Interview Dr. Mariangela Hungria

A Tribute to the Women Shaping the Future of Science

Heslley Machado Silva[1]

[1]Centro Universitário de Formiga (UNIFOR/MG)

The 21st edition of the Scientific Initiation Exhibition of the University Center of Formiga – UNIFOR-MG (XXI MIPE) is committed, this year, to honoring and celebrating the pivotal role of women in the advancement of scientific knowledge. Aligned with this purpose, the current issue of Conexão Ciência devotes its special interview section to one of the most distinguished Brazilian scientists of our time: ***Dr. Mariangela Hungria****, a senior researcher at Embrapa Soja and a global reference in the fields of soil microbiology and biological nitrogen fixation. An agronomist and master's graduate from ESALQ, Dr. Hungria holds a Ph.D. in soil science from UFRRJ and completed postdoctoral studies in the United States and Spain. She has established herself as a leading figure in the development of sustainable biotechnologies that have transformed tropical agriculture. Her groundbreaking work with soil bacteria, such as Rhizobium and Azospirillum brasilense, has significantly reduced the reliance on chemical fertilizers in the cultivation of legumes such as soybeans and beans, lowering production costs*

and mitigating the environmental impact of agricultural activities. Her contributions transcend the boundaries of science, representing a direct advance in the fight against hunger, climate change mitigation, and the promotion of food sovereignty in numerous countries. Author of over 500 publications and of the first Portuguese-language manual on microbiology of tropical soils, Dr. Mariangela Hungria was recently awarded the ***Women and Science Prize*** *(CNPq) and the 2025* ***World Food Prize****, widely regarded as the "Nobel Prize of Food", becoming the first Brazilian woman to receive this prestigious honor. Her scientific career, marked by academic excellence, a deep commitment to sustainable development, and the overcoming of gender barriers in science, stands as an inspiration to new generations of researchers. In this interview for Conexão Ciência, Dr. Hungria not only shares her remarkable journey but also offers profound reflections on the challenges facing science in Brazil, the fundamental role of education, the dangers of denialism, and strategies to confront the major environmental and health crises of our time. This is a timely and essential testimony, reaffirming the urgent need to value science, sustainability, and, above all, the transformative role of women in society. The interview was recorded and later transcribed, thus it retains a conversational tone, yet it remains equally significant both academically and for our personal and professional lives.*

1. Dr. Mariangela, you are affectionately known as the "mother of agricultural microbiology" in Brazil. Could you share with us an overview of your scientific career that has led you to this position of prominence, especially the advances in studies with rhizobia and strains of *Azospirillum brasilense*?

Dra. Mariangela: Look, I don't think I'm the mother of agricultural microbiology in Brazil, because I'm already the daughter, okay? There was a very important generation before me, with emphasis on Dr. Johanna Döbereiner, who was my scientific mentor, and also Professor João Ruy Jardim Freire, of whom I was never a student, but who was a great inspiration, and I was able to talk and exchange many ideas with him. My scientific career really began when I entered university, but it could be considered even before that, because my vocation had been there since I was a child, I wanted to be a

microbiologist, and I wanted to work to help reduce world hunger. So it was more or less natural for me to go into agronomy, but always with the idea that I wanted to work with biology.

I entered agronomy in the mid-1970s. It's important to put each era into context, and it was precisely the decade of maximum impact of Norman Bourlaug's Green Revolution, which was essential in lifting millions of people out of hunger and reducing the world's concern about food production. This agronomist showed that, through breeding and heavy chemical fertilization, it was possible to greatly increase food production and keep up with the exponential population growth that was being projected. It was very important, but it was a vision that only chemical fertilizers would allow this great production, and I was convinced that no, there was room for biologicals.

When I finished my degree, people looked for jobs and then went on to do their masters and doctorates already employed. But I wanted to be a scientist right from the start. So I applied for a scholarship, got it, and decided to go straight into continuing my studies with biologicals in agriculture.

I started my career with biological nitrogen fixation in bean cultivation. I did my master's degree at the Center for Nuclear Energy in Agriculture at USP, at ESALQ, with Dr. Alaídes Ruschel, who opened the doors to this world that I wanted so much, which was research with microorganisms in agriculture. When I finished my master's degree, I decided to look up this researcher who was the most famous in Brazil and one of the most famous in the world when it came to biological nitrogen fixation, Dr. Johanna Döbereiner. She was head of what is now Embrapa Agrobiologia, in Seropédica, and I started my doctorate at the Federal Rural University of Rio de Janeiro. Dr. Johanna was a great source of inspiration for me, she was my mentor, who really taught me how to be a scientist. After eight months there, she called me and hired me. After six years, I went abroad to do a post-doctorate. Back in Brazil, I had to turn my life around because I had two 14-year-old daughters and I needed school and treatment for my youngest, who has special needs.

So I started my career at Embrapa Soja, in Londrina, with biological nitrogen fixation in soybean cultivation. At the time, farmers no longer used inoculants because the soil population was already sufficient for nodulation. But I started investigating whether it was possible to increase this contribution by introducing bacteria every year that were physiologically ready to start the process

of biological nitrogen fixation. And I continued with various studies. I'm sure that these studies have contributed to the fact that today we are the world leaders in reaping the benefits of this microbial process. We have the highest contribution rate in the world for biological nitrogen fixation in soybean cultivation, completely dispensing with mineral fertilizers.

This work with soy brought benefits to farmers, who began to request solutions for other crops, such as corn and wheat. Through research and studies, we ended up finding bacteria of the *Azospirillum brasilense* species for these crops, which also turned out to be a great success, and are now found in almost half of all the areas cultivated with corn, for example.

A third stage also came from farmers who began to report that when they used *Azospirillum* on corn and wheat and then planted soybeans, they saw more benefits in the soybeans. It was then that we studied and developed co-inoculation, which would be the application of *Bradyrhizobium* and *Azospirillum* to the soybean crop, thereby increasing root volume, nodulation and the contribution of biological nitrogen fixation. This technology was launched just over 10 years ago and is already in almost 40% of the entire area cultivated with soybeans in Brazil.

2. Considering the benefits of microorganism inoculation technologies for biological nitrogen fixation, why are these techniques still not being applied on a large scale in all agricultural systems, even in countries facing serious food crises?

Dra. Mariangela: We have a leading position in soybean cultivation, as around 85% of the entire area under soybean cultivation in Brazil receives biological products based on *Bradyrhizobium* and *Azospirillum* every year, undoubtedly the highest adoption rate in the world. As already mentioned, in the case of corn we already have almost half of the cultivated area using biologicals. Research trials show incredible solutions for practically all the crops studied, but research is needed to identify the most suitable microorganisms for each one. But the interesting thing is that we already have, for example, for legumes, a fantastic collection of more than 100 rhizobial stipes for more than 80 legumes that include grain producers, tropical and subtropical forage crops, tree species, green manures. Unfortunately, adoption in these legumes is still very low and we will certainly have incredible solutions for other non-leguminous plants too. But unfortunately, research has provided solutions, but the private sector ends up

being interested in production and distribution only for large crops, which will make quicker and easier profit. So this is a limitation that needs to be resolved, because there are many solutions already made available by research for many crops, but which don't make it into commercial products for farmers.

3. Several studies indicate that the technologies developed by your research group contribute significantly to mitigating climate change. How can biological nitrogen fixation and the use of agricultural bio-inputs help to reduce greenhouse gas emissions and adapt production systems to global warming?

Dra. Mariangela: The flagship of our research group has always been research into biological nitrogen fixation with the soybean crop and we have achieved this world-leading position, being totally independent of the application of nitrogen fertilizers. This is important because, in addition to the economic cost, nitrogen fertilizers are highly implicated in environmental pollution, both through leaching, because nitrogen is highly soluble, polluting rivers and water reservoirs, and through the emission of greenhouse gases, since 1 kg of nitrogen fertilizer is equivalent to 10 kg of CO2 equivalents. So, considering the last soybean crop alone, by replacing nitrogen fertilizer with biological nitrogen fixation, we stopped emitting 230 million tons of CO2 equivalent. In addition, we stopped spending 130 billion reais on the purchase of nitrogen fertilizers.

4. It is estimated that in the last soybean harvest in Brazil alone, the savings generated by reducing the use of chemical fertilizers, thanks to the use of microorganisms, reached around 130 billion reais. Could you explain how these savings occur and what the relevance of this technology is in a scenario of geopolitical conflicts, such as the war in Ukraine, which has affected the international supply of fertilizers?

Dra. Mariangela: In answer 4, it's the same thing: since we don't use fertilizer, but rather the biological nitrogen fixation process, the savings are due to the fact that we no longer use this nitrogen fertilizer on the soybean crop, because it's not necessary, so we didn't spend the 130 billion reais in the last harvest that would otherwise have had to be spent on buying nitrogen fertilizers.

5. On May 13, 2025, you were awarded the World Food Prize, becoming the first Brazilian woman to receive this honor.

What aspects of your work do you think were decisive for this achievement? What was it like to take part in the award and what impact has it had on your career and personal life?

Dra. Mariangela: On May 13, it was announced that I had won this prize, which is considered the Nobel Prize for agriculture and food, something I could never have imagined in my career. The award will actually take place on October 23rd, and I think what really weighed heavily were the four decades of intensive dedication to biological studies. It began at a time when it was not believed that biologicals could play an important role in agriculture. So I think the award was for resistance, resilience and perseverance in never giving up on biologicals. In addition, the vision of research aimed at maximizing production contributed. Because I knew that it wouldn't be possible to go to a farmer and tell him that he would have a technology that would be very good for the environment, for the soil, but that he wouldn't have top production. So it's a continuous search that continues every year, because technologies change, to have production ceilings and to tell farmers that they can use biologicals and they'll get the same or even better yields than if they used chemicals, while still helping the environment and soil health.

6. In your biography, you mention the influence of your grandmother, a science teacher, as one of the initial inspirations for your career. Could you tell us a bit more about this story and how education, both formal and informal, can be a determining factor in shaping future scientists in Brazil?

Dra. Mariangela: Ever since I can remember I was very curious, so I would dig in the soil, look for insects in plants, look at the color of the leaves. I was really interested, I had that scientific curiosity, especially about the things around me in nature. And I was lucky enough to have a grandmother who understood this. I lived next door to her house, then I ended up living with my grandparents for a few years, and she, who was a science teacher, had a lot of love and affection and encouraged me in this scientific curiosity. In the science books, she would show me the pictures, study with me, explain things to me, do experiments with me in the yard. And, very decisively, she gave me a book called “Microbe Hunters”, about the life of microbiologists. I was delighted and the next day I told my grandmother that I wanted to be a microbiologist. Soon after, she gave me Marie Curie's biography and I realized that I could be a female scientist. Until the end of my life, my grandmother was the biggest

supporter of my career, she was the first person I called to tell if I had achieved anything. She really was a magical grandmother.

7. The theme of our scientific exhibition this year is precisely the role of women in science. In a field that is still predominantly male, what were the main challenges you faced in your career as a woman scientist? What strategies have you used to overcome them and what message would you leave for young Brazilian female researchers?

Dra. Mariangela: I've had to face many difficulties as a woman. In agronomy, in the scientific world, and although there's a lot of talk that things have improved, there's still a lot of inequality. For example, at the CNPq there are already more than 50% of scholarship holders in general, and at universities we see that even in traditionally male courses, female participation has increased a lot. But at the top of the most qualified scholarship holders, or in the rectories, or as directors of private companies, there are still few women. In addition, women have other roles. They have motherhood, they are the caregivers if someone has a health problem in the family, including elderly parents. And that, of course, leaves less free time for research. But I'm sure, from my experience and that of my students, that motherhood brings a focus, and women compensate for motherhood time with a greater focus on work. I've also experienced a lot of prejudice for having a daughter with special needs. Many people think that you have to take your child to the doctor, that you can't work properly. But in my case, I can say that if on the one hand I have limitations, on the other hand I use those limitations to develop other skills. I haven't been able to travel much, to take part in all the congresses I've been invited to, because I can't, I have my daughter's limitation that I have to be more present with her. And when she's ill, I really can't travel, but I don't see that as a limitation. As I had to stay at home more, I was able to devote more time to writing books, book chapters, scientific papers, and this made me the most cited Brazilian scientist in the field of agronomy and microbiology. So, because of my family limitations, I ended up being able to excel in another field. So that's what the world had to understand, that women in particular can have what might be considered a limitation on the one hand, but that they can develop other skills and be much more efficient on the other. So I hope we can get more women, because we have exceptional women, for example, Professor Helena Nader, president of the

Brazilian Academy of Sciences, but the first in over 100 years to hold the position of president. So, things are still taking time and we hope that the prejudices about women being associated with limitations will end.

8. You are the author of hundreds of scientific publications and produced the first Brazilian manual of soil microbiology methods adapted to the tropics. How was it possible to achieve such scientific productivity? What are the main challenges faced in this process and what advice would you give to young people interested in an academic and scientific career?

Dra. Mariangela: I've already mentioned the publications, but I want to talk about the methodology manual, which was a dream of mine. I loved the lab, I had extremely detailed notebooks, and it tormented me when I took a protocol and it didn't work. In those days we didn't have the internet, so I would write a letter to the author of that protocol, say it didn't work, then the author would say there was a strategic step missing that wasn't described. Wow, I would get so angry, because in my notebook I would add every possible detail, so that someone could easily repeat that methodology. And it was precisely at a time when my daughter became very ill, so I focused on writing the manual, and another book as well. Consequently, from a difficulty, from a difficult time when I couldn't travel much because I had a health problem at home, I turned this difficulty into an opportunity, this first manual.

9. We are living in a paradoxical moment: despite great scientific advances, we are seeing a worrying rise in denialism, including in relation to climate change and the role of the Amazon. How do you, from your prominent position in Brazilian science, interpret this phenomenon? What paths do you believe are effective in tackling it?

Dra. Mariangela: We are living through a truly incredible paradox of fake news. I think it has become very clear during the pandemic, and we have seen how important it is for key people in society to disseminate correct information. I still can't understand it, I try to give a clear, objective, short message, with robust scientific data, but I get thousands fewer views than an amateur with no scientific content. I think it's very important to invest in communication science, because we need to know how to reach society with our communications.

10. To close this interview, we would like you to leave a message of encouragement to young students and researchers who face the well-known scarcity of resources for science in Brazil. How was it possible for you to achieve international recognition in the face of so many obstacles? What would you say to those who want to pursue a career in science without losing hope?

Dra. Mariangela: I'd rather leave the message not to young students and researchers, but to our government officials. Research is something that requires continuity, and we have very rich people in Brazilian science. Rich in the sense that they are extremely creative and know how to make the most of the resources allocated to research. It's extremely frustrating to be a person with excellent training, often superior to that of researchers from abroad, to know that that research is going to bring a great benefit to the country but not have the minimum resources necessary to conduct that research. This is very frustrating. Researchers are frustrated because they don't have the resources, because they don't have continuity of funding. Sometimes the research takes too long. I'm winning an award because it has brought many benefits, but for research that has lasted four decades. So you receive funding for two or three years and, just as you start to get favorable results, the resources run out and you can't finish your technology, your product, which will serve society. Government officials need to understand the need for a public policy of continuous funding. Only research will bring the results we need to advance at all levels of knowledge and not have external dependencies on knowledge. Because being dependent on other countries for knowledge means the lowest level of sovereignty a country can have.