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#ENVIRONMENT

STEM project at school boosts rural sustainability

Student's creation is an example of sustainable innovation and shows how science knowledge can offer ecological solutions for agriculture.

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COMMUNITY/CITY
El Verde, Jayanca

SCHOOL
Carlos Mariátegui Educational Institution

PROJECT NAME
Rhizobium

STEM AREAS
Science and Technology

OTHER AREAS OF KNOWLEDGE
Environmental Education and Chemistry

El Verde, in the Peruvian district of Jayanca, is a rural area far from the urban center. There are no pharmacies, markets or roads for cars to enter anywhere. The main gathering point is the school: the Carlos Mariátegui Educational Institution. Imagine the pride when in 2024 the winners of the country's Solve for Tomorrow program came out of there: the "Rhizobium" project, created by four students in the fifth year of secondary school, the last year of compulsory schooling.

The mediator teacher, Juana Puicón, was in her first-year teaching Science and Technology at the school and the students are residents of four nearby communities. The group created a biological fertilizer as a sustainable STEM solution in agriculture, the main local economic activity. They observed that trucks loaded with urea, a chemical fertilizer marketed massively in the world, were constantly arriving. So, they decided to think of an alternative: rhizobium: a bacteria that lives in the soil, especially in agricultural soil. "If a farmer plants some kind of legume, by just placing the seed in the ground and it sprouts, the roots release a hormone that calls these free bacteria in the soil to make an association," Puicon teaches.

In this biological association, the plant provides shelter for the bacteria and, on the other hand, this microorganism in agriculture breaks down the nitrogen in the environment to nourish the plant. This nitrogen can replace urea. "The problem is that there are many soils damaged by insecticide, pesticide and herbicide excesses. This means that the natural microbiology of the soil is not enhanced," says the teacher.

Teachers and young people observed the needs of the community where the school is located and combined their knowledge in the science laboratory to come up with creative solutions.

Appreciation of Science in Schools

The teacher believes that reaching this idea is the result of the school appreciating science, despite the logistical difficulties and the lack of internet connection in the place. "Here, I have a laboratory just for my classes, which makes it easier for my students to experiment," she emphasizes.

Puicon is a biologist and has already studied microorganisms. Taking advantage of the new space, she brought her own microscope from home and the students were delighted with the equipment. In addition, the school already had experience with Project-Based Learning and maintains that you learn more when you build something. For "Rhizobium", then, the idea started from an exercise of inquiry and reflection on environmental problems at a global level. By discovering a new world behind the microscope, the students learned that there are microorganisms in agriculture that can improve the environment and decided to go down this path.

An important ally was a brother from Puicon, who is a farmer and allowed the team to plant part of his land. In fertile soil without chemicals, the students got to work and planted legumes. When they grew, the first step was to obtain the root nodules, which are new organs consisting mainly of plant cells infected with Bacteroides that provide nitrogen fixation. That is, they cut a part of the root to extract the bacteria.

The plants were grown in a laboratory, in jars with water, without soil, using a material called vermiculite, which is like a small stone filled with micronutrients, and the seeds inoculated with rhizobium were placed there. They found that the use of biological fertilizer is effective and reduces the dependence of local agriculture on other types. The benefits of biofertilizers include having a more organic and natural plantation, in addition to reducing production costs and the dependence on purchasing fertilizers from other countries.

Eureka moment!

If the first results in the laboratory, with a controlled environment, were exactly as they expected, the next stage was not without its challenges. The team made a greenhouse with sticks and blankets and planted it in the garden. They planted new seeds, but they did not grow. “This discouraged the students, because days and weeks went by and we did not get any results. I told them: do not despair; in Science we always look for a new way out,” says the teacher. They took out various data and could not discover what the problem was. Next, they compared the first stage with the second. And what has changed? The temperature! In the first phase, the teacher removed the seeds at her house, which is in another area of the district and the temperature is lower than in the school community, a difference of more than 10 degrees. “We had to do a new study to calculate the time to remove the seed so that it does not ferment at this new temperature,” says Puicon.

“Each new situation that was presented to us was another opportunity for learning, for scientific inquiry, and the students were obtaining and improving their work until they reached a refined one to win”,

says the educator.

The challenges to achieve the results of the biological fertilizer

In addition to this situation, the young people faced other obstacles. Still in the laboratory phase, there was a fungal infestation in the plantation. They were using white sugar to fix the bacteria to the seed, but once again the climate in the rural area made it difficult. It is a very humid area, conducive to fungi. They had to change to vegetable oil as a fixative.

The entire project took six months dedication. In the greenhouse stage, they planted pallar beans and chileno beans, and used several groups with different combinations of seeds and bacteria to test how each one would behave. “We did another test, sowing in sterile soil, where we added seeds without bacteria and we put urea. All the work demonstrated the greater efficiency of the bacteria compared to urea,” she concludes.

The students created a greenhouse in the school grounds to test various planting combinations with rhizobia under natural conditions.

Trying until you succeed

The teacher had already considered participating in Solve for Tomorrow when she worked at another school, but the registration dates had already passed. In 2024, she had forgotten about the program when she received a contact from the organizers of the initiative and decided to sign up for the first time.

With the support of the school’s director, she thought about enrolling ten groups with whom she was already working on STEM projects in class. “But it seemed like a small program, with few participants. When I realized how big Solve for Tomorrow was, we were already enrolled and I was worried. We are from such a small community, how were we going to compete with the big schools in urban areas?" she recalls.

Of the 10 projects, "Rhizobium" was the one that advanced to the final. When it won the program nationwide, the teacher said it was a turning point for the school community. "The school had never entered into a competition. The children had never traveled by plane. My dream was just to get to the final, that was much more than we imagined," she says, excited.

The project still won the online vote, even though there are only 120 students in the institution: "I don't know where they got so many votes, but they were talking to everyone they knew and they created a huge mobilization."

Puicon believes that more teachers and even family members can now see the potential of science for positive social transformation. Young people are also increasingly excited and encouraged by the idea of entering the teacher's laboratory and creating their own projects.

Explaining!

The dependence of countries on fertilizers such as urea is something that even the Food and Agriculture Organization of the United Nations (FAO) is concerned about. Especially since 2022, with the Ukraine war, importation prices have risen; especially from Ukraine, Belarus and the Russian Federation, which are important producers of systemic fertilizers. For this reason, FAO has reinforced the importance of Latin American and Caribbean countries sharing methods and practices to diversify nutrient sources and have a more resilient and natural agriculture.

Focus on the practice!

Take a look at the teacher's guide on how to improve crops using rhizobium bacteria.

Empathy

Students at the Carlos Mariátegui Educational Institution in El Verde, a rural area of the Jayanca district in Peru, identified the local dependence on chemical fertilizers as a critical problem for agriculture, their main economic activity. Observing the constant arrival of trucks loaded with urea, they reflected on their environmental and economic impact. Guided by their Science and Technology teacher, Juana Puicon, they explored sustainable alternatives and discovered the potential of Rhizobium, a beneficial bacteria for nitrogen fixation in the soil.

Definition

The team defined their problem as soil degradation due to the excessive use of chemical fertilizers and the economic dependence of local farmers. Their goal was to develop a biological fertilizer based on Rhizobium, which would improve soil fertility and reduce the need for synthetic inputs. With support from the institution and the teacher's experience in microbiology, the students defined their methodology based on Project-Based Learning, allowing for an experimental and practical approach.

Ideation

To carry out the project, the team designed a research and testing plan. They set out to extract Rhizobium from root nodules of legumes grown in soils not treated with chemicals. The process included setting up a greenhouse and planting legumes in different conditions to evaluate the effectiveness of the biofertilizer. A key factor in the strategy was the collaboration with a local farmer, who provided land for the experiment, thus allowing for application in real growing conditions.

Prototype

The team began the process by extracting Rhizobium from root nodules, growing it in the lab and applying it to seeds before planting them in a controlled substrate with vermiculite. During the experimental phase, they faced challenges such as a fungal infestation, which they solved by changing the bacteria's fixative from sugar to vegetable oil. They also had to adjust the seed removal time to adapt to the higher temperatures in the area. Comparative tests with urea showed that the biofertilizer could be a viable alternative.

Testing

The evaluation of the project included several stages of testing in the laboratory, greenhouse and open field. The tests demonstrated the efficiency of the biofertilizer in improving plant growth and reducing dependence on urea. The recognition of the project in the Solve for Tomorrow competition not only validated its impact but also encouraged the educational community to continue exploring scientific solutions to local problems.