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HOW NEGLECTED CROPS CAN SOLVE THE WORLD'S FOOD PROBLEMS?

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YOUNG REVIEWERS:

ISTITUTO MAESTRE PIE FILIPPINI
AGES: 12–13

JULIETA
AGE: 13

LEAF
AGE: 9

Humankind is in crisis! Our ever-growing population, global warming, and changing climate is threatening our ability to produce enough food in the future. We rely on only a few major crops (such as maize, wheat, and rice) as our main food crops. These crops have been successfully farmed over thousands of years to feed humankind and keep people from being hungry. However, the major food crops do not provide sufficient nutrition, and these crops are also struggling to grow and produce food under changing climate conditions. We need alternative food crops! Legumes like peas and beans are one tasty alternative. In this article, we will tell you how legume crops are useful to humankind and why they are so well suited for our ever-changing world.

A FOOD CRISIS BY 2050?

We are used to reading and hearing news about global warming and climate change, but do we take time to think about how these changes

NUTRITION

All the stuff in food that helps our bodies to grow strong and healthy, such as vitamins, proteins, fats, and more.

ESSENTIAL AMINO ACIDS

Certain amino acids (building blocks of proteins) that humans cannot make themselves, so they come only from what we eat.

GREEN REVOLUTION

A series of new technologies and ways to grow, harvest, and process major food crops that allowed farmers to produce more food, faster.

LEGUMES

Healthy, edible fruit or seed rich in protein, fiber, and nutrients obtained from a plant that can also fix nitrogen in the soil.

will impact the world we live in? Global warming affects our ability to produce food for humanity. We farm only a few major food crops (e.g., maize, wheat, and rice) to supply our food needs. While these food crops provide most of the food to the world, they have little **nutrition**. For example, maize is rich in (has a lot of) a complex sugar, called starch, that our bodies use to make energy. Although starch can provide us with an energy source, maize is poor in (has little to no) **essential amino acids** and proteins that humans absolutely need to be healthy. So, even if a person eats enough food, a diet only rich in starch can still lead to many kinds of diseases linked to poor nutrition.

Humankind did not always farm such a small number of crops to meet their food needs but, as the world's population grew, we wanted our food crops to produce even more. American scientist Norman Borlaug had a big influence on global efforts to study how food crops could produce more food. He started something we now call the **green revolution**, which focused research on only a few major food crops. Although this worked very well, and between 1960 and 2000, production of wheat, rice, and maize increased for all developing countries (regularly updated information can be found from the Food and Agricultural Organization of the United Nations), it is no longer good enough to meet our food needs. The world's population is expected to double to 9 billion people by 2050, global warming and climate change are reducing food production, and current food crops are nutritionally poor. It does indeed seem as though humankind is in dire trouble. Well, maybe not! We have access to a number of alternative food crops that early humans used to farm but no longer do. We often call these the underutilized and neglected crops, and we are now "rediscovering" their value and possible role in solving the world's growing food problems.

GROWING ENOUGH NUTRITIOUS FOOD

Unlike the major food crops, underutilized and neglected crops are not traded internationally, and they get much less research attention to improve their growing ability or to train people how to farm them better. These crops are typically grown in Africa, Asia, and/or South America and eaten as part of local diets.

There are many crops that fit this definition, but we want to focus on a specific group called the **legumes** [1]. You may already be familiar with a few of them, including peas, beans, and chickpeas. Less familiar types of legumes include pigeon peas (grown in Asia), Bambara groundnuts (grown in Africa), and faba beans (grown in the Middle East). Figure 1 presents an activity to help you understand the diversity of legume seeds.

But are legumes more nutritious than the major food crops? Unlike those major crops, legumes are rich in essential amino acids and

	Common pea	Pigeon pea	Chickpea	Bambara ground nut	Common bean	Faba bean
What is your ratio number? The ratio number helps determine the real-life seed sizes from the photo and will be the same for all your measurements. First, measure the scale bar to the left of the seeds with your ruler. Our example = 1.4 cm (1 cm scale / your measurement of the scale bar = ratio number)	1 cm / 1.4 cm = **0.7** cm					
What is the seed size? Measure the seed length in the picture with your ruler, from top to bottom.	**1.1** cm					
How big is the seed in real life? (ratio number x seed size)	0.7 cm x 1.1 cm = **0.77** cm					

Figure 1

Figure 1

Figuring out the real-life sizes of legume seeds. If you measure the length of the seeds with a ruler, you can then use the 1 cm scale bar to calculate the actual size of these seeds and compare them. Follow the instructions in the table and write in the empty squares. In short: (1) Measure the 1 cm scale bar with your ruler to get the ratio number. (2) Measure the seed size with your ruler. (3) Use the ratio number to find out what the size of these seeds are in real life.

proteins. This means we can get these essential building blocks from eating a more diverse range of plants, especially legumes.

LEGUMES CAN HELP OTHER PLANTS GROW!

All legumes have a special superpower—they can basically make their own fertilizer. Usually, when we grow plant food crops, we must use fertilizers to help the plants grow better. Fertilizers are a mixture of compounds that plants need to grow, like nitrogen, phosphorus, and potassium. Although these substances are very helpful to the plants, they are very harmful to the environment. You can read more about these essential compounds and how they are recycled in nature in this Frontiers for Young Minds article.

Legumes have special structures on their roots, called **nodules**. Many millions of special bacteria live within these nodules. The bacteria, called **rhizobacteria**, have a close relationship with the legume plants because they provide the plants with an essential compound—nitrogen. Rhizobacteria do this by capturing nitrogen from the air and "fixing" it in the nodule. "Fixing", also called **biological nitrogen fixation**, means changing the nitrogen into ammonium, which is a form of nitrogen that is soluble in water. This means that plant roots can easily take up nitrogen when it is in the form of ammonium, so that the plants can grow (Figure 2).

In return, the plant provides the rhizobacteria with sugars that they need to grow. This exchange is extremely important because all plants need nitrogen to grow well and produce seeds. Remember, we eat the seeds of our most important food crops. So, imagine if we could grow legumes, which enrich the soil with nitrogen, and then, after we harvest the legumes, we could grow other crops in the same

NODULES

A special tiny bump or swelling on plant roots that help them team up with bacteria to make the soil better.

RHIZOBACTERIA

Friendly soil microbes that team up with plant roots, offering nutrients and protection, helping to create a healthy environment for plants to grow strong and happy.

BIOLOGICAL NITROGEN FIXATION

A natural process where certain rhizobacteria team up with plants to change atmospheric nitrogen into a usable form to make the soil better for plant growth.

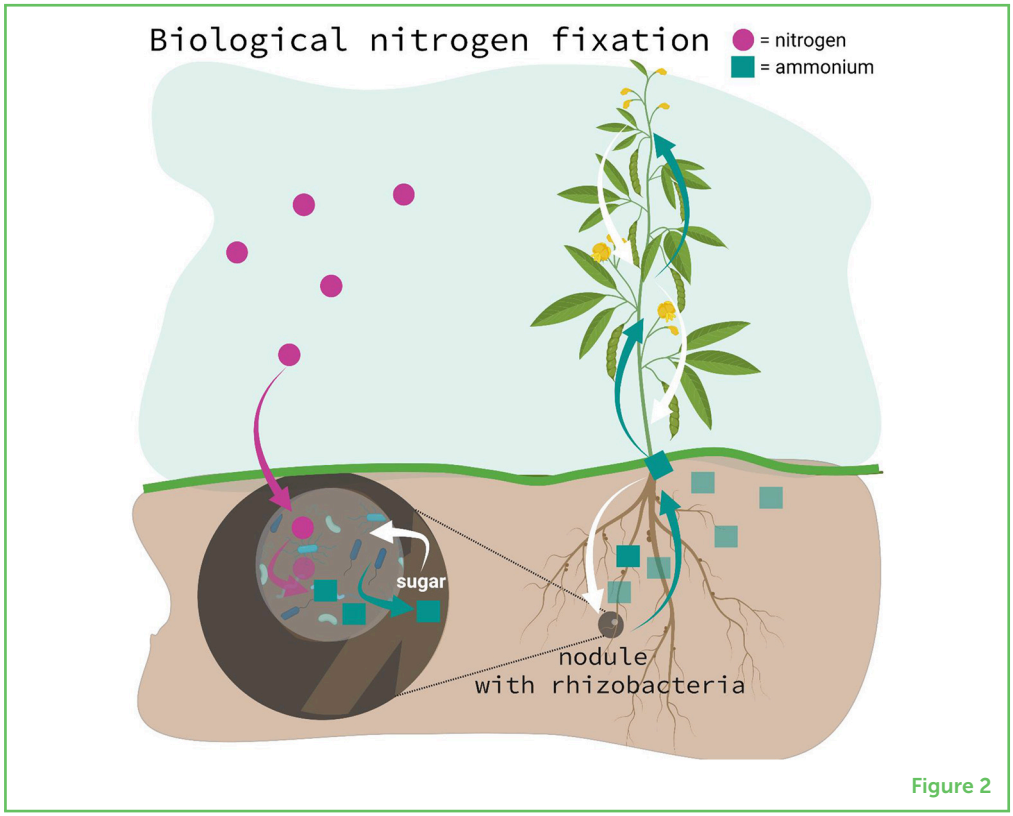

Figure 2

Biological nitrogen fixation is like a superpower that some tiny organisms, called nitrogen-fixing bacteria (or rhizobacteria) have. Rhizobacteria live in the soil or on the roots of legumes, in houses called nodules. The magnified nodule (bottom left) shows the oblong-shaped rhizobacteria living inside. There, nitrogen gas (pink circles) is changed (fixed) into a water-soluble form of nitrogen, called ammonium (turquoise squares), which plants can use to grow. In return, plants give rhizobacteria the sugars (white arrows) that these bacteria need to grow. It is a win-win exchange!

soil, so they could use the leftover nitrogen. This process, called **crop rotation**, can help us to produce more food while reducing the use of harmful fertilizers. It is an important part of our plan to produce more food in the future. The legume crops themselves are a very important part of this plan, too [2].

CROP ROTATION

A farming practice that involves changing the types of crops grown in a field each season to help keep soil health, reduce pests, and make more food.

PREVENTING A FOOD CRISIS

Legume food crops are also better adapted to survive harsh environments while still producing food for us. This is quite unlike our common food crops, which are sensitive to harsh environments like extreme heat, cold temperature, saline soil, or drought and can easily die before they make their seeds. See our previous Frontiers for Young Minds article to learn about how plants deal with drought. Imagine a future when we no longer need to rely on drought-sensitive maize and wheat plants to produce most of our food! This is why the Food and Agriculture Organization of the United Nations declared 2016 as the "year for pulses" (another name for legumes). The "International Year of Pulses" played an important role in highlighting the importance of pulses in achieving global sustainability and food security goals. This was a way to tell the world about the idea that we could look at other food crops as options to produce more food, in better ways, in the future. Simply put—we have no choice! The way we are farming today will not sustain the human population into the future, so we must consider other crops. Not only can these underutilized and neglected

food crops be very good for our health, but these crops can also be good for the soil [3], helping other plants to grow and helping the world meet the rising demand for food.

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YOUNG REVIEWERS

ISTITUTO MAESTRE PIE FILIPPINI, AGES: 12–13
This is how students describe theirs class: our class is quite noisy and sometimes we break the rules, despite of this we are united and there as a funny mix of laugh and fights. We are curious and joyful, in fact we make a lot of questions. We know how to cheer up each other and we have a lot of funny nicknames! This is us!

JULIETA, AGE: 13

Hi, my name is Julieta I was born in Minnesota (United States of America) but now I moved with my family to Uruguay. I speak English and Spanish. I like roller skating and making pottery. At school my favorite subject is Math.

LEAF, AGE: 9

I am now in 4th grade, and my favorite subject is art and science. I love observing changes in the world. I like to work as a Young Reviewer as I can observe many more changes using scientist's equipment. In my spare time, I like hiking, swimming, and riding bikes with my friends.

AUTHORS

BIANKE LOEDOLFF

From a young age, I have had a passion for plants and the nutritious chemicals they make. This passion led me to become a scientist (and entrepreneur!), to further understand why plants are so special. My main research interest focuses on human nutrition and how we can use plants to keep us healthy. Science is not my only passion—I am also a keen artist and enjoy spending my free time painting or sketching (this actually helps me think about my nutritional research). In essence, my world is driven by color, be it art or science. *bianke@sun.ac.za; bianke@biosupport.co.za

SHAUN PETERS

I have been fascinated by biology since I was a kid. My hero, Sir David Attenborough, has been making nature documentaries for television since 1954! This helped greatly when I chose what subjects to study at school and university—biology of course! After completing my doctoral studies in Switzerland, I returned to my home country of South Africa and now work at the Institute for Plant Biotechnology (Stellenbosch University). I am passionate about science education and studying how plants work. In my spare time, I enjoy reading and spending time with my daughter Arya. *swpeters@sun.ac.za