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TOWARDS SDG 2: HEALTHY SOIL LEADS TO HEALTHY FOOD

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YOUNG REVIEWERS:


AISYAH
AGE: 15


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AGE: 14

Sustainable Development Goal 2—Zero Hunger, set by the United Nations, aims to ensure no one in the world Goes hungry. This goal involves growing healthy food that is good for the planet and ensuring everyone has enough to eat. However, growing food can be tricky, especially in certain climates or places with poor soil. But we can get a little help from tiny friends—microbes. Soil has helpful microbes that act as natural fertilizers, improving soil quality and protecting plants. We are exploring how to use microbes to help plants grow in warmer climates. One place we test our science is in school gardens, which allows students to learn about healthy soils and how to grow delicious, nutritious food using new technologies. By understanding how food, the environment, and human health are

XIAO

AGE: 15

connected, we are helping achieve SDG 2 and ensuring everyone has enough tasty, nutritious food.

Watch an interview with the authors of this article to learn even more! (Video 1).

HOW TO HAVE A HEALTHY LIFE ON A HEALTHY PLANET

Imagine your daily meals—what if it suddenly became hard to find food, or the food you had was not healthy? Sadly, this is a reality for many people around the world. When we do not produce enough good food or do not have enough to eat, it affects many parts of our lives. We can get sick, we struggle to learn (no one can learn on an empty stomach!), and farmers cannot support their families.

The Sustainable Development Goals (SDGs) are 17 goals created by the United Nations (UN) to help us live healthy lives on a healthy planet. These goals, agreed upon by all countries that are part of the UN, target many issues: from stopping poverty and giving everyone access to education to protecting our land and seas. Sustainable Development Goal 2, Zero Hunger, aims to end hunger worldwide. This goal is not just about making sure everyone has enough food; it is also about ensuring that food provides all the essential **nutrients** for good health. When people do not get enough food, or if their food is unhealthy, they cannot grow strong and live healthy lives. SDG 2 also aims to help farmers who grow food on a small scale, by providing them with everything they need to grow and sell their crops, investing in roads and buildings in rural areas, and ensuring that the rules about buying and selling food are fair for everyone.

NUTRIENTS

Substance that provide nourishment essential for maintaining life and growth.

When farming is not done correctly, the land can become dry and less able to grow food, turning into desert-like areas. But if we take care of the land and grow food correctly, land can become healthy and full of nutrients, which helps farmers grow even more food in the future. These issues are connected to other SDGs, like SDG 3 (Good Health and Wellbeing), SDG 4 (Quality Education), SDG 1 (No Poverty), and SDG 15 (Life on Land). That is why achieving SDG 2 is so important—it helps us reach many other goals, too. The good news is we can all play a part in addressing these challenges by learning how to grow food more effectively, regardless of where we live.

GROWING FOOD IN HARSH CONDITIONS

We must include plenty of vegetables and other plant-based foods in our diets as they provide essential nutrients such as proteins, healthy fats, fiber, vitamins, and minerals—all of which contribute to overall health. Scientists are working hard to ensure that everyone can have enough of such tasty, nutritious crops. They are coming up with all sorts of new ways to grow plants, like using special farming

techniques, creating plants that can survive in harsh conditions, and using technology to make sure we can grow fresh produce in places where it is difficult, like deserts.

Deserts are incredibly tough places to live because they are very hot, have very little water, and have poor-quality soil [1]. The soil in deserts is dry and lacks essential nutrients that plants need to grow. Sometimes the soil even contains salt, which makes it hard for most plants to survive. However, over time, plants have figured out clever ways to deal with the challenges of living in the desert (Table 1 and Figure 1). Figure 1 highlights some of the differences between desert plants and plants that grow in cooler environments.

Table 1

Features of desert plants adapted to harsh environments.

High heat	Leaf shape—small or narrow leaves	Plants change how their leaves are shaped, sometimes pointing them up or down to avoid getting too hot.
	Leaves covered in thick wax	Some plants have wax layers (like sunscreen) on their leaves to protect themselves from the sun.
Lack of water	Deep roots	Desert plants often have deep roots that go far into the ground for water.
	Coating around roots	Plants make a protective coating around their roots using soil particles. This helps them hold on to water and get nutrients from the soil.
	Special form of photosynthesis	Plants also have unique ways of photosynthesis, which is how they make food. Some plants use a unique process to save water and survive when it is super-hot and dry.
Salty soil	Intracellular compartments for storing salt	Some plants can absorb salt and store it in unique compartments within their cells.

Table 1

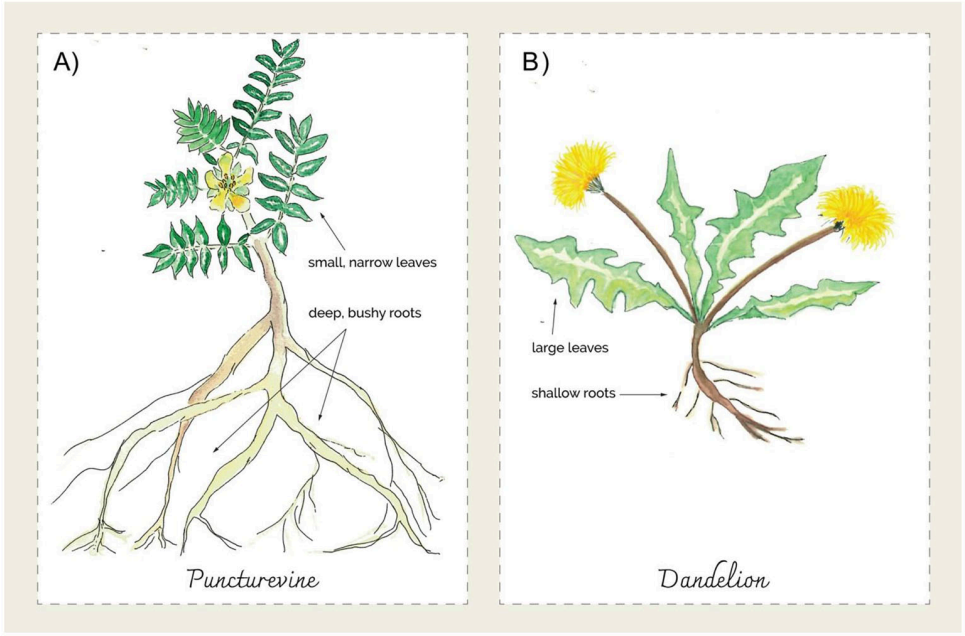

Figure 1

Differences between desert plants and plants that grow in cooler environments. **(A)** The puncturevine plant is native to hot regions. Its small, narrow leaves protect the plant from getting too hot. The long, bushy roots help to collect as much water as possible. **(B)** The dandelion plant is a plant that grows in places with moist soils and a moderate climate, where temperatures are not too hot or too cold. Its large leaves and shallow roots help it thrive in these environments (Figure credit: Jovana Cvorovic).

Figure 1

HOW DO MICROBES HELP PLANTS?

MICROBES

Microscopic organisms such as bacteria, viruses, fungi, and protists.

In addition to the mechanisms mentioned above, plants can get help from other living things. Soil has a team of helpful **microbes** that help plants survive and thrive. These tiny organisms live in the soil surrounding the plants and help them get nutrients and water and stay healthy. Scientists have discovered that different types of microbes live in various kinds of soils. In the desert, helpful microbes live in other parts of desert plants, like in the soil around the roots, on plant leaves, and inside the plant itself. These microbes help plants get nutrients, protect them from diseases, and promote their growth.

PLANT GROWTH PROMOTING RHIZOBACTERIA (PGPR)

Helpful bacteria that live around plant roots and help them grow stronger. They give plants important nutrients, protect them from bad germs, and even help them survive in tough places like deserts.

For instance, a group of microbes called **plant growth promoting rhizobacteria (PGPR)** live in the soil near the roots and help in a few different ways. First, they make nutrients from the soil available to the plants, making plants strong. The microbes also produce special substances that help the plant's roots grow better and help them not to get sick. Finally, the microbes can communicate—not only with each other, but also with the plants!

PGPRs are incredibly important in the desert because they form a unique team of plant helpers adapted to harsh desert conditions, such as extreme heat and limited water. Scientists are now trying to use these desert microbes to help other plants that do not usually live in the desert to strengthen and grow better in dry places. Using these tiny helpers, scientists hope to improve the soil for growing food, even in deserts. This could help us to produce enough food in places where crop plants struggle to survive.

DISCOVERING NEW DESERT MICROBES

At KAUST, a science and technology university in Saudi Arabia, our team explores how microbes can help plants grow better [2]. So far, our research has found over 10,000 types of helper microbes living in deserts across the Middle East. This is excellent news for the region, since growing food in this part of the world is hard. By using some of these local microbes, we might be able to make some plants strong enough to succeed here.

Other scientists have also been doing incredible experiments to help plants thrive in deserts (Table 2) [3]. These experiments have discovered that microbes found in salty soil and in native desert plants play several essential roles in plant growth and health. First, these microbes can improve plants' ability to tolerate harsh conditions like lack of water and too much salt. Second, some microbes produce essential nutrients, making the plants richer in nutrients. Third, certain microbes protect the plants from diseases.

Table 2

Plant species found in the world's deserts and the benefits they receive from soil microbes.

Desert region	Studied plants	Benefits from soil microbes
South America	Tola tola (a shrub)	• Salty soil microbes provide a particular hormone that improves plant growth. • Microbes help the plant get iron from the soil. Iron is an essential nutrient that allows plants to grow and be healthy.
North America (Sonoran Desert)	Ghaf tree Foothill palo verde Blue palo verde	• Native desert plants have PGPR that help them thrive in harsh conditions. Native PGPR can be introduced in other plants to help them grow taller and with more branches, even in damaged soil.
The Great Indian Desert	Pomegranate ⋆ Mung bean ⋆	• Microbes ensure plants get enough nitrogen. Nitrogen is like food for plants; it helps the plants grow taller and produce more leaves and fruits.
Northwest China	Camelthorn	• Camelthorn is a desert plant that can live in dry, salty soils. • Scientists introduced microbes Camelthorn into wheat and observed an improvement in in the plants' ability to tolerate dry conditions.
South Africa	Marama bean ⋆	• Microbes help marama beans survive in nutrient-poor environments and make them rich in proteins. • Plants with high protein are important for humans because protein helps us build strong muscles, repair tissues, and keep our bodies strong to fight sickness.
North Africa	*Desert grass* ⋆	• Certain microbes produce chemicals that prevent the growth of diseases in the soil. • These microbes help maintain plant health and reduce the risk of disease.

Edible plants are indicated with a ⋆ symbol.

Table 2

BRINGING SCIENCE TO OUR GARDENS

The research that scientists do in the lab is not just for learning—it can help us in the real world, like in our gardens. The things scientists discover can be used to make plants grow better and stronger, right in our backyards! As an example of this, we collaborated with The KAUST School (TKS) to create the KAUST Edible School Garden (Figure 2), where school students have the unique opportunity investigate the fascinating world of plant science and discover how plants make our planet a better place to live. In the garden, students learn how to grow plants and vegetables, and why healthy soil is important for both plant and human health. Plus, spending time outdoors in the Edible School Garden is not just educational—it is also great for student health and happiness!

As examples of student projects, some grew cowpea plants and experimented with various environmental factors to test their impact on plant growth. Other students used desert microbes native to Saudi Arabia to see if vegetable plants grow better outside with

the help of these microbes, while others examined the effects of various environmentally friendly materials, like **biochar** and **compost**, to improve soil health. These materials are all locally sourced and developed by scientists at KAUST. Students learn how to conduct scientific experiments and collect data through these hands-on experiments. They also start to understand how essential healthy soil is for helping plants grow, and they learn where our food comes from and how much work goes into making it. This allows them to think more carefully about not wasting food.

BIOCHAR

A charcoal-like material made by burning organic waste from farming and forests (called biomass) in a controlled process called pyrolysis.

COMPOST

A natural way to turn organic waste, like leaves and food scraps, into a helpful fertilizer that helps soil to stay healthy and plants to grow better.

Figure 2

(A) Diagram of the TKS Edible School Garden - A learning space where students explore plant science, discover gardening practices, and connect with nature (Art by Jovana Cvorovic). **(B)** A thriving section of the KAUST Edible School Garden. Sunflowers, leafy greens and other crops grow, demonstrating how science-based gardening practices support sustainable food production.

GROWING A SUSTAINABLE FUTURE: HOW MICROBES AND YOU CAN MAKE A DIFFERENCE

When we care for the soil and save water, we can grow enough food for everyone alive today and ensure plenty of food for future generations. Scientists play an essential role in helping plants grow strong and healthy by using various methods, including studying tiny microbes in the soil. Microbes can be found around roots, on leaves, and inside plants, and different types of microbes live in different environments, like deserts. These microbes act as allies, supporting

plant growth, protecting plants from diseases, and promoting survival in challenging environments. Research about microbes helps us increase food production even in difficult environments, ensuring people have access to nutritious food and can live healthy lives.

Guess what? You can be part of the solution, too! Here are some tips:

- Do not waste food
- Learn about sustainable eating
- Try growing some herbs and vegetables at home
- Stay curious and keep learning about science
- Think about how you can make a difference in your community and beyond.

Together, we can help ensure everyone gets enough healthy, tasty food and thus contribute to achieving Sustainable Development Goal 2: Zero Hunger!

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YOUNG REVIEWERS

AISYAH, AGE: 15
I am a young science enthusiast with Social Studies and Economics being my favorite subjects. When I am not working on homework, I like cooking dishes, jumping around playing badminton, or sitting down doing a coding course. I love learning about the world, and sharing my learning with others.

ATHENA, AGE: 14
My name is Athena, and I am a student at The KAUST School, in 9th grade. I enjoy reading books and playing sports.

HANIYA, AGE: 13
My name is Haniya, and I am currently in Grade 8. I especially enjoy reading, drawing, and gymnastics. When I grow up, I want to become an ecologist and write research papers like this one.

LOKYA, AGE: 14
Hi, my name is Lokya, and I am currently in The KAUST School. I enjoy gymnastics, playing badminton, and science.

XIAO, AGE: 15

Hi, I am Xiao. Ever since I was young, I have been intrigued by the many aspects of nature and science. This interest has bloomed and continues to grow even now in my Middle to High school career I have participated in many science-related activities and excelled in my science studies. My love for science was my motivation to become a young reviewer.

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Jovana Cvorovic holds PhD in biomedical sciences from the University of Trieste, Italy. With over ten years of research experience across academic institutions in Italy, Spain and the USA, she decided to pursue a career in science communication, combining her fascination with science and passion for storytelling. Jovana is currently the editor of KAUST Discovery, a digital magazine showcasing cutting-edge research from King Abdullah University of Science and Technology.

MARY MAY

Mary Elizabeth May leads Planting Change Consulting, a team of educators who create curriculum to connect students to food knowledge, food heritage, and environmental stewardship. She also works closely with ranchers and producers with holistic land management. Previously she served as Sustainability Coordinator and Edible Education Program Coordinator at The KAUST School (TKS) in Saudi Arabia, and has over 25 years of secondary science education experience. She holds a Master in Sustainability: Sustainable Food Systems (Harvard), a Master in Science Education (SUNY), and a Bachelor in Molecular Biology (CU Boulder).

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