Tropical Savannah, is estimated at 2,036,448 km (IBGE, 2020).



Ms. Mary, visibly worried, said that they might not have the necessary ingredients.

Peter, trying to help, suggested that they go to the supermarket, but Anne explained that they couldn't because the closest one was two hours away from the farm and no one could take them.

Finally, December 5th arrived.

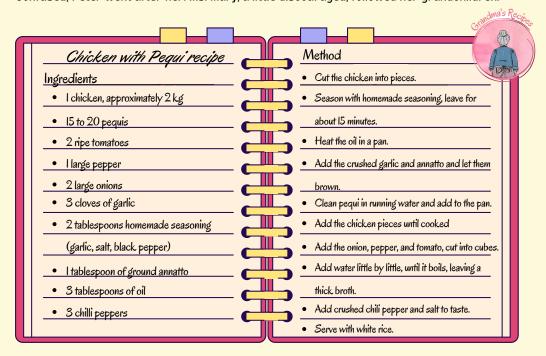
Louise dropped Peter off at the farm with Anne and their grandmother, Ms. Mary. Then she returned to their new home to unpack. The cousins were finally together!

To celebrate the date and welcome Peter, Anne took her grandmother's recipe book and asked her to prepare a delicious chicken with pequi.



"But I know what to do!" said Anne and hurried out into the yard.

Confused, Peter went after her. Ms. Mary, a little discouraged, followed her grandchildren.



In the garden, the children noticed that the tomatoes, peppers and onions did not look very good.

Peter commented that in the market the food seemed more appetizing. Anne replied, saying that the farm was also wonderful, but...

"Unfortunately, the plants have looked weak and lifeless for a while now. I often come to the garden hoping to find more lush plants, but they seem worse every day."

In the chicken coop, they observed their grandmother taking a look at each of the chickens but none of them would be big enough for the recipe.

Anne, a little desolate, showed her cousin that the corn reservoir for the birds was almost empty and the corn stalks didn't look healthy either.

Upset, they returned home to prepare a simpler meal.



Ms. Mary thought it was time to talk to Louise, who had graduated in Agronomy and Soil and Plant Nutrition. The field hadn't been looked at by a professional in a long time and Louise was the new Agronomist of the region.



Louise, saw how bad the farm had become and remembered how productive it used to be. Her mother agreed too:

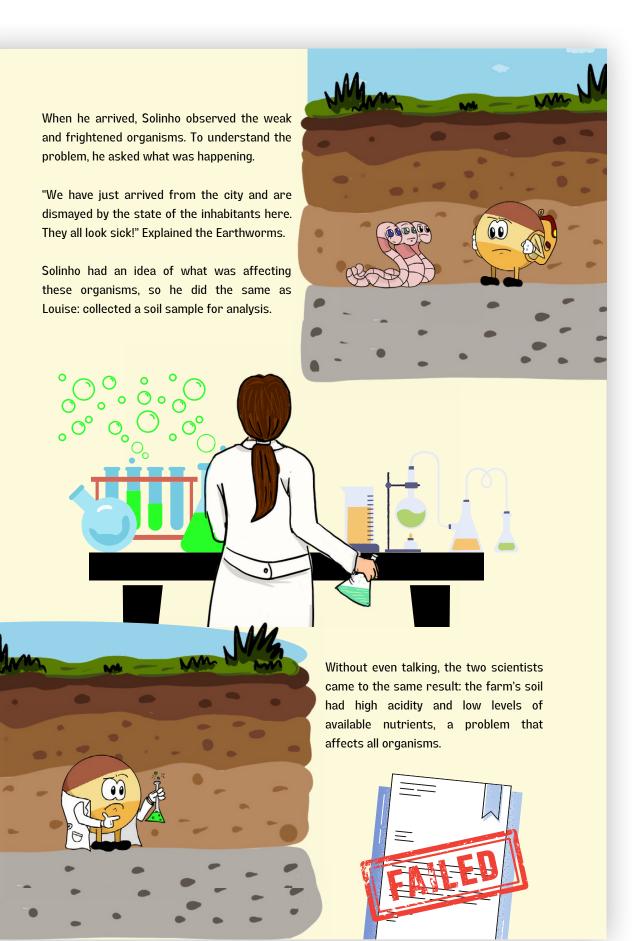
"Yes, we produced everything! Now, only native plants develop well, like ipê and pequi."

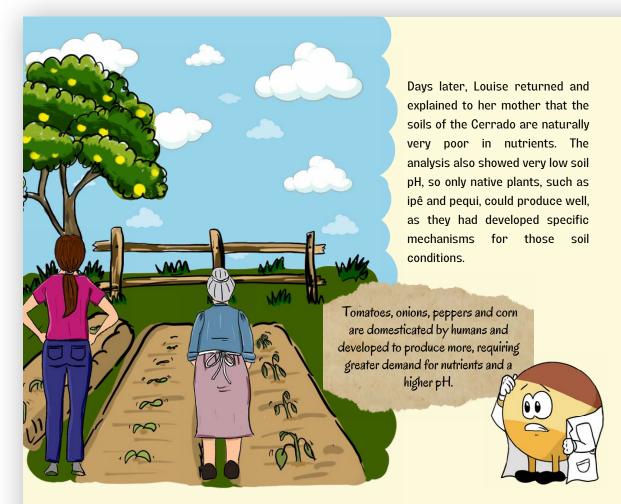
Worried because her mother had not told her anything before, Louise asked if the problems could be related to the management of the farm.

"I've been doing what the last Agronomist instructed - preparing the soil and using good seeds. I just haven't been able to buy fertilizers, because they are very expensive," explained Ms. Mary.

Louise asked her mother for permission to take a soil sample to the city's laboratory.







Louise, seeing her mother's concern, explained that correcting the acidity with limestone and introducing nutrients with fertilization could greatly improve the quality of the local soil.

Ms. Mary understood but warned her daughter that she would not be able to invest in limestone and fertilizers at the same time. But Louise reassured her:

"With some waste materials from the farm to compost it is possible to produce low-cost organic fertilizers, which will save enough money to buy limestone!"

- The most common types of Cerrado soils are the Ferralsols and Acrisols (WRB/FAO, 2015), which generally
 have a low pH (acidic), causing high levels of aluminum (Al⁺3), which is toxic to plants, and low levels of
 nutrients such as potassium (K⁺), calcium (Al⁺) and Magnesium (Mg⁺2), which different organisms need for
 development. Low pH results in delayed development and reduced productivity.
- Limestone is a basic rock that has Calcium and/or Magnesium. When ground, it can be applied to the soil, as it
 has the ability to reduce acidity.
- Fertilizers are substances, of mineral (ground rocks) or organic origin (animal or vegetable waste), that are applied to soil or plant tissues to provide nutrients.
- pH is a measure of the amount of Hydrogen (H⁺) present, "the most abundant chemical element in the entire
 universe" that makes up "various types of organic and inorganic substances", which indicates the acidity or
 alkalinity of these substances.



Beneath them, Solinho explained:

"The organisms in the field are weak because there are few nutrients in the soil. We need to find as much organic material as possible to get these nutrients."

"Come on..." said a camp termite, moving with difficulty.

Seeing the other organisms were also struggling, Solinho realised that they could not perform the task.

Above ground, the excited children began to stack organic materials - tree leaves, fruit and vegetable peelings, animal manure - to form a compost.

Meanwhile, Ms. Mary applied limestone to correct the soil.



Soon, the organisms were able to feel a change in the soil and could smell plant residues. Solinho, excitedly identified it as organic material that was being stacked just above where they were.

"So, the problem is solved?" asked the city's Earthworms.

"Almost, but we still need to release the nutrients to the others."

"How do we do that? This is our first time in the field."

"I'll show you!" said Solinho.

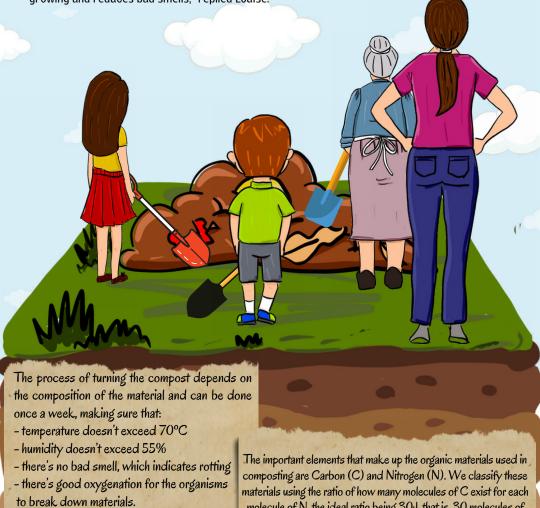
The process of releasing nutrients begins with the breaking of organic material into smaller pieces, an action performed by the mesofauna and soil macrofauna, such as earthworms and beetles. Then the fungi and bacteria – soil microorganisms – release the nutrients to be aken up by plants and animals.

As if she were connected to Solinho, Louise mentioned that the soil organisms would be responsible for breaking down the collected material into nutrients the farm needs.

"But to help these organisms, it is important to turn over the pile of organic materials often," she explained.

"How does that help them?" asked Anne.

"When we turn the material, we allow oxygenation which stops unhelpful microorganisms from growing and reduces bad smells," replied Louise.



With the help of the grandmother and grandchildren turning the pile, the organisms gradually resumed their activities, the organic material providing them with nutrients while they broke it down into compost.

molecule of N, the ideal ratio being 30:1, that is, 30 molecules of C to I molecule of N. It is possible to mix different materials, to get the optimal ratio and thus optimize the compost.



Once nutrients are available in the soil, they are absorbed by the roots and distributed to all parts of the plant. When vegetables are eaten by animals or humans, they contribute to their nutrition.

Four months after the process started, the material was ready to be used in the soil. Louise and Peter went to the farm to help Ms. Mary and Anne.

Based on the results of the soil analysis, Louise was able to calculate the amount of organic fertilizer to be applied.

Thrilled, she knew that the quality of the fertilizer achieved was due to the excellent work of soil organisms.

"You know, kids, even if we can't see the work happening, the soil organisms play a very important role in that process."

Everyone smiled at them gratefully.

Nutrients are classified according to the amount required by plants:

- Macronutrients required in larger quantities: N, P, K, Ca, Mg, S.
- Micronutrients required in smaller quantities: B, Cl, Mo, Cu, Fe, Zn, Mn.

After the application of organic fertilizer, the nutrients that were missing for the vegetables produced at the farm were now available. Gradually, all the seeds and seedlings planted by the grandmother and grandchildren germinated and grew strong and healthy.

The amount of limestone and other fertilizers should be recommended by professionals in the area.



The corn also developed well and could soon be used as chicken feed. Louise was happy for her mother and niece, and the results found on the farm would be used in scientific studies in the laboratory where she worked.

Peter researched and found that besides Anne, his grandmother and his mother, the Brazilian Cerrado has several heroines, including:

Mercedes Bustamante.

master in Agricultural Sciences and PhD in Geobotany, is "one of the main references in the Cerrado biome, working in the area of ecosystem ecology focused on changes in land use, biogeochemistry and global environmental changes".

To learn more, click here



https://bit.ly/3CFcT71

Joana Döberainer,

agronomist from Czechoslovakia living in Brazil. pioneered research on improving soybeans and other vegetables through Biological Nitrogen Fixation, which made the country's agriculture competitive with other nations.

To learn more, click here



https://bit.ly/2w9ZKor

leda Mendes,

Agronomist, PhD in Soil Sciences and researcher at Embrapa Cerrados. Her studies on biological nitrogen fixation, microbial ecology and soil quality bioindicators influenced the development of soil bioanalysis technology through which farmers identify soil quality.

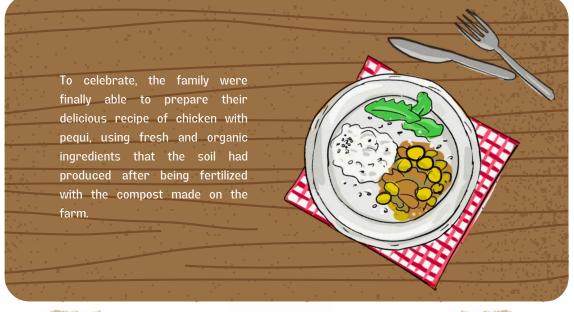
To learn more, click here



<u>https://bit.ly/3zmN8M3</u>







Nutritional properties of pequi: The pulp and almond contain 267.9 kcal/100 g and 317 kcal/100 g, respectively, constituting a rich source of calories (Unicamp, 2006).

Under the new management, all organic waste was now composted and used in the production of food for humans and animals.

The organisms were also happy and healthy due to the abundance of nutrients in the soil.

Even unintentionally, the humans and soil microorganisms had collaborated to produce a nutritious soil and healthy plants.

Then Solinho knew that it was time to say goodbye.

In that story, we learned a few lessons:

- We must pay more aftention and value native plants and

their mechanisms of survival in the environment:

- We can in addition to mineral fertilizers, use afternative

sources of nutrients.

such as organic fertilizers. Thus, we should prioritize
sources associated with the recycling of compounds, such
as domestic organic waste:

 We have seen that soil fertility is not only the chemical part, but also biological (and can affect soil physics!).

Did you know?
Brazil is the only country so far that has a biological evaluation system for routine fertility analyses.

https://bit.ly/3EhqkH



Bruna Arruda, Aline Martineli Batista, Marcia Vidal Candido Frozza, Wilfrand Ferney Bejarano Herrera, Nayana Alves Pereira, Clécia Cristina Barbosa Guimarães, Antonio Carlos de Azevedo

Revisor

Cyan Turner

Cover

Beatriz Rosa Chiodeli Josiane Millani Lopes Mazzetto Tiago Ramos de Azevedo

Illustrators and Designers
Beatriz Rosa Chiodeli
Josiane Millani Lopes Mazzetto
Tiggo Pames de Azgrado





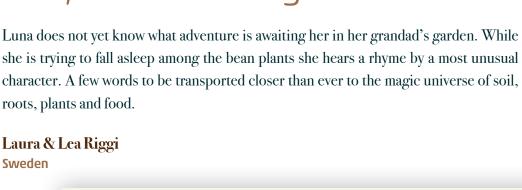


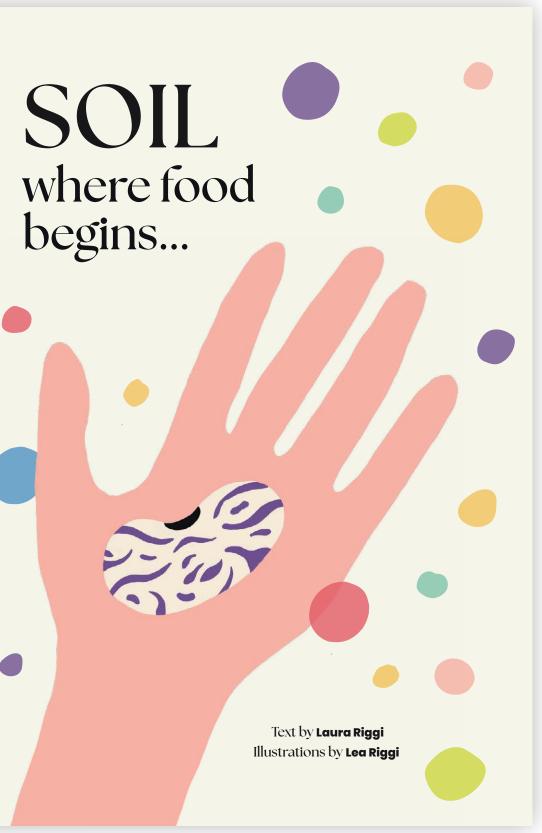


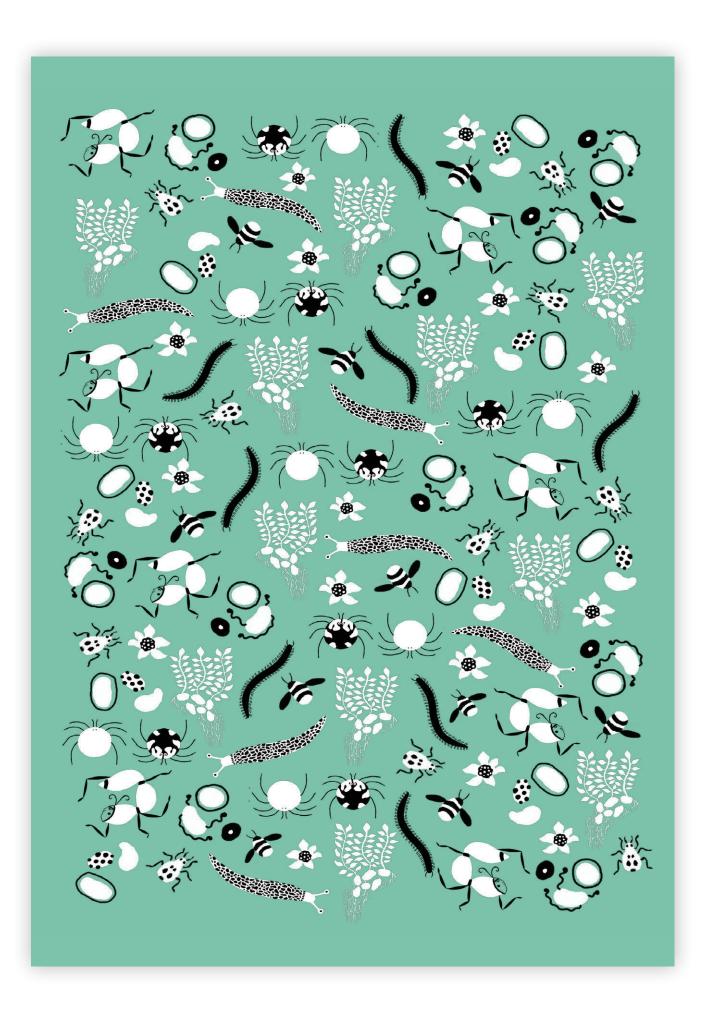
The end

Soils, where food begins

roots, plants and food.







Chapter 01	Grandad's sound garden	01
Chapter 02	The earthworm ride	03
Chapter 03	First encounters	04
Chapter 04	Dawn of the soil	05
Chapter 05	The Lady and the root-boy	06
Chapter 06	Micro-mania	07
Chapter 07	The nodules of the bean	08
Chapter 08	The other-side	09
Chapter 09	The soil trembles	10
Chapter 10	Up-side down	11

Chapter O1

Grandad's sound garden

Luna could not sleep, it was too hot, too noisy, and too bright. The garden was the theatre of a great summer concerto. The bassoon buzz of the bumblebees, the chirping cellos of a thousand crickets, the wail and whistle of the wind, the melody of the black birds and all the whoosh of the leaves... but louder than all, the grumbling, snorting and rumbling of her grandad snores. Luna's grandad was taking a nap in the shade of the big oak tree. Like every day since the first flower buds had appeared, he would lay by his vegetable garden after lunch and fall deep and loudly asleep.



Luna closed her eyes and lay still in the grass. She tried very hard to doze off. It was no good. The grass blades were tickling her and something hard under her was giving her trouble. Turning round, she found a bean. It looked bigger and more beautiful than any she had ever seen.

Perhaps, she said to herself, this is the magic bean her grandad was telling her about last night. He had told her of this boy named Jack, who had beans that could grow to reach over the clouds, to magic castles with giants. But Luna was scared of heights. She loved having her two feet on the ground.





Luna could not stop staring at the bean. It was really beautiful, with rainbow shades, and on its tip a little root was growing like a long hair. It had a little black eye that was staring at her. And the more she stared the more she was convinced that it was staring right back. "Little bean, if only you could speak and share where you have been, how can you grow from a seed to be so tall and so green...?"

"Hello there, Luna, isn't it?" Luna jumped. "Ah-ha" the bean whispered. "You'd never guess that a bean can talk!" Luna was crouching a little now and pushing her face closer and closer to the bean until the tip of her nose was actually touching its hair.

"And now," the bean said "if you really want to know, all you've got to do is bow low and slow.

Look for the worm borrow, on the surface of the ground where plants grow.

The worm can take you down below.

In a world of magic, and explain it all"

The bean winked at her and then closed its eye. Luna looked around, wondering what had just happened. The bean rimes were turning round and round in her head like a spell. Almost without knowing what she was doing, she went on her belly on the surface of the soil, and around her grandad vegetable plants she searched for the worm.

Luna was so close that she could smell the soil, it was earthy and musty. Being so close, she realized that the dark brown of the surface was actually made up of a thousand reflections. Digging a bit with her hand she saw a hole, a bit smaller than her fingers. This isn't just a hole, she thought excitedly. It's a tunnel! and pulled by an invisible force, she put her finger in it.

The earthworm ride

"Stop, right there you squishy soggy thing!" shouted someone, something, inside the tunnel. "Who are you to destroy my work? it is a construction site, can't you see, or are you too big to care?". Luna, for the second time in a day was jumping in surprise, as she saw the head of the earthworm with a yellow helmet sticking out of the hole. But this time she knew not to wait and to spoke fast.



"Hullo Sir Worm, do not be angry, my name is Luna and Mr Bean told me to find you. All I want to know is what happens down below, is soil alive, and how do things grow? Could you be my guide and take me for a ride?"

The earthworm, a proud creature, cooled down by Luna's interest, rose with all its length from the tunnel. "Life is soil and soil is life, my dear. But you will not be able to see well underground. Close your eyes and start looking through sound. Feel your way with your other senses. In the soil most life is blind, we have feelers and hairs to get around". Luna closed her eyes. The earthworm continued his rhapsody. "But above-all, you will need to be small, hoooo soooo small!!!!, to fit through this hole and seat on my back for an under-stroll". And as the earthworm was chanting these words, Luna was getting smaller, smaller, and smaller...



First encounters

...Luna opened her eyes to find she was now a little smaller than the earthworm. Under the shade of the bean plants, she was startled by all the activity around her, it looked like a circus. Six-legged acrobats were jumping in the air. "What are they? With their spring and their colors" Luna asked.

"They are the springtails. Aren't they incredible, they can jump over twenty times their size. And the little round ones running and rolling are the mites. They are both decomposers animals, just like me, only that I can dig deep and move soil all around. They will eat and break down dead plant material and make more food and soil for the plants and crops to grow. Without decomposers, dead leaves, would pile up everywhere. Imagine that!"

"Come on my back and I will take you for a ride"

Luna hopped on the earthworm back and together they dive down the tunnel.





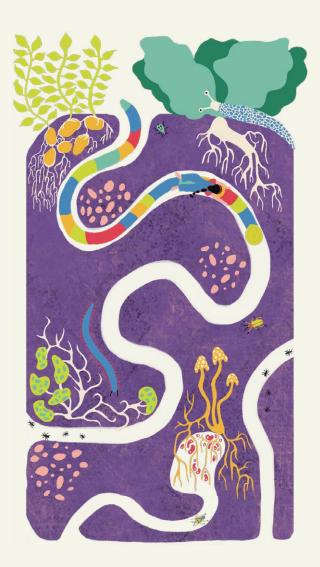
4

Dawn of the soil

As they enter the soil, the darkness leaves place to a magical sight.

"Soils are largely unknown universes. Luna" declares the earthworm. "Full of bubbles, pores, roots. Bursting with colors. despite the darkness. and music of drops and screeches and scratches. Soils are complex systems formed by a mixture of air, minerals, and organic compounds made by dead plants and animals..." "But where is the life is the soil only material and mineral?" Luna interrupts.

"Hahahah," his laughter was resonating through the galleries and reverberating over the walls. "Look a bit closer, open your ears, there is life of all sizes down here! I do not even know how many species live in the soil, but what I do know is that soils contain the greatest biodiversity on Earth, Taken together, the soil animals that live belowground weigh more than the sheep and cows above them".



Now travelling under the vegetable garden, Luna sees the roots of the pumpkins, of the beans and of the poppy flowers of her grandfather. She can hear her grandad voice singing to his sunflowers in Italian "Hooo sole mioooo!"

The Lady and the root-boy

Behind the bend of a root Luna sees a white veil, made of a thousand silk threads, moving like a jelly-fish to a rhythm Luna cannot yet hear. "Shhhh, listen," says the earthworm "it is lady mycelium, she's a real hyphae, a real star down here".

Luna sees that the white lady is entangled, in a passionate embrace with the root of the pumpkin. She is moving and stretching through the soil... Luna is hypnotized by her movements, all her arms stretching and searching the soil. "What are you looking for?" Luna asks.

"I am looking for nutrients to bring to my root-boy." Intervenes the white lady. "I am a mycorrhizae fungi, my hand, I mean my threads, or some call them hyphae, stretch and search to get nutrients from the soil. I help this big lazy root-boy and bring it nutrients. I may look small and fragile, but let me grow and I will spread and connect all roots. Most plant roots would dance with me given the opportunity." Luna is under the spell of the white lady, who is still dancing and extending all around her.

"See, I help the plants with nutrients so that they can grow and be strong and they give me energy in return ...except in some places, I heard, aboveground, the soil-surface dwellers give food to the plants directly so that I am not needed any more. Our relationship is vital but fragile. We need each other and together we're strong. But I do not resist well when the soil gets turned and grated and if plants do not need me to get nutrient, I sulk and despair"

To the rhythm of some mites playing jazz, the lady, her hyphae and the root waltz away.



Micro-mania

The earthworm and Luna continue through the labyrinth of roots and hyphae. They enter a soil pore. Suddenly there is a lot of noise. It is a party. The springtails are jumping, they are smaller and whiter than on the surface, they are feasting with some mites eating dead plant material. There is music and more dancing. So many tiny creatures of all shapes and colors. "They are microbes. They are tiny organisms that cannot be seen with the naked eye, as most of them are made up of only one cell" The earthworm shouts over the music. "They are releasing nutrients and participating to the nutrient cycle, that is the movement and exchange of nutrients between the non-living and living parts of the soil. Nutrient cycling helps plants grow!"

In a dark corner of the room, Luna sees a big, ugly mass being cornered. "It is a pathogen" intervenes the earthworm. "He is trying to reach the potato roots and feed on them, but the other guys, the microbes, are blocking the way. If they left it, it would damage the plant and there would be no potato to eat. Like aboveground there are the good guys and the bad guys. If the soil is not healthy and happy, the bad ones can take over".

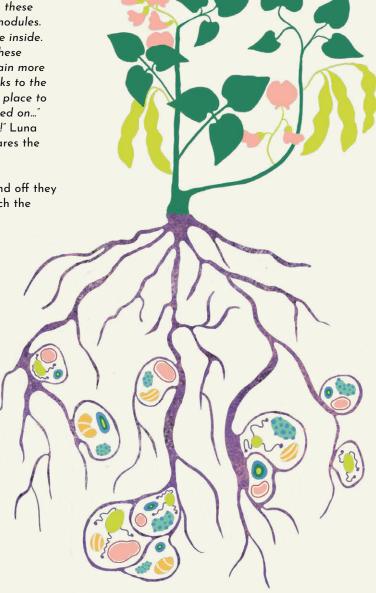


The nodules of the bean

At the next red light stop, Luna is intrigued by the cutest little houses attached to the roots. "This is a bean root. All legumes form these wee houses, they call them nodules. They are for microbes to live inside. Thanks to the microbes in these nodules, the plants can obtain more food from the soil and thanks to the plants, the microbes have a place to live and a lot of sugar to feed on..." "Like the white lady hyphae!" Luna shouts. "Exactamente!" declares the earthworm.

The red light turns green and off they go. They ride until they reach the garden's wall.

"Luna, do you want to keep going and see the other side where the fields are?" ask the earthworm. Luna nods. "I see! Then, brace yourself, as that world is full of pits and falls and risks".



The other-side

On the other side of the wall there is an immense field of wheat. Nothing else till the eye can reach.

Luna and her companion are travelling through a soil that is sooo silent, sooo dark, soooo compacted, nothing seems to be alive here... the same thin, lonely, sad looking roots extend forever, no dancing, no music.



Luna closes her eyes very hard to try to catch a sound, any sound. After what seems like a long long moment she hears a song, so sad and so deep. She opens her eyes and sees an old hyphae... he is all blues and singing like a broken record.

"Ain't no sunshine when she's gone, It's not warm when she's away, And this house just ain't no home, Anytime she goes away". "Who are you singing to? Who is gone away?" asks Luna.

"Ho my roots do not need me. You see young lady, the plants get all the food they need from above...the farmer here gives them liquid nutrients. Plants do not need me anymore... Ain't no sunshine when she's gone" "But where is everyone?"...

The old man replies "Because of pesticides nothing wants to live here and few could survive anyway. Only the tough ones that resist stay, I am too old to leave. The ones who stay are the young violent microbe gang, they do not do much good around. They miss their function and so are lost and bored."



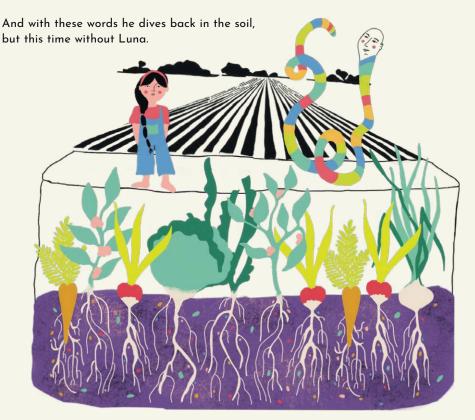
The soil trembles

Suddenly the soil trembles... it's the tractor coming over to harvest the wheat. The earthworm takes Luna on a run towards the wall. To the safety of the field side and from the wall of the garden, with the view on both worlds, her grandad's garden and the wheat field, the earthworm tells Luna:

"Remember Luna, to protect the soil balance needed for a healthy soils and plants. Soils need love and life. If soils loose too much biodiversity due to poor soil management, this could reduce the ability of the soils to grow plants. Healthy soils are important because they support the growth of crops, ultimately help farmers grow enough food to feed us all! Soils are where food begins!"

"Yes I'll remember... everything down here seems to work and fit together, a bit like a puzzle, but where the pieces would be so very tiny and attach in so many ways. And what do you do Sir Worm?"

"I am an ecosystem engineer, I mix, create, modify, and maintain the soil structure. If your soil is healthy and welcoming you will find me borrowing there."



Up-side down

Luna wakes up with the bean in her hand, close to her chest. Her grandad is nearby talking to his pumpkins now. Luna remembers everything, this cannot be a dream she is sure of it. It felt all too real. Luna kneels in the ground, where the beans are growing and staring she finally finds them...the circus springtails.

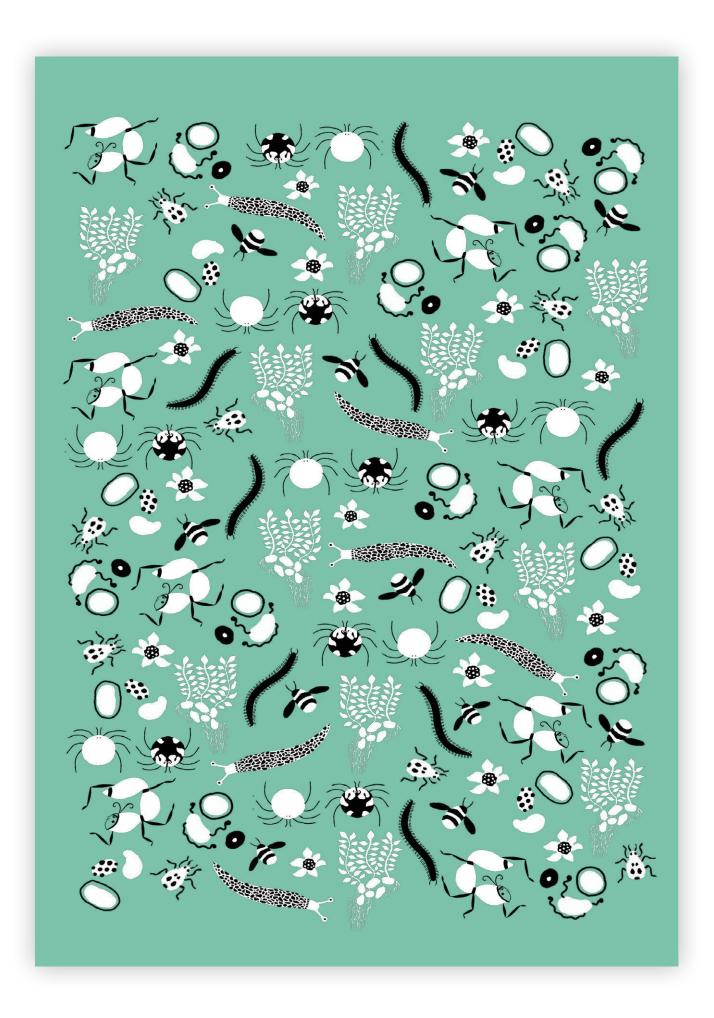
Her grandad is now calling from the kitchen "Lunch is ready, Luna!".

Luna stares one more time at the acrobats, and then makes a little hole in the ground, where she plants the bean, "I wish you a good waltz with the lady hyphae Mr Bean and a good party with the microbes. I will be looking out for the worm and for your beans".





the end...



SOIL where food begins...

Luna does not yet know what adventure is awaiting her in her grandad's garden. While she is trying to fall asleep among the bean plants she hears a rhyme by a most unusual character. A few words to be transported closer than ever to the magic universe of soil, roots, plants and food.



Laura & Lea Riggi are two sisters interested to bring together science and arts and associate their complementary skills. Laura is a researcher in agro-ecology, looking into above and belowground biodiversity. Lea is an illustrator and graphic designer.

Further information about their previous work and research can be found through the links below:

https://www.researchgate.net/profile/Laura-Riggi https://www.behance.net/Irleariggic7e2 https://www.instagram.com/Iea__rosa/

Food for soul

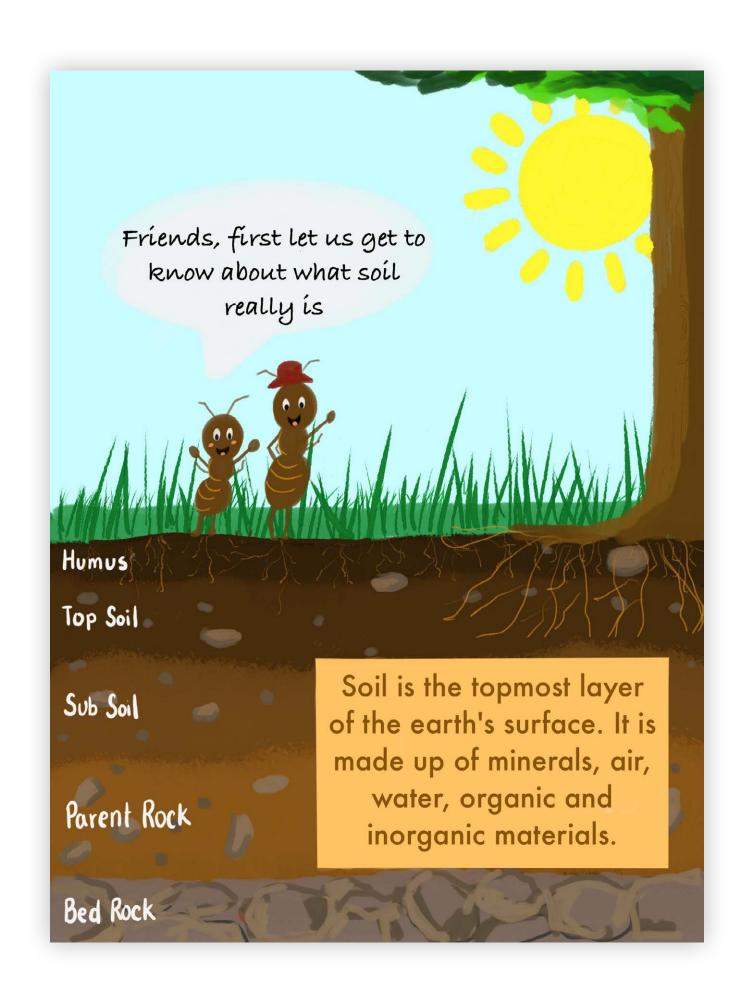
This book is about soil and how important it is to maintain healthy soil for nutrition and food to convey the message to young kids about how soil health is directly correlated to human health.

Sayba Binte Sharif Bangladesh



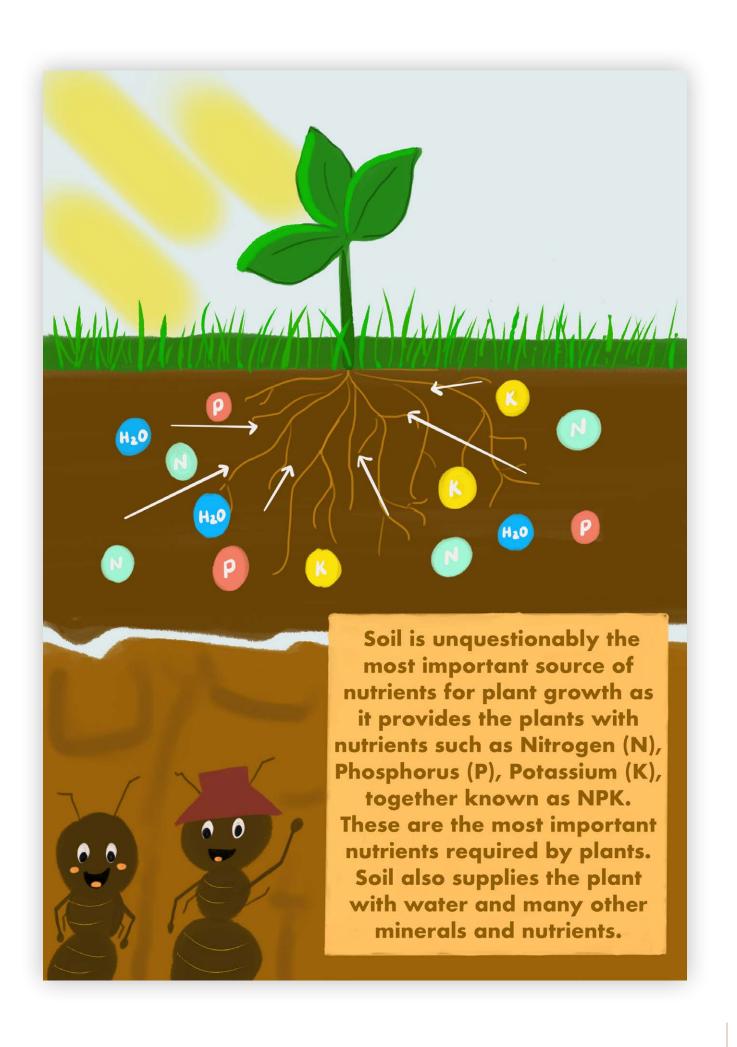


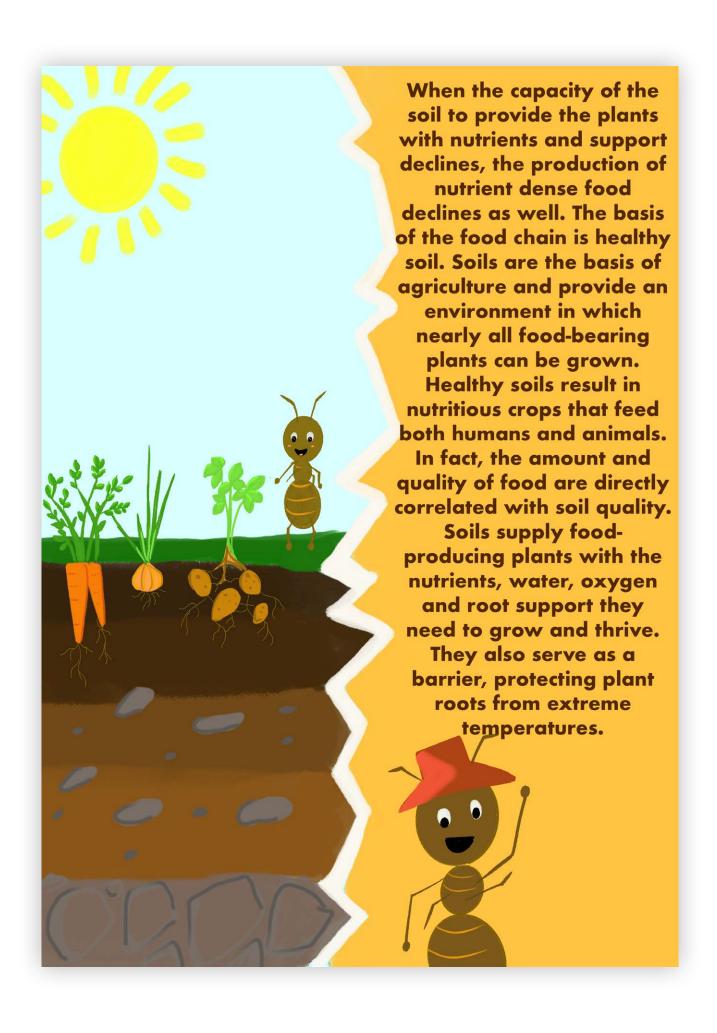




Soil is one of the essential components of life on earth. It provides structural support to the plants, provides the plants with nutrients and also is home to many like us! It produces food, cleans the water, protects us from flooding, and helps mitigate drought. In addition to this, it is essential in the fight agaisnt climate change since it absorbs and stores significant amounts of carbon.





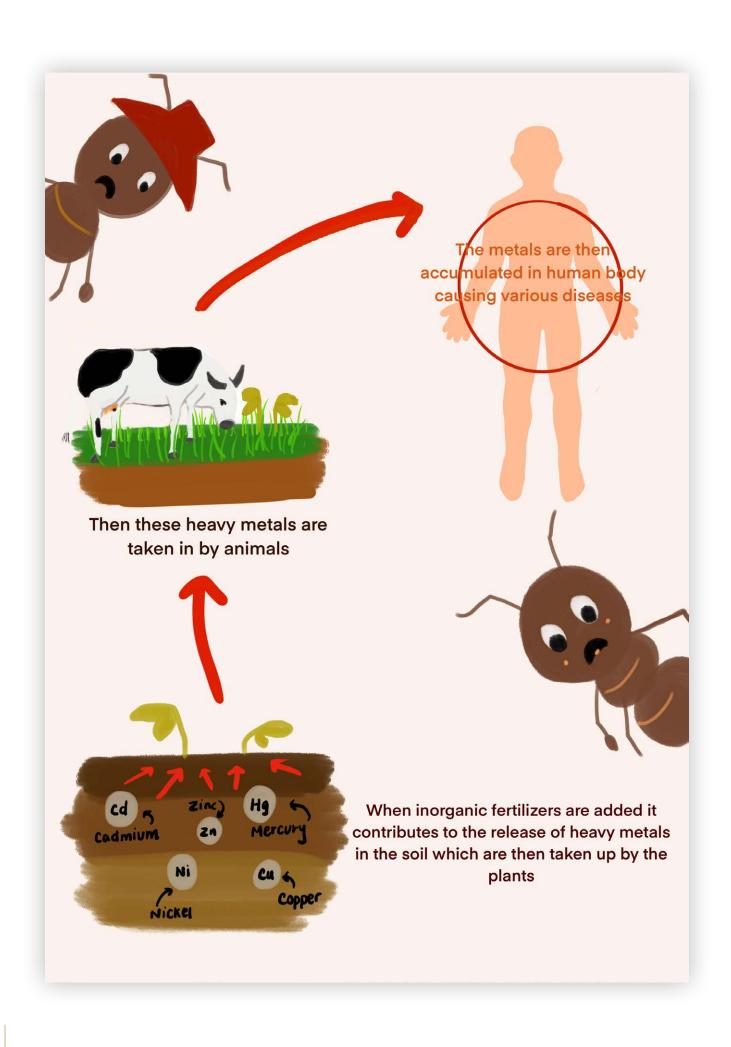


Soil biodiversity is the variety of life found in soil in all its forms. Human health and the environement as a whole may be adversely affected if soil biodiversity is lost. When soil biodiversity in an ecosystem decreases, both the productivity and the services it provides such as maintaining the soil, purifying the water, providing food and etc. suffer. The entire functionality of the ecosystem is at risk when biodiversity declines. Hence, it is mandatory for us to protect soil biodiversity.



Protect Soil Biodiversity at all costs

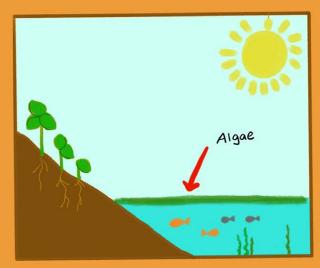






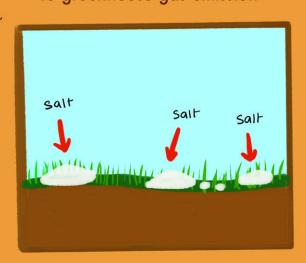
Due to lack of fertilizers and chemicals in soil, the soil may become nutrient deficient. This leads to nutrient deficiencies in plants, causing yellowing of leaves, holes in leaves, roots will have stunted growth and may even cause death of plants.





Soil salinity is another reason why it is difficult to grow healthy crops. It is when excessive amount of salt is accumulated in soil and this excessive accumulation may lead water to flow from the plant roots back into the soil causing a decline in yield or the death of plants

Sometimes there might be excessive nutrients as well which can be toxic to the environment as well as plants and animals. It can lead to eutrophication where excessive nutrients runoff to the waterbodies and increase the growth of algae blocking the entire surface of the water and decreasing oxygen levels, killing the aquatic life. Not only that excessive nutrients can also contrinute to greenhouse gas emission



So, how should we protect our soil?



Use of organic fertilizers because they ensure better water movement into the soil and also ensures healthy root.



By using soil biodiversity for nutrient recycling, regulating organic matter, to purify water and prevent soil erosion



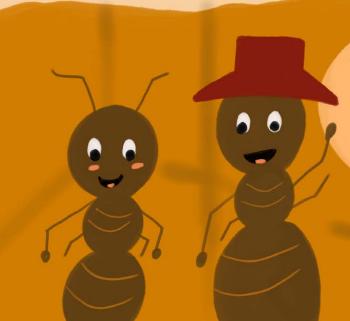
By using proper methods of irrigation (irrigation refers to applying water using tools like sprays, pumps etc.)



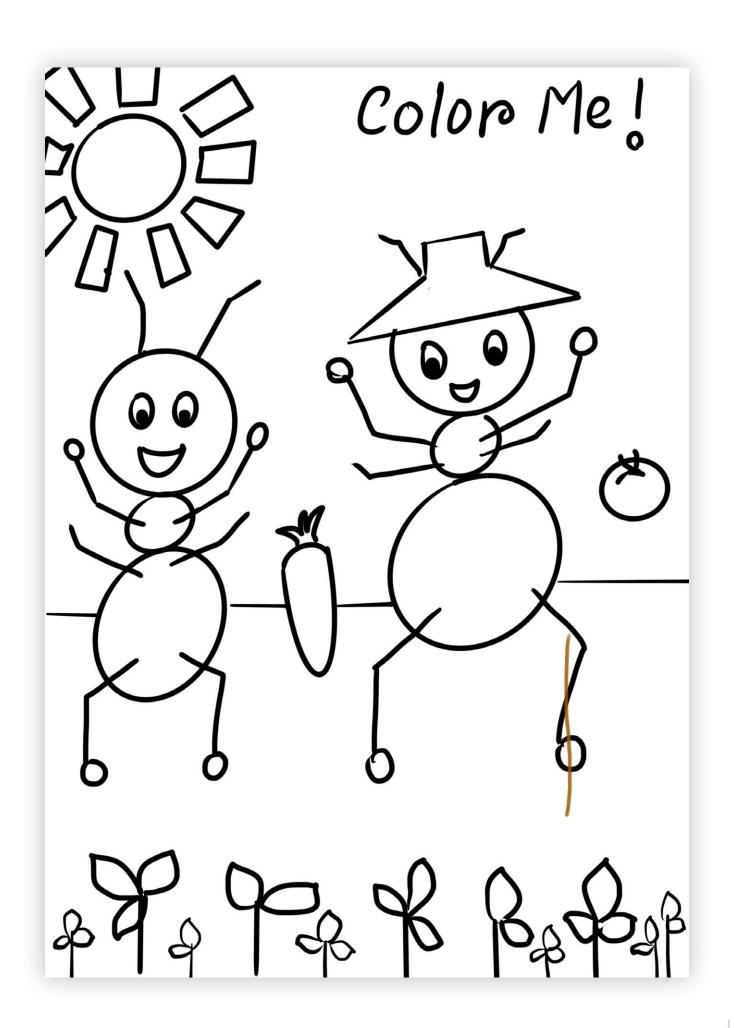
By planting trees and roots that go deep into the soil to hold the soil together and prevents soil erosion. An example could be vetiver grass with roots going as deep as 2-3m. Not only does it help keep the soil together but also reduces soil salinity to some extent



Another way is to inform farmers of better methods and ways of farming



Daughter, lets inform the humans and our little friends on how we can all come together and help in making our soil strong and healthy.



Biology of Soil - Lesson 5 - Plant and Soil Interactions (no date).

Available at:

https://www.iowaagliteracy.org/Article/Biology-of-Soil-Lesson-5-Plant-and-Soil-Interactions

FAO (2022) Soils for nutrition: state of the art, Food and Agriculture Organization of the United Nations
Rome, 2022. Available at: https://doi.org/10.4060/cc0900en.

Kulkarni, S. and Goswami, A. (2019) 'Effect of Excess Fertilizers and Nutrients: A Review on Impact on Plants and Human Population', in SSRN Electronic Journal. Elsevier BV. Available at:

https://doi.org/10.2139/SSRN.3358171.

Nutrient Cycle: Definition, Examples and Importance (no date).

Available at:

https://byjus.com/neet/nutrient-cycle/

Soil types / RHS Gardening (no date). Available at: https://www.rhs.org.uk/soil-composts-mulches/soil-types

What is biodiversity? | Pages | WWF (no date). Available at: https://www.worldwildlife.org/pages/what-is-biodiversity

Wollongbar Agricultural Institute (1992) Plant nutrients in the soil, New South Wales Department of Primary Industries. Available at: https://www.dpi.nsw.gov.au/agriculture/soils/soil-testing-and-analysis/plant-nutrients



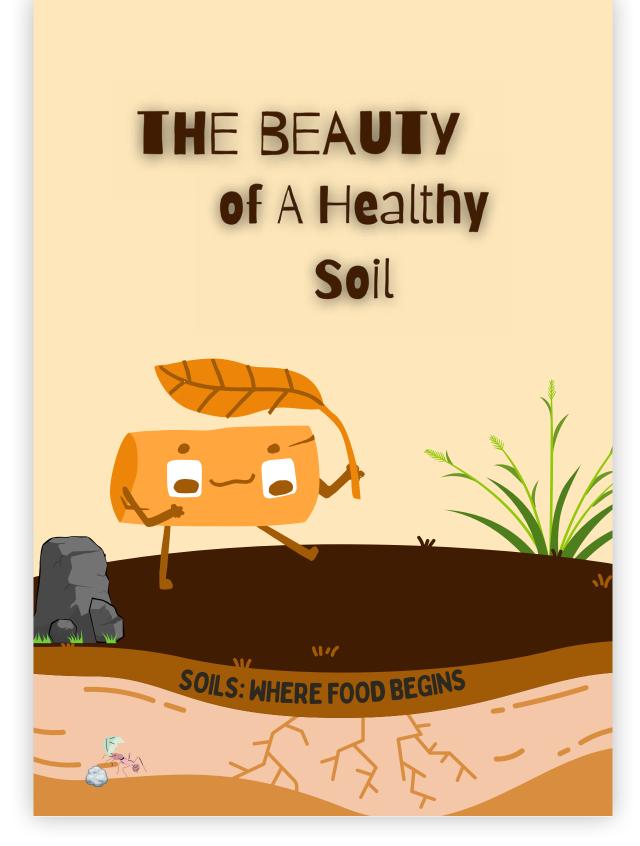
The beauty of a healthy soil

Having a Healthy Soil really means to us. It is our big responsibility to do something that can improve the soil. We need to know the condition of the soil in order to build soil health. Knowing the status of the soil is the key to monitoring and managing the soil.

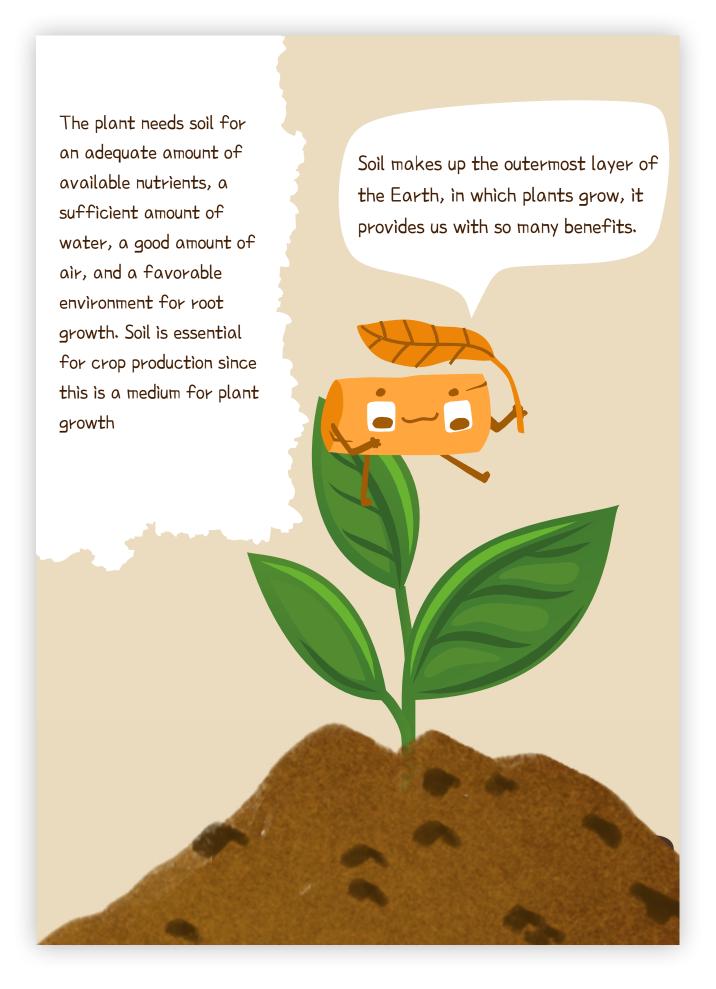
Precious Dane Tagas

Xavier University-Ateneo de Cagayan, Instructor **The Philippines**

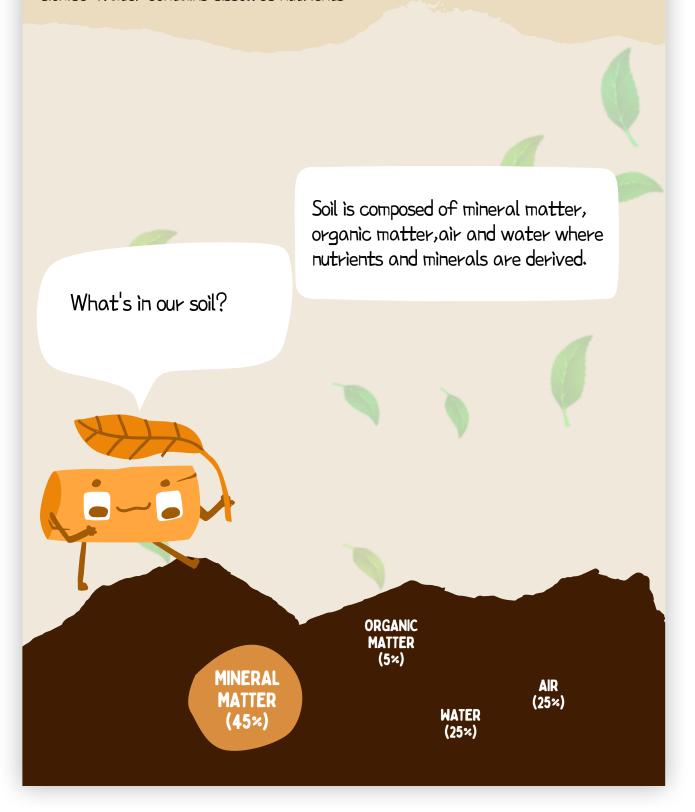


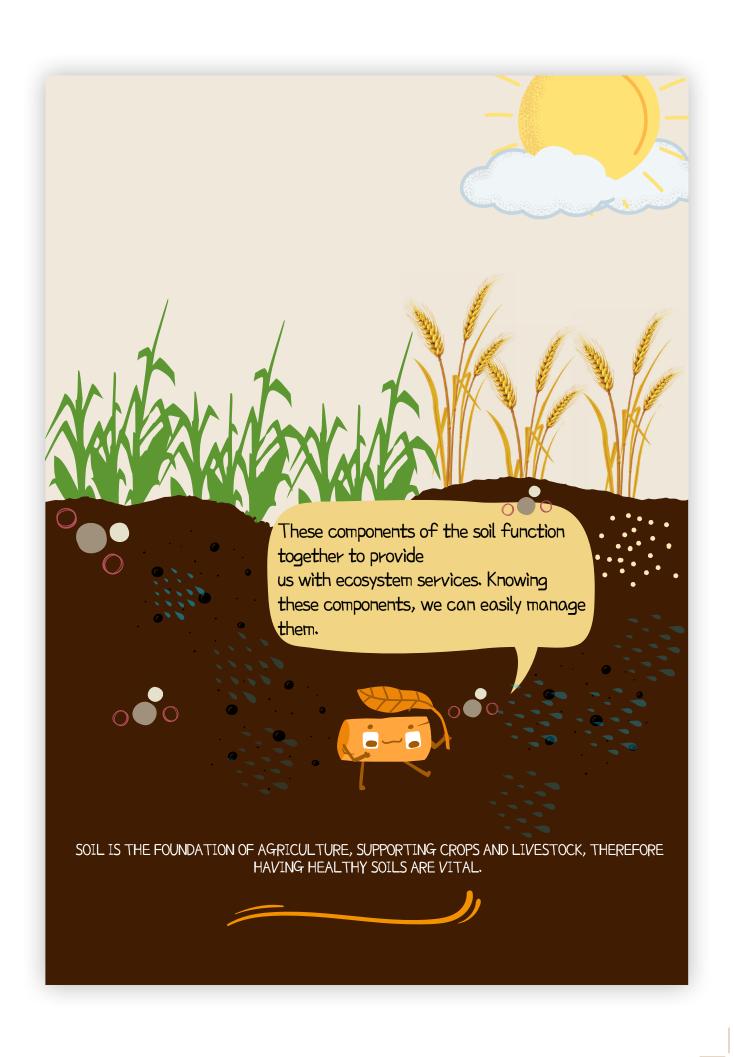


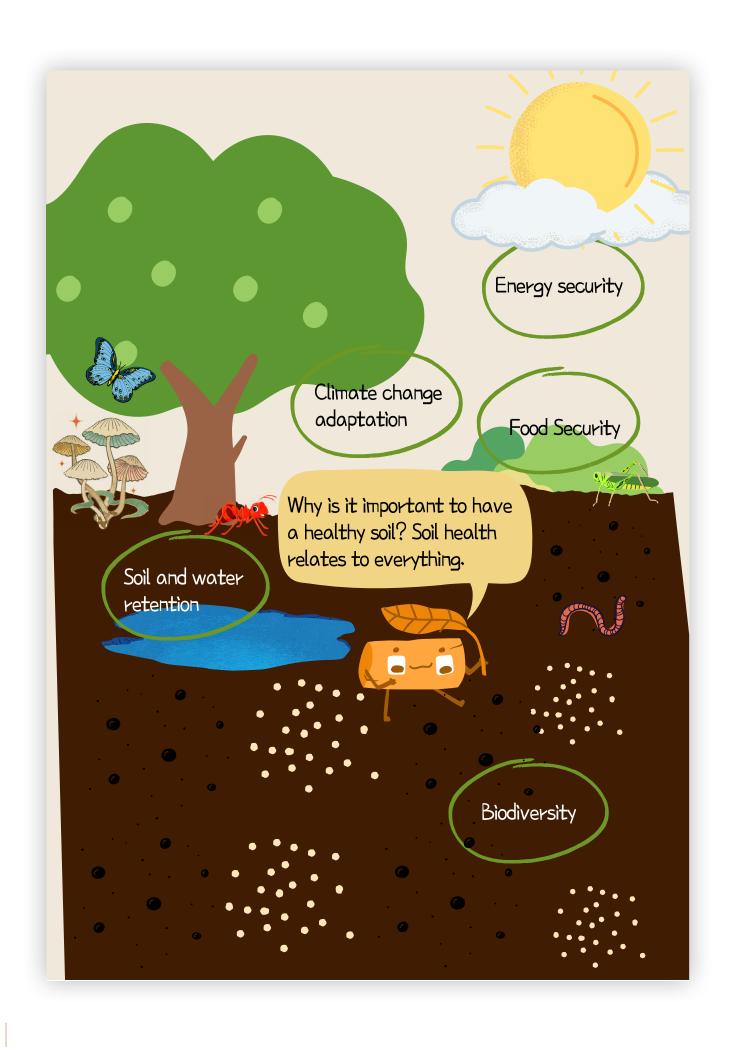




Mineral matter are the non-living parts of the soil made up of solid particles of different shapes and sizes and are really important for building soil texture. Organic matter is made up of dead plant and animal materials at different stages of decay or decomposition Soil air contains the primary gases namely nitrogen, oxygen, and carbon dioxide. Water contains dissolved nutrients.

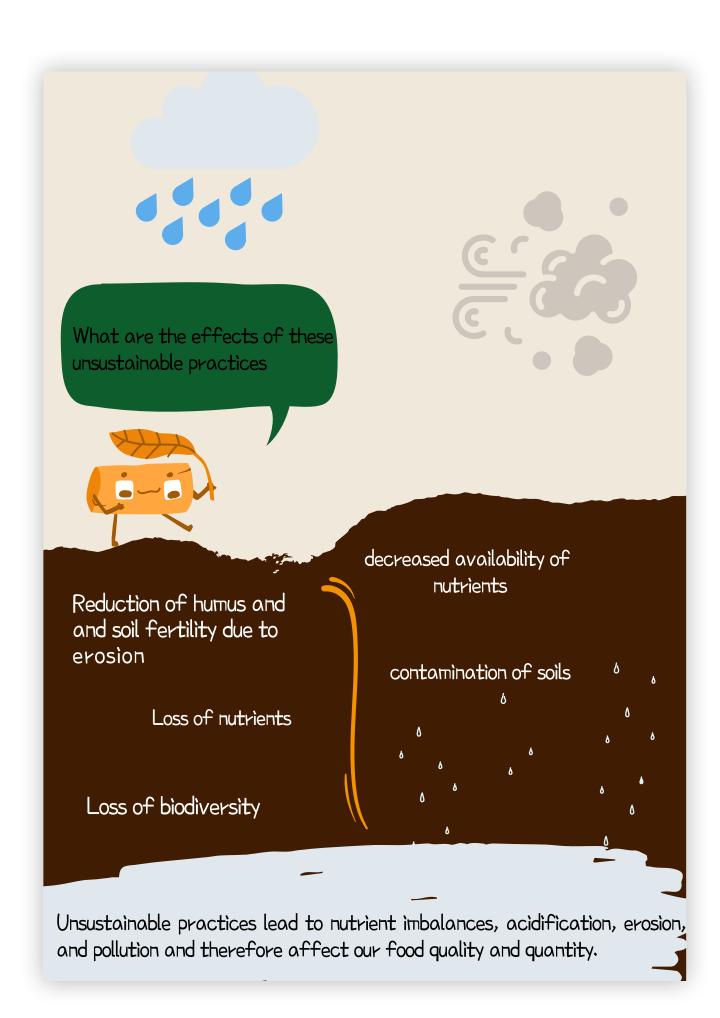






Crop production systems, and problems with tillage loosen the soil and expose soil to drying which can lead to wind or water erosion and exposing soil organic matter to oxidation.





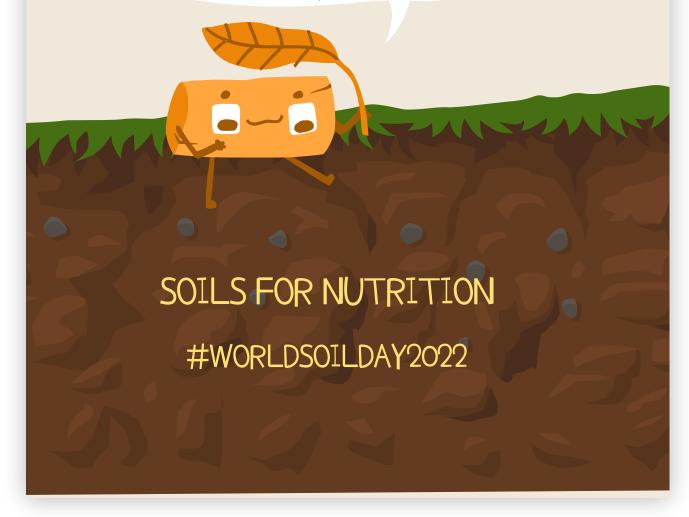






Soil is not just a medium for holding up crops, it is a complex living system that when manage properly, provides all the nutrients crops will need, stores water more effectively, and nurtures a rich and invaluable microbial life.

I am part of the solution. Come on and let's be responsible in our own little ways.



References

Doran, J.W., and T.B. Parkin. 1994. Defining and assessing soil quality. p. 3-21. In: J.W. Doran et al., (ed.)

Defining Soil Quality for a Sustainable Environment. SSSA Spec. Publ. No. 35, Soil Sci. Soc. Am., Inc. and

Am. Soc. Agron., Inc., Madison, WI.

Food and Agriculture Organization of the United Nations. Global Soil Partnership. https://www.fao.org/global-soil-partnership/areas-of-work/awareness-raising/en/

Morgan, Christine. 2020. Soil Health Institute. Assessing Soil Health Webinar Series. www.soils.org/education

Natural Resources Conservation Services: Soil Health. 2012. Retrieved June 23, 2016 from http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/.

Rodale Institute. What is healthy soil? https://rodaleinstitute.org/why-organic/organic-farming-practices/soil-health/

Taos Soil and water Conservation District. Soil Health.https://tswcd.org/natural-resources/soil-health/



The Global Soil Partnership (GSP) is a globally recognized mechanism established in 2012. Our mission is to position soils in the Global Agenda through collective action. Our key objectives are to promote Sustainable Soil Management (SSM) and improve soil governance to guarantee healthy and productive soils, and support the provision of essential ecosystem services towards food security and improved nutrition, climate change adaptation and mitigation, and sustainable development.

Land and Water division - Natural Resources and Sustainable Production GSP-secretariat@fao.org www.fao.org/global-soil-partnership

Food and Agriculture Organization of the United Nations Rome, Italy



Thanks to the financial support of



Ministry of Finance of the Russian Federation



Schweizerische Eidgenossenschaft Confédération suisse Confederazione Svizzera Confederaziun svizra

Swiss Confederation



Australian Government

Department of Agriculture, Water and the Environment

