



Women scientists in Public Research Institutes and Universities in Peru



NUCLEAR TECHNOLOGY AND SUSTAINABLE DEVELOPMENT

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Women scientists, nuclear technology and sustainable development

Dr. Mario Mallaupoma Gutiérrez
President of Peruvian Institute of Nuclear Energy

The United Nations Organization in its publication called “Our common future” in 1987, coined the expression “Sustainable Development” as “that which allows us to satisfy current needs without compromising the ability of future generations to meet their own needs”. The power to achieve it considers three dimensions that have an integrated and indivisible character and are combined in a balanced way; which includes economic, social and environmental aspects. Its technical organization, the International Atomic Energy Agency (IAEA) provides assistance and cooperation to its Member States, including Peru, to achieve the 17 Sustainable Development Goals (SDGs) established in the United Nations 2030 Agenda for Sustainable Development.

In our country, the governing body in nuclear energy is the Peruvian Institute of Nuclear Energy (IPEN), which uses nuclear technology in areas such as food production and preservation, nutrition, energy, human health, and adequate water management, environmental protection, among other relevant issues of national interest. A series of projects have been worked on with the support provided by the IAEA; however, we have identified that we must work with many more interest groups, which must include the different regions of the country. It is extremely important to know the existing needs in different regions so that, based on this, the IAEA can offer us cooperation and support with equipment, materials and expert missions that help to solve the identified problems.

In that sense, we identify that in the field of natural sciences and engineering, the participation of women is growing in an important way and they also contribute with their professional work to solving many problems. For this reason, we have considered to highlight their work, learn about the research they are developing, their relationship with nuclear technology, and their impressions on the research priorities that our country should develop. They represent an important nucleus due to their great experience and professional recognition as RENACYT researchers. Their suggestions and recommendations allow us to have a positive approach, that it



is possible to continue integrating professionals and researchers with a common objective, which is to serve better to our country and its population.

Their professional contributions, based on their experiences, should lead us to lay the foundations to promote, in the near future, greater integration to carry out effective and efficient research as well as the development of joint scientific and technological projects of national interest. This also coincides with a great objective that IPEN is currently promoting, that is to improve the collaboration amongst scientific institutions to join forces and achieve synergies to solve problems that benefit our country.

Relevant topics have been identified where nuclear technology can help to solve problems such as food, nutrition, adequate water management and its use in agriculture and its relations with climate change, health considering the prevention and treatment of cancer, as well as in research on insects that affect both human and animal health, the environment, the appreciation of our cultural heritage and the care of our sea, among others.

IPEN has the RACSO nuclear center, where there is a 10 Mw nuclear research reactor, and which is the largest investment that the Peruvian State has made to promote the development of nuclear and conventional science and technology. This commits us to carry out an optimized management of its resources that must serve the entire scientific community. We have outlined this great challenge that must go hand in hand with the search for strategic alliances with national institutions and countries in the Latin American and Caribbean region, which can give us that opportunity to promote “nuclear technology for the sustainable development of our country”.



Interviews with **Women scientists in Peru**



National Institute of Health (INS)

Miriam Palomino Salcedo

Could you tell us where you work, what research lines you have developed using nuclear techniques, and which interest groups you usually conduct your research with?

I work at Peru's National Institute of Health (INS). The research lines I have developed focus on arthropod vectors of diseases, such as dengue, chikungunya, Zika, sylvatic yellow fever, and malaria. Projects cover topics like insecticide resistance in *Aedes aegypti* and its role as a vector for dengue, chikungunya, and Zika, as well as resistance in species of *Anopheles albimanus*, *An. darlingi*, and *An. pseudopunctipennis*, and the study of the ecology of malaria vectors. Recently, I have been involved in molecular studies of the mechanisms of resistance to pyrethroid insecticides (knockdown resistance (kdr) mutations) and the use of nuclear techniques such as the sterile insect technique (SIT) for controlling the *Ae. aegypti* vector.

Do you think public research institutions (IPIS) work together or as strategic allies? What is your experience in this regard?

In the country, public research institutions conduct research work with limited economic resources and trained personnel. Acquiring supplies and equipment involves lengthy administrative processes that hinder adhering to a schedule of activities. Each institution has its own systems for acquisition and its own scientific and ethical committees.

What strategies would you consider to achieve greater interaction and integration among public research institutes?

I recommend forming multidisciplinary teams, identifying mutual interests to develop and implement short, medium, and long-term programs for the benefit of society. Training staff at all levels, identifying potential in personnel, and fostering interest in research are essential. Promoting working meetings for exchanging experiences, analyzing and evaluating results, as well as developing competencies in personnel.

Are you familiar with the lines of research using nuclear technology that are being developed in our

country and internationally?

The line of research using nuclear techniques such as the sterile insect technique (SIT) for controlling the *Ae. aegypti* vector has the advantage of being non-contaminating and environmentally friendly. Another technique being tested is determining gunshot residues using nuclear technology, both as new alternatives in health and crime control.

In your opinion, what are the research lines that should be prioritized in our country?

The priority research lines should focus on different types of exposures and risk factors causing cancer, factors associated with anemia in children, developing tools to prevent, diagnose, and cure tuberculosis, factors associated with HIV-AIDS infections, and definitively, addressing social determinants and controlling vector-borne diseases, among others.





Marine Institute of Peru (IMARPE)

Michelle Gracco Carlucci

Could you tell us where you work or which institutions you work for, what research lines you develop using nuclear techniques, and which interest groups you usually conduct your research with?

I work at the Marine Institute of Peru (IMARPE), an institution whose functions are related to the sustainable use of marine living resources.

For several years, we have been conducting various research projects in the field of marine sciences in collaboration with different national universities such as the Scientific University of the South (UCSUR), Cayetano Heredia University (UPCH), National University of San Marcos (UNMSM), and Ricardo Palma University (URP). We also collaborate with national institutes such as the Peruvian Institute of Nuclear Energy (IPEN) and international institutes such as the French National Research Institute for Sustainable Development (IRD) and GEOMAR of Germany.

Specifically, since 2019, in conjunction with IPEN, we have been collaborating on the ARCAL RLA7025 project to strengthen coastal marine studies and the INT0098 project to enhance disaster response, such as the oil spill that occurred in early 2021. Techniques like Neutron Activation and X-ray Fluorescence are being used for sediment characterization, along with alpha spectrometry for dating sediments with Pb 210. The latter technique is currently being implemented.

Our research aims not only at the academic and research level but also at benefiting users and decision-makers. We seek to benefit the fishing and aquaculture sector and, in general, to provide a better understanding of marine systems for improved resource management.

Do you think public research institutions (IPIS) work together or as strategic allies? What is your experience in this regard?

I believe that IPIS can and should work together. There are many strengths and potential for development at the national level that should be channeled to strengthen research in Peru. IPIS are excellent platforms for undergraduate and postgraduate research, and it is essential for the development and advancement of these

institutes to collaborate with universities.

For years, there has been close collaboration among IPIS within the framework of the study and forecasting of the El Niño Phenomenon (ENFEN), where institutions like the Marine Institute of Peru (IMARPE), the National Service of Meteorology and Hydrology of Peru (SENAMHI), and the Geophysical Institute of Peru (IGP) participate. Personally, there is a history of collaboration and mutual support with IPEN that has allowed us to combine strengths to conduct studies in the coastal marine field.

What strategies would you consider to achieve greater interaction and integration among public research institutes?

Interaction and integration among IPIS can occur through various strategies. One of them is through projects generated through the International Atomic Energy Agency (IAEA), ARCAL, regional, international, or national projects addressing common issues and research interests. Another approach is through the development of postgraduate theses that can involve multiple institutes, in addition to the university. The establishment of specific agreements is also a way to bring IPIS closer together.

Are you familiar with the lines of research using nuclear technology that are being developed in our country and internationally?

Nuclear technologies are widely used for various research in oceanography, paleoceanography, such as dating and paleoenvironmental reconstructions, coastal pollution assessment using elements like Pb-210; sediment and other matrix characterization through neutron activation analysis; utilization of stable isotopes to study the origin of organic matter, changes in past oxygenation, and trophic studies, among others. These techniques complement other methods very well and, in some cases, like dating, they represent the only way to approximate the required results.

Are the research lines you develop linked to the Sustainable Development Goals?

Yes, we are directly involved in the SDGs, particularly Goal 14 - Life Below Water. Through the RLA7025 project, we are reporting SDG Indicator 14.3.1 related to ocean acidity and have projections to advance with other indicators in the fields of eutrophication, microplastics, and strengthening research for the health and sustainability of the Peruvian sea. The reporting of this indicator is carried out by IMARPE in Callao, and support is being provided to other national groups so they can be trained and replicate it in their regions. Specifically, with the Pedro Ruiz Gallo National University (UNPRG), a group has already been trained through different IAEA projects (INT7019, RLA7025) and is currently working on monitoring activities with scallop aquaculturists, thereby reaching the interest groups in our country.

In your opinion, what are the research lines that should be prioritized in our country?

The study of the Peruvian sea is very important. Our society has a long history associated with the sea, benefiting from all the goods and services it provides. Moreover, it represents a significant source of food and harbors biodiversity yet to be discovered. Advancing in the understanding of aspects such as acidification, oxygen loss, pollution, and food security are key elements that also integrate into a changing ocean and the challenge of understanding how to adapt and mitigate climate change. This can only be tackled in a multisectoral and multidisciplinary manner, which motivates institutes like IMARPE and IPEN to join forces, integrating powerful techniques and research platforms and researchers who can study the Peruvian sea in a coordinated and articulated way for its sustainability, benefiting the Peruvian population and the health of the global ocean.



Geological, Mining, and Metallurgical Institute (INGEMMET)

Vicentina Cruz Pauccara

Could you tell us where you have worked, what research lines you have developed using nuclear techniques, and with which interest groups you usually conduct your research?

At the beginning of my professional career, I participated in volcanological research projects at the Geophysical Institute of Peru (IGP). Later, from mid-2005, I started working at the Geological, Mining, and Metallurgical Institute (INGEMMET), where I continued my work in volcanology. In 2007, I decided to participate in research projects focused on the country's geothermal resources. The goal was to support environmental conservation by promoting the development of geothermal energy and its inclusion in the country's energy matrix. Since then, I have been involved in the "Master Plan for the Development of Geothermal Energy in Peru," as well as in pre-feasibility projects in two geothermal fields in the Tacna region. However, it was challenging to develop these projects since the necessary training was only available outside the country.

Nevertheless, through international cooperation in research projects, we received training and promoted the results of our investigations on the country's geothermal resources in national and international conferences, congresses, and events.

Currently, I lead the geothermal program at INGEMMET, which comprises multidisciplinary experts in geology, geochemistry, geophysics, remote sensing, as well as studies of environmental isotopes and rock dating using Ar-Ar.

Do you think public research institutions (IPIS) work together or as strategic allies? What is your experience in this regard?

I have not had experience in conducting studies with public research institutions in the country. The research projects have been carried out with government funding and non-reimbursable international cooperation with institutions such as the Japan International Cooperation Agency (JICA) and the University of Nevada, USA.

Currently, we are developing the project "Strengthening Capacity for Assessing Geothermal Resources" in the

Tutupaca geothermal area, Tacna region, with cooperation from JICA.

What strategies would you consider to achieve greater interaction and integration among public research institutes?

At the very least, there should be joint research projects between public research institutes and international funding, rather than solely relying on limited government budgets. For example, in these times of global energy crisis, it is essential to contribute to diversifying the country's energy matrix with renewable and clean energies. The country has researchers in different public research institutes with the capacity to conduct such studies.

Are you familiar with the lines of research using nuclear technology that are being developed in our country and internationally?

I am aware that nuclear technology has advanced significantly in medicine, such as the use of radiopharmaceuticals for diagnosing and tracking diseases.

This technology should have more significant progress in the country, for which research projects with international cooperation should be developed, especially with institutions that are currently working on these projects.

Are the research lines you develop linked to the Sustainable Development Goals?

Yes, because geothermal energy represents one of the green and clean resources for electricity production in the country. It is environmentally friendly and independent of climate changes that may affect its production, making it a reliable, efficient, and inexhaustible energy source, generating electricity 24 hours a day, 365 days a year, without interruption. The steam from the geothermal reservoir is heated by a heat source from the earth's interior, commonly associated with volcanic systems. The steam emerges to the surface through faults and fractures and is harnessed by drilling deep wells, where its pressure drives turbines to generate electricity. Moreover, this energy is renewable, ensuring electricity demand in the face of accelerated demographic and economic growth. This energy is sustainable; for example, the Larderello geothermal power plant in Italy is the world's oldest geothermal plant with over 100 years of production.

In your opinion, what are the research lines that should be prioritized in our country?

Research lines should be prioritized based on the missions of the research institutions belonging to various sectors of the country, such as energy and mining, health, education, environment, etc.



Peruvian Institute of Nuclear Energy (IPEN)

Lourdes Zegarra Mayo

Could you tell us where you work and what research lines you have developed using nuclear techniques? Also, which interest groups you usually conduct your research with?

I work at the Peruvian Institute of Nuclear Energy (IPEN) in the Radioisotope Production Plant. I started in the production of components for radiopharmaceuticals, and currently, I work in the Quality Control area, conducting physical, chemical, and nuclear controls of the radiopharmaceuticals, radioisotopes, and components for radiopharmaceuticals produced by the plant. Quality control ensures the technical characteristics of the product with reliable results, as well as the safety and efficacy of the drug.

I am also part of the Cyclotron Technical Team and participated in the assembly and commissioning of the radiopharmacy at the Cyclotron Facility of the Sabogal Hospital of the Peruvian Health Social Security (ES-SALUD), which has been operational since 2016, when IPEN transferred the technology to them.

Do you think public research institutions (IPIS) work together or as strategic allies? What is your experience in this regard?

Yes, I believe that research institutions can work together, achieving synergy with specialized personnel for the benefit of society.

However, it is necessary to have greater cohesion among research institutions to achieve the intended objectives for solving national problems that benefit the population.

What strategies would you consider to achieve greater interaction and integration among public research institutes?

I would suggest the following possible actions: promoting the signing of framework agreements with specialized institutions or centers to open up possibilities for joint work, with a specific work program, defined communication mechanisms, and led by a professional with extensive experience and knowledge of the subject matter; forming multidisciplinary work teams with experienced personnel dedicated to development

and research, with a decision-maker committed to driving and supporting communication, dissemination, and budget management; scheduling working meetings to monitor progress and plan future actions, as well as organizing visits to centers or institutes where one party has a particular interest in conducting specific tests, aiming to achieve cross-cutting integration in research, among others.

[Are you familiar with the lines of research using nuclear technology that are being developed in our country and internationally?](#)

As a specialized and competent institution in the nuclear field, IPEN is currently working on the technical dossier for the installation of a Cyclotron and its specialized radiopharmacy. The IPEN Cyclotron Technical Team has designed a facility that complies with Good Manufacturing Practice requirements in terms of clean rooms, equipment, materials, radiological protection, and functional environments. The positron-emitting radioisotopes and radiopharmaceuticals produced by the cyclotron are used in Nuclear Medicine through Positron Emission Tomography (PET) imaging technique for the early and effective diagnosis and treatment of oncological, neurological, and cardiovascular diseases. Thus, this technology contributes to improving citizens' quality of life and helps bridge gaps in public health by reducing mortality from oncological diseases.

[Are the research lines you develop linked to the Sustainable Development Goals?](#)

Yes, they contribute to achieving Sustainable Development Goal 3, Health and Well-being, which aims to ensure healthy lives and promote well-being for all, at all ages, closing gaps in public health.

[In your opinion, what are the research lines that should be prioritized in our country?](#)

The research and development lines that I believe should be prioritized in our country are in the health area, focusing on the new trends in the development and production of short-lived radioisotopes for diagnosis and therapy in Nuclear Medicine.

I also consider environmental research lines to be of importance, including monitoring and determining air and soil quality, allowing us to identify the presence of contaminants that pose risks to the population's health due to the existence of solid waste and emissions from industrial, social, and economic activities. Additionally, this contributes to Sustainable Development Goal 15, Life on Land, aiming to prevent, halt, and reverse the degradation of ecosystems.

Another important research line is related to food preservation for healthy nutrition.





Peruvian Institute of Nuclear Energy (IPEN)

July Ramos Trujillo

Could you tell us where you work, what research lines you have developed using nuclear techniques, and which interest groups you usually conduct your research with?

I work at the Peruvian Institute of Nuclear Energy (IPEN) in the Radioisotope Production Plant (PPR) in the Quality Control Department, where I serve as the Head of the Physicochemical Controls Section. Initially, I worked at the RP-10 Nuclear Research Reactor in the water treatment area.

A radiopharmaceutical is a medicine that incorporates a radioisotope into its structure, used in nuclear medicine for diagnosis or therapy. The PPR supplies radiopharmaceuticals to the medical community, meeting quality standards such as Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) required by the national regulatory authority, both for the drug and the radiological aspect.

Currently, I am part of the team developing a new radiopharmaceutical, Tc99m ethyl cysteine dimer (ECD), which is used for diagnosing brain diseases.

Do you think public research institutions (IPIS) work together or as strategic allies? What is your experience in this regard?

Public research institutions have the main purpose of producing knowledge that contributes to the country's economic and social progress through scientific research and technological development in their areas of interest.

I believe there is a need to create closer links between public research institutions, leveraging their infrastructure, knowledge, and potential to achieve Peru's Sustainable Development Goals.

What strategies would you consider to achieve greater interaction and integration among public research institutes?

For greater integration and interaction among public research institutes, decision-makers or leaders from each institution should hold meetings and establish alliances of interest between the institutes, national

universities, and the private sector.

Additionally, promoting the signing of inter-institutional agreements with national and international research centers is crucial.

Working in multidisciplinary teams, encouraging collaborative work with experienced researchers and utilizing acquired infrastructures can enhance cohesion among these institutions for the country's development.

Are you familiar with the lines of research using nuclear technology that are being developed in our country and internationally?

In our country, there are several lines of research using nuclear technology, such as nuclear techniques applied to the health sector (production of radioisotopes, radiopharmaceuticals through irradiation at nuclear facilities like the RP-10 nuclear reactor and cyclotron), technology for irradiation in agroindustry, sanitary and phytosanitary treatment, and food preservation. Additionally, the sterile insect technique (SIT) for controlling *Aedes aegypti* mosquitoes, the Secondary Standards Dosimetry Laboratory (SSDL), and radiological protection are also areas of research. The use of nuclear technology can significantly contribute to solving the country's needs and addressing problems in various areas, including health, industry, food, and hydrology.

Are the research lines you develop linked to the Sustainable Development Goals?

Yes, the third Sustainable Development Goal is health and well-being, ensuring healthy lives and promoting well-being for all at all ages. At IPEN, through the Radioisotope Production Plant (PPR), where I have worked for many years, we produce radiopharmaceuticals. These medications are made available to the medical community for safe use in diagnosis and therapy to monitor and evaluate health issues such as tumors, cardiovascular diseases, kidney diseases, and others.

In your opinion, what are the research lines that should be prioritized in our country?

The research lines that should be prioritized in our country encompass various areas. In health, for example, developing new radiopharmaceuticals for early cancer diagnosis and other cardiovascular diseases, tuberculosis, mental health disorders, among others. Implementing the sterile insect technique for controlling mosquito vectors of pathogens such as dengue, Zika, and chikungunya is also crucial. Other research areas could include studying the adaptation of plant species to climate change to increase productivity, investigating environmental pollution using nuclear or conventional techniques, studying Peru's water resources, considering water as a key element for economic growth. Additionally, research in artificial intelligence and robotics could be conducted. Artificial intelligence is becoming an essential technology for the coming years, providing opportunities for the benefit of the country and the population.



Pontifical Catholic University of Peru (PUCP)

Patrizia Pereyra Anaya

Could you tell us where you work or which institutions you work for, what research lines you develop using nuclear techniques, and which interest groups you usually conduct your research with?

I am an associate professor at the Department of Sciences at the Pontifical Catholic University of Peru (PUCP), and I currently serve as the coordinator of the Research Group in Nuclear Track Techniques (GI-THUNU). Our group is ranked among the top 30 out of 140 research groups at our university, and we are continuously evaluated based on our scientific and academic output.

We maintain close collaboration with various internal research groups in fields such as geological engineering, electronics, mining, architecture, geography, and chemistry, among others. Moreover, we engage in interinstitutional collaboration with other educational entities such as the National University of San Marcos (UNMSM), National University of Saint Anthony the Abbot in Cuzco (UNSAAC), Pedro Ruiz Gallo National University (UNPRG), and National University of Barranca (UNAB). Additionally, we collaborate with national research institutes (Peruvian Institute of Nuclear Energy; Geological, Mining, and Metallurgical Institute) and international ones in Europe, North America, and South America.

Considering the results obtained in your research, could you comment on the social, economic, and environmental impact achieved to date?

Recently, we published an article presenting the results of the first large-scale measurement of radon concentration in our province of Lima, the first at a national level. These results were obtained using validated methods and are of utmost importance for decision-makers in the government regarding radiological protection in our country.

It is essential to remember that radon is the leading cause of lung cancer in non-smokers and one of the five most frequent types of cancer in our population, which has been classified as having low tobacco prevalence worldwide. Furthermore, we have developed our own methodologies to carry out radon measurements in indoor environments, which allows us to continue advancing in this field.

Additionally, we have conducted research to assess the contribution of various construction materials to

radon concentration and analyze the radiometric content of new materials. All these efforts are centered around radiological protection and the minimization of health risks for the population.

Lastly, we are also conducting studies applying radiometric methods for natural hazard prevention, such as seismic activity and avalanches, among others. In this way, we aim to contribute to the identification and mitigation of potential risks, always prioritizing the safety and well-being of the population.

Are you familiar with the lines of research using nuclear technology that are being developed in our country and internationally?

We maintain constant interaction with research groups both at the local and international levels in our thematic area. I firmly believe in the need to work collaboratively at a national and regional level, joining efforts in terms of human resources and equipment to achieve robust and high-quality scientific development. Our research is valuable and unique, but it should not be limited solely to reporting measurements; we must also focus on developing our own methodologies, adapted to the diverse climatic conditions we have in Peru.

Are the research lines you develop linked to the Sustainable Development Goals?

I can cite, for example, the study of radiometric evaluation of mining tailings with the aim of transforming them into geo-polymerized cement. This research contributes to environmental and economic sustainability by utilizing mining tailings as raw materials and avoiding the generation of environmental liabilities.

Firstly, by utilizing the tailings, we prevent the generation of environmental liabilities and reduce the environmental impact associated with their disposal. In this way, we promote responsible management of natural resources and contribute to the conservation of the environment. Furthermore, using geo-polymerized cement as an alternative to traditional cement implies lower consumption of natural resources, such as clinker, the main component of conventional cement. This reduces the extraction of raw materials and greenhouse gas emissions during cement production, thus contributing to climate change mitigation.

In your opinion, what are the research lines that should be prioritized in our country?

There are many, among them, we can mention generating electricity with nuclear technology, which does not produce greenhouse gases, thus contributing to environmental protection; improving techniques for the long-term management and disposal of nuclear waste; developing various applications of nuclear technology aimed at mitigating issues related to food security, water stress, pest control, etc., to improve the quality of life for our population.

How do you communicate the results of your research?

We aim to expand our outreach not only through international scientific publications but also directed to the general public, using media such as videos and social platforms like Facebook. Additionally, we focus on reaching science students in different national and regional universities who are interested in our field. The virtual environment has been very helpful in approaching this audience. Furthermore, we strive to disseminate our work in national institutions that request it, and we encourage continuous participation of students and group members in local and international academic events for greater visibility. We consider it of great importance to have a nationally peer-reviewed academic publication that meets quality standards and has sufficient periodicity to encourage our young scientists to engage in academic publishing. This would be a significant step towards strengthening the scientific culture and knowledge exchange at the national level.



National University of the Center of Peru (UNCP)

Edith Rossana Huamán Guadalupe

Could you tell us where you work or which institutions you work for, what research lines you develop using nuclear techniques, and which interest groups you usually conduct your research with?

Currently, I work at the National University of the Center of Peru as a researcher and professor, recognized by RENACYT (National Registry of Science, Technology, and Innovation). My research line is focused on food and nutritional security.

Additionally, I am a partner in Project RLA6079, which aims to address infant malnutrition (undernutrition and overnutrition), leading to high levels of mortality and the development of non-communicable chronic diseases in adulthood, resulting in significant economic and health costs worldwide.

This project proposes to obtain body composition values in infants aged 6 to 23 months to design reference curves for Latin America and the Caribbean, based on the measurement of body fat using the deuterium oxide dilution technique. The purpose is to create an instrument for monitoring the health of infants, implementing interventions and treatments, and thereby contributing to reduce the impact of double malnutrition burden, particularly the prevalence of obesity, and its relation to non-communicable chronic diseases.

Considering the results obtained in your research, could you comment on the social, economic, and environmental impact achieved to date?

Currently, we are working in a multidisciplinary manner with the beneficiaries of the project, including personnel from health establishments in Junin and Arequipa. We are also collaborating with other regions and engaging with authorities and policymakers from the poverty reduction committee, Regional Health Directorate, Municipalities, and Regional Governments.

Are you familiar with the lines of research using nuclear technology that are being developed in our country and internationally?

Nuclear energy is of great utility for solving problems in various fields such as energy, health, environment,

water, food, agriculture, and the industrial sector. Among these applications, the use of radiation for food preservation and improving food quality stands out, as it helps eliminate microorganisms and pathogens that cause diseases.

Are the research lines you develop linked to the Sustainable Development Goals?

Yes, currently, I am working with the United Nations Sustainable Development Goal (SDG) 2, which is focused on Zero Hunger. This goal aims to end all forms of hunger and malnutrition by 2030. In relation to Zero Hunger, nuclear technology and science can help combat hunger and malnutrition in Peru.

In your opinion, what are the research lines that should be prioritized in our country?

Within the United Nations Sustainable Development Goal (SDG) 2, related to Zero Hunger, the priority should be to focus specifically on pregnant and lactating mothers and children under 5 years of age.

How do you communicate the results of your research?

As a result of the research conducted with a multidisciplinary team, the findings and results are documented in a scientific article published in the Scopus database journal "Nutrición Clínica y Dietética Hospitalaria." These findings and results will be communicated to the target audience, which includes authorities and policymakers from the poverty reduction committee, Regional Health Directorate, Municipalities, and Regional Governments.





National University of Engineering (UNI)

Tarsila Tuesta Chávez

Could you tell us where you work or which institutions you work for, what research lines you develop using nuclear techniques, and which interest groups you usually conduct your research with?

Currently, I work at the Faculty of Chemical and Textile Engineering (GIA-FIQT-UNI) of the National University of Engineering (Universidad Nacional de Ingeniería), as a teaching researcher and leader of the Food Research Group.

The food research group GIA-FIQT-UNI is composed of students and professors from both the National University of Engineering and other institutions such as the National University of San Marcos, the National Agrarian University La Molina, and Le Cordon Bleu University, among others in the country. Together with this large family of researchers, we collaboratively work on various research projects financed by external and internal funds in the area of food, aligned with the Sustainable Development Goals. We still have not explored the potential of nuclear technologies in our research line, but are open to the possibility of incorporating them into our future projects.

Considering the results obtained in your research, could you comment on the social, economic, and environmental impact achieved to date?

The basic and applied research we conduct in the Food Research Group begin from the interests of the productive sector or public health issues affecting communities. We have developed laboratory-level products that lead to thesis defenses and publication in indexed journals, serving as precedents for future research within the scientific community.

Regarding the social impact, the projects developed in the research group have contributed to the development of products that aim to improve the well-being of society. For instance, in response to the public health problem of anemia, we have developed laboratory products such as “fortified chocolate milk with heme iron” and “fortified ice cream with non-heme iron” to potentially increase iron levels in children.

Additionally, we work on projects related to trout, leveraging its protein and Omega 3 and Omega 6 fatty acid

content. Moreover, in terms of economics and the environment, we are exploring new ways to use waste products and non-commercial items to turn them into commercially viable items. For example, we extract pectin from tuna peels and produce vinegar from discarded apples.

Are you familiar with the lines of research using nuclear technology that are being developed in our country and internationally?

Yes, during my time as an intern and thesis student at the Peruvian Institute of Nuclear Energy, I had the opportunity to work in the production of radiopharmaceuticals at the Radioisotope Production Plant and in radioactive waste management. I also learned about food preservation by irradiation to extend its shelf life.

Are the research lines you develop linked to the Sustainable Development Goals?

Indeed, our research lines encompass food fortification, the development of food products, and the valorization of agro-industrial waste. According to the 2030 Agenda for Sustainable Development, approved by the United Nations General Assembly, several Sustainable Development Goals (SDGs) are outlined. Our research aligns with SDG 2: Zero Hunger (proposing alternatives to contribute to food and nutritional security), SDG 3: Good Health and Well-being (potential alternatives to address public health issues), SDG 12: Responsible Consumption and Production (generating commercial products from national resources), and SDG 13: Climate Action (avoiding the generation of greenhouse gases by utilizing resources that would otherwise become waste).

In your opinion, what are the research lines that should be prioritized in our country?

We believe that all lines of research in different critical sectors, aligned with the Sustainable Development Goals, are essential for our country. However, to contribute to food and nutritional security, it is crucial to prioritize research that addresses specific issues. This includes developing strategies to reduce food losses and waste, strengthening local capacities in food production and management, promoting inclusive and equitable agri-food systems involving small-scale farmers and rural communities, among other approaches. These research lines should be prioritized due to their potential to improve the availability, access, and quality of food, aiming to contribute to the food and nutritional security of our country.

How do you communicate the results of your research?

The research projects we have developed culminate in thesis defenses and publications in indexed journals. Additionally, we present our findings at national and international conferences, as well as participate in academic scientific and technological fairs. Finally, it is our commitment to promote technology transfer to the productive sector and civil society.





National University “Federico Villarreal” (UNFV)

Luz Castañeda Perez

Could you tell us where you work or which institutions you work for, what research lines you develop using nuclear techniques, and which interest groups you usually conduct your research with?

I am a Principal Professor and RENACYT Researcher at the National University “Federico Villarreal”. My main lines of research are focused on the environment and sustainable development, occupational health, and the synthesis of new polymers. In the nuclear field, I have had the opportunity to work on the project ‘Articulated Robotic Arm for Interventional Radiology Assistance.’ The aim of this research was to reduce exposure time to X-rays and offer greater effectiveness and precision in surgical interventions. The procedure for using the robot has been published in the Peruvian Journal of Neurosurgery and is available at the following link: <https://doi.org/10.53668/2021.PJNS34211>

Considering the results obtained in your research, could you comment on the social, economic, and environmental impact achieved to date?

Yes, for example, when we have developed new adhesives using water as solvent or hot-melt adhesives, eliminating toxic and hazardous organic solvents, we have had a positive environmental impact as they are eco-friendly adhesives. Socially, they are practically harmless to the health of those who produce and consume them, and economically, it has been of great benefit to the company we collaborated with in the research, as they generated innovative products that are now exported to other countries in South America, creating economic well-being for the company and our country. In the case of the robotic arm, it represents a technological contribution that avoids exposing medical and radiology personnel in complex interventions. We have developed various eco-friendly and innovative equipment for the treatment of aqueous and gaseous adhesives generated in different industries, which has a very positive social and environmental impact. Additionally, we work on the development of software that allows modeling and simulation of environmental aspects to prevent and mitigate pollution in chemical processes.

Are you familiar with the lines of research using nuclear technology that are being developed in our country

and internationally?

In our country, we are proud to have the Peruvian Institute of Nuclear Energy, which produces radiopharmaceuticals for the radiodiagnosis needed for the treatment of cancer. During my last visit to IPEN, I was able to observe their research applied to the contamination of hydrocarbons in the sea, sediments, etc. They have made advancements in dosimetric calibrations and food safety, agriculture, among others.

Internationally, nuclear technology has a wide range of applications that contribute to improving the quality of life in our societies. For example, the use of nuclear techniques in responding to natural disasters, neutron scattering for medical studies to repair bones, analyze brain protein studies, and create high-tech magnets, among others.

Are the research lines you develop linked to the Sustainable Development Goals?

Our research is closely linked to SDG 12 "Responsible Consumption and Production". We are constantly focused on developing products that are environmentally friendly, promote health, and integrate into the circular economy. Additionally, we strive to contribute to SDG 13, 'Climate Action,' by working on the study of greenhouse gas emissions (GHG). For example, we are involved in a project developed by the National Program for Sustainable Urban Transport (MTC) that aims to reduce GHG emissions from urban transport, measure them, and find the best options to mitigate these emissions. Our research also intersects with SDGs 9, 11, and 3.

In your opinion, what are the research lines that should be prioritized in our country?

I believe that in our country, there is a serious problem concerning the malnutrition of our children, and we should prioritize research in this area to find the best solutions. Ironically, we are in a country with a renowned gastronomy and a biodiversity characterized by highly nutritious foods, yet it is contradictory not to have solved this problem that affects the development of our children. In the field of nuclear technology, it is essential to expand research in radiopharmaceuticals for radiodiagnosis and treatment of particularly aggressive cancers. Additionally, nuclear technology can contribute to the development of innovative and environmentally clean technological equipment. Lastly, we must take on the challenge of leveraging our biodiversity to generate products for the global market through our research.

How do you communicate the results of your research?

We first communicate the results to the entities that fund our research and try to share them with stakeholders involved in the topic, such as companies, collaborating institutions, ministries, etc. These results are shown through the publication of articles in journals, presentations at conferences, and by generating invention patents or utility models. Additionally, our findings are communicated through books that contain the results of our research or software registered as intellectual property with INDECOPI, which are made available as open access."





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