Concept Number: RLA2020014

Title: Radiation technology in natural and synthetic polymers for the development of new products, with emphasis on waste recovery

Original Language Title: Promoción del uso de la tecnología de la radiación en polímeros naturales para el desarrollo de nuevos productos, con énfasis en la recuperación de residuos

Project Number: ?????

Project Type: REGIONAL LATIN AMERICA

For: ARCAL

Submitted By: Member State and/or Observers With Rights

Priority: 0

Project duration (Total number of years): 2

Project duration (Start date): 2022-01-01

Field of Activity: 18 - Radioisotopes and radiation technology for industrial, health-care and environmental applications

FOA Distribution:
FoA Code: 18 = 100%

Sustainable Development Goal:
98 - Multiple SDGs

Link to RB Programme: There is No RB Programme Link.

Project Description/Abstract: The Latin American and Caribbean (LAC) region is extraordinarily rich in natural resources. However, economic production and subsequent industrialization generate residues composed of high-value natural polymers. On the other hand, synthetic polymers are mainly discarded as waste after use, taking a long time to degrade and generating microplastics that end in the marine environment. Therefore, to have alternative treatments to reduce their environmental impact is the main goal. An interesting alternative is to transform these problems into opportunities, recycling and/or converting these wastes and residues into novel value-added products. The role of radiation technologies is that gamma ray, X-ray, and electron beam can be used to recycle polymers wastes by radiation-induced grafting, accelerating the degradation, modifying some chemical, mechanical, or surface properties, to obtain raw materials or additives for biopolymers, hydrogels, nanoparticles, construction materials, furniture, filters, recovery of thermoplastics, fabrics, packaging, absorbent materials, among others. The overall objective of this project is to contribute to reduce the environmental accumulation of natural and synthetic polymer wastes, while the specific objective is to demonstrate the feasibility of radiation technology for the modification of different polymer wastes. This will be done by identifying the problems, opportunities, and capacities of the LAC region, training on methods for obtaining and characterizing advanced value-added materials from natural and synthetic polymers wastes modified by radiation, training in technology scaling from the laboratory up to industrial scale, carrying out a technical-economic feasibility study of implementation, and improving strategic communication capabilities. The regional strategies are those of integration, cooperation, harmonizing efforts to mitigate the effects on the environment that economic

growth entails and to achieve a productive and technological base for sustainable development. With this, it is expected to encourage research and development for added-value products form polymers wastes and increase the demand for irradiation services in the region.

Problem to be addressed: Agriculture, livestock, and fishing are important sectors for the economy in LAC countries. The region is a leading exporter of agricultural products such as soybeans, maize, sugar and coffee. Also, livestock production has grown substantially because of the expansion of aviculture, swine and cattle ranching sectors and by technological innovation [1]. Fishing and aquaculture are mainly for regional consumption, but also for exportation [2]. However, plant and animal base production generate a large amount of waste such as biomass from sugar cane or wood remains; by-products from livestock of valuable proteins such as collagen or gelatin, and fish waste contains a high percentage of proteins and carbohydrates in scales, cartilage, and crustacean exoskeletons [1,3,4,5]. On the other hand, synthetic polymers are discarded as waste after use. They are gradually accumulated into the environment, and due to its high resistance takes a long time to degrade and generates microplastics that end in the marine environment. In 2017 8.3 billion metric tons of synthetic polymers had been produced worldwide, and LAC has 4% of the total production. To reduce the generation of plastic waste, political and intervention measures are being taken in LAC. Some countries reported national policies in place about plastic bag through bans and levies [6,7]. Also, waste picker cooperatives contribute to the management of solid waste, but the recycle rate is still low (4.5%) [6,8]. A common strategy for waste final disposal is incineration but is highly polluting and causes negative effects on the environment. The circular economy promotes to reduce the environmental impact of waste through a more sustainable development where economic, environmental, technological, and social aspects in production are considered [10]. Therefore, to have alternative treatments to reduce their environmental impact is a main goal. An interesting alternative is to transform this problem into opportunities and converting the wastes into value-added products. One of the challenges for the future lies in to determine what place the waste may occupy in LAC [1]. Recycling has several advantages: reduced consumption of energy, emissions of carbon dioxide, nitrogen oxides, sulfur dioxide; the amounts of solid waste going to landfill, and conservation of nonrenewable fossil [9]. Wastes from plant and animal can be used for different applications: cellulose for food additives, paper manufacturing, pharmaceuticals [3]; Collagen and gelatin in food industry [4]; Chitin for biodegradable polymers, agriculture, and porous materials [5]. While synthetic polymers waste such as thermoplastics can be mixed with virgin polymer and reused [10]. The role of radiation technologies is that gamma ray, X-ray, and electron beam can be used to modify and recycle polymers wastes by radiation-induced grafting, accelerating the degradation, modification of some chemical, mechanical, or surface properties, to obtain raw materials, additives, hydrogels, nanoparticles, construction materials, furniture, filters, thermoplastics, fabrics, packaging, absorbent materials, among others. There are many reports that demonstrate the potential of radiation technologies for the development of new products using wastes: The effect of adding polyethylene terephthalate (PET) from bottles; Polycarbonate from computer monitors and displays or waste tire rubber from cars and ionizing radiation on the mechanical properties of polyester mortars was studied. The results demonstrated improvements in the mechanical properties up to 46% for PET irradiated mortars. Its use for parts that require high mechanical resistance may be feasible [11]. Sugarcane bagasse (SCB) fibers was study as a reinforcing filler for recycled high density polyethylene with radiation. The results showed that the combination between the chemical modification of fibers and the irradiation of polymer composites were more effective in compatibility and gave the best mechanical properties, lowest water up-take and the highest thermal stability [12]. Also, the effect of radiation on the recovery of total reducing sugars from delignified SCB was analyzed. The results showed that irradiation increases the yield of total reducing sugar by three-fold due to the breakage of cellulosic cell walls [13]. The problem in this project was included in the Regional Strategic Plan 2016-2021: need T2 and T5 [14]; and ARCAL 2030 Agenda: need T4 and T8 [15]. Recognizing the potential benefits that radiation technology can offer for processing polymers, the IAEA has implemented several activities and documents in response to Member States (MSs): CRPF23036 [16]; ARG1029 [17]; RLA1013 [18]; CRPF22046 [19]. It is expected that this project will be enriched by the events that took place in the past, will be fed back from the activities in progress and will serve as a basis for the participation in future activities.

Why should it be a regional project?: The problem of urban and industrial solid waste is common to all LAC countries. Synthetic polymer waste in general ends up in sanitary landfills, and although efforts are being made in the region still is not enough. Although efforts are made to reduce its volume through policies to decrease the utilization of plastic bags, or to facilitate the recycling of polymers with collectors' cooperatives, much work remains to be done. The production and industrialization of natural resources in LAC, as occurs in fishing-aquaculture, forestry, agriculture, and animal husbandry, also generate wastes that are generally discarded, sometimes in the sea. Both, natural and synthetic waste impact the environment polluting the soil, water, atmosphere, and the oceans, endangering the life of plants, animals, and human being. LAC countries not only need to improve the use of their natural resources, but the reuse of synthetic and natural polymer waste has the potential to improve industrial competitiveness while preserving the environment to achieve sustainable development by applying circular economy tools. The contamination of these wastes affects the population and the ecosystems in areas close to the industries or spaces for the disposal of waste. The origin, final disposal, and problems of these wastes are shared by the LAC countries, as many government regulations, policies, and programs. The application of radiation technologies from sources of gamma rays, X-rays and electron beams can help us to reuse the waste from production and industrial processes while minimize the impact of human activities on the environment. This project is relevant because nuclear technology can be conveniently inserted into cleaner production strategies to achieve sustainable development with waste recovery. LAC countries has important scientific-technological capabilities for applications of nuclear technologies in mining, metallurgical, oil industries, agroindustries, food industries and wastewater treatment companies. However, in some countries access to radiation technologies is still limited, the same as the applications of radiation to solve environmental problems, or for the development of materials through the recycling of wastes. Conducting a joint approach between the LAC countries will allow us to identify problems related to the generation of natural and synthetic polymer waste and seek alternatives to mitigate their impact on the environment. Carrying out a regional project will allow LAC participants to share strengths in techniques and enrich with the knowledge and experiences of others. In this way, the knowledge gap of ionizing radiation applied techniques of the participating states can be reduced. On the other hand, we can also reduce the technologies gap in irradiation sources or characterization analysis equipment with collaborations.

Stakeholder: Project beneficiaries are Government / Education research institutions related to the application of radiation technologies. The role is to facilitate the participation of researchers in regional training courses and activities. The end-users of the project are plastic waste collectors and classifiers, companies that recycle synthetic polymers and are interested in reducing wastes and give them a new chance to be a value-added product; companies that generate synthetic and natural polymer waste that agree to be part of the project. The responsibilities of the end-users include actively participate throughout the project especially in the activities of scaling up the technology and the feasibility study to produce products that allow the recovery of waste using ionizing radiation. Important stakeholders are national Ministries of Science, Technology, Education, Environment, Industry and the Universities. The role is to facilitate the participation of experts in the activities and provide institutional support. Other important stakeholders are United Nations Industrial Development Organization (UNIDO), World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO), United Nations Environment Program (UNEP), the Economic Commission for Latin America and the Caribbean (ECLAC), the Latin American Network for Education in Nuclear Technology (LANENT), and the Latin American Association of Radiation Technologies (ALATI). The roles of this organizations will be to provide updated information and statistics for the region, to contribute to disseminate the knowledge acquired and to provide experts for courses . Meanwhile, the role of National and international scientific societies related to radiation, environment, polymers and recycling is to contribute to disseminate knowledge (national and regional events). The role of regulatory authorities in the nuclear field is to provide the legal framework for the industrial use of radiation technologies. The role of media, scientific and information magazines, social networks, web pages, is to disseminate benefits of the Project.

Partnerships: Potential partners are the national plastics recycling chambers, plastics associations, agroindustries, the production of building materials, biotechnology products, environmentally friendly companies and industries that promote the production and consumption of recycling products. They will contribute by being part of the project by establishing partnerships with counterparts, participating in communication events, and facilitating the delivery of results to stakeholders. Other partners are the Centro Atómico Constituyentes, Dan Beninson Nuclear Technology Institute, and the National University of San Martin, whose role is to collaborate with professionals for the activities carried out in Argentina.

Overall Objective: To contribute to the reduction of the environmental impact of natural and synthetic polymer wastes using irradiation techniques.

Role of nuclear technology and IAEA: In this project, sources of gamma radiation, X-rays and electron beams will be used. These technologies will be used to modify the properties of natural and synthetic polymer, enabling its degradation, cross-linking, grafting, inactivating microorganisms or enzymes, and for the purpose of development of biomaterials, hydrogels, nanoparticles, construction materials, polymers heat shrinkable, packaging, and different products that are not single use. The advantage of using nuclear techniques totally or partially replacing other techniques is that they reduce the generation of chemical waste and allow material modifications that cannot be achieved by other methods. To take full advantage of the benefits of radiation technologies to transform polymers and the recovery of waste is essential to have not only the necessary infrastructure, but also trained researchers. That is why to achieve the objectives of this project it is essential to have the advice, assistance, and support of the IAEA.

Participating Member State(s):
Argentina
Bolivia

Brazil
Colombia
Cuba
Mexico

Physical infrastructure and human resources: The Radiation Applications and Technology Management (CNEA), has polymers, food, biotechnology, microbiology, effluents, and dosimetry laboratories. Nuclear facilities include a 60Co semi-industrial irradiation plant (820 kCi), and during 2021 the arrival of a 2 KeV electron accelerator is expected. Human resources are made up of an interdisciplinary team made up of more than 20 professionals, including Specialists in technological applications of nuclear energy, Specialists in radiochemistry and nuclear applications, Magister in medical physics, PhD in science, Master’s in biotechnology, Chemical Engineers, Materials Engineers, Bachelor of Foods, Biochemists, Bioengineers, Biologists and Microbiologists. These professionals together with the technical staff are working and investigating the applications of radiation technology in different fields. Also, the Constituyentes Atomic Center, Dan Beninson Nuclear Technology Institute, and National University of San Martín professionals and installation will play an important role in the implementation of the project.

Sustainability: After the project ends, the project outputs and outcome will be sustained by means of agreements made by the beneficiaries, partners and end users. Furthermore, the knowledge acquired by the beneficiaries can be applied to other end-users interested in producing value-added products from waste. To ensure long term sustainability of the Agency's support, it is important that the counterpart institutions have proposals to retain the trained staff and have incentive plans that ensure self-reliance and operational capability to continue promoting the reduction in waste generation.

Safety and Regulatory Compliance: Counterpart institutions will be responsible to obtain the operation licenses required for the project. They must consider standards of the IAEA and National Regulatory Authorities.

Requirements for participation: Criterion 1: For the implementation of the project, each participating country must ensure the generation of a multidisciplinary project team with the participation of personnel qualified in radiation technology applications and familiar or experienced in the modification of natural and/or synthetic polymers. In addition, there must be an innovative proposal already developed at least in the design phase that shows how the value chain would be carried out from the collection of the polymeric waste (natural and/or synthetic) to the generation of a value-added product or process through the use of radiation technology. The proposal should include how the country will benefit from the implementation of the technology. Criterion 2: The participating country must have laboratory infrastructure and national capabilities with proven experience in irradiation processing of natural and/or synthetic polymers. Equipment for the characterization of polymeric materials and gamma radiation, electron beam or X-ray facilities for industrial applications should be available. Criterion 3: The project envisages two groups of projects participating countries: 1) Countries where irradiation technology applied to polymers is already implemented and experience is already advanced. 2) Countries willing to introduce these applications in polymers through the use of irradiation technology in a sustainable manner. Also, the project team of each country must have at least one end user (who will benefit from the product or process obtained from natural or synthetic polymers. It can be the same one working with the generation, collection or production of materials from the polymeric waste) and a supplier of the radiation technology (interdisciplinary group with knowledge/experience in polymer processing and with access to gamma, electron beam or X-ray irradiation facilities for industrial purposes). Criterion 4: To achieve the expected results, cooperation between partners and stakeholders will be vital. Therefore, counterpart institutions are encouraged to sign collaboration agreements to facilitate cooperation between technical institutions and private or non-profit parties, and to achieve the implementation of radiation technology in this application area.

Cross Cutting Issues Environment: This project has a positive impact on the environment because it seeks to reduce the accumulation of polymers in garbage and organic waste generated by productive activities that involve animals and plants. By recycling these natural and synthetic polymers, the pollution that is generated and contaminate the soil, water and the atmosphere will be reduced, generating a lesser impact on the ecosystems.

Cross Cutting Issues Gender: Give priority to the participation of women and young researchers in regional training courses (RTC). It is important to promote generational change and the training of new generations of nuclear researchers, encouraging their interest in the application of techniques to seek solutions to regional problems.

Implementation strategy: To achieve the outcome, a series of steps were designed to accomplish the proposed outputs. Discussion and analysis meetings, RTC, development of technical-economic feasibility studies, HBA (home based assignment) and national communication events to disseminate progress and results are included. The milestones of the Project are the agreements with the end-users that are the initial step of the transfer of technology and products, the training activities, which will allow training researchers not only in their technical capacities related to the application of radiation technology, but also provide them with knowledge of technology scaling, technology transfer and technical-economic feasibility study and communication strategies methodologies. Another milestone is represented by the communication activities at the national level that will disseminate the results of the project among the beneficiaries, possible end users and the public. The role of the executing institutions is to facilitate the implementation of the activities to achieve the project's outputs and ensure the sustainability of the project. Other important stakeholders are the end-users, whose role is essential in the development of the project and is to take the products developed and evaluate their transfer to the productive sector. The activities to achieve the first outputs of “Project team established, and project implemented within scope, time, and budget” are to set up cooperation mechanisms for efficient and effective project implementation; to monitor project progress and report on project achievements and to elaborate communication and outreach strategy and material (web articles, video, social media). For the second output: “Staff trained in methods of reducing polymer residues with radiation”, the activities included are to train in modification of natural polymers waste with radiation for products and advance material development and characterization; to train in modification of synthetic polymers waste with radiation for products and advance material development and characterization (each participating MS will decide if they participate in the first and / or second course according to their interests and the type of polymer they work with), and to train in scale-up of the technology from the lab scale to the pilot scale plant. For the third output “Technical-economic feasibility study of implementation developed”, the activities to be carried out include: to train on technology transfer and technical-economic feasibility and to develop technical-economic feasibility studies applied to the selected product. For the fourth output "Communication of alternatives for the reduction of polymer waste with radiation technology enhanced", the activities to be carried out are to train in strategic communication and to hold national events for the dissemination of project results. The overall management roles and responsibilities are to comply with what is established in the Project, including the design of the activities, the PPARs and PAR and to be attentive to any other request or communication that comes from the PMO or TOs.

Monitoring and progress reporting: The monitoring plan or framework includes an active and permanent communication between the DTM with the counterparts, the PMO and the TOs. Face-to-face / virtual review meetings will be held at least 1 time every 6 months, and if required, the frequency will be increased. The activities will be monitored through the activity programs, list of participants, certificates, deliverable material, reports. The PPARs will be delivered annually, which will include information on all the activities carried out and progress related to the project. At the end of the project the PAR will be delivered.

Lessons Learned: This project is built on lessons learned from past experiences such as seeking sustainable solutions to the problem of natural and synthetic polymer residues, reducing the knowledge gap between the MSs of LAC countries, and promoting the use of technologies from the radiation based on gamma sources, X-rays and electron beams to reduce environmental impact as part of a production and consumption model based on circular economy. This project seeks to give continuity to RLA1013-ARCAL “Creating expertise in the use of radiation technology for improving industrial performance, developing new materials and products, and reducing the environmental impact of the industry”. Similarly, it seeks to strengthen itself with the following projects: ARG1029 “Implementation of radiation technology using electron beam for industrial and environmental applications” and CRP F23036 “Recycling of polymer waste for structural and non-structural materials by using ionizing radiation” (expected to start in 2021).

Risk management: The potential risks that may affect the project are the following: 1. Not enough presence of research centers and professionals in the region with the capability to apply radiation technology in the development of materials. This risk falls into the category of institutional capacities and a low probability of occurrence is indicated, with a high level of impact. The response measures to prevent or mitigate this risk are that the counterpart coordinates and informs the participating counterparts in advance of the conditions of the project and checks whether it meets the requirements. Before and during the implementation it must be verified that counterpart meets the participation requirements. The DTM and counterpart coordinators are responsible for this. 2. Not enough commitment between the countries and the end-users. This risk falls into the category of parties involved and a low probability of occurrence is indicated, with a medium impact level. The response measures to prevent or mitigate this risk are that the counterparts coordinate cooperation to motivate the interest of end-users to participate in the project. Before and during implementation the counterparties must have at least one end-user interested in participating. The counterpart coordinators are responsible for complying with this. 3. Trainees do not remain in the institution performing their expected duties. This risk falls into the category of human resources and a low probability of occurrence is indicated, with a medium impact level. The response measures to prevent or mitigate this risk are that the counterparts coordinate knowledge management measures in their respective institutions and plans are established in the country to replicate the knowledge acquired. Before and during implementation, the counterparts commit to have a knowledge management plan in their institutions. The counterpart coordinators are responsible for complying with this. 4. Persistence of the health situation affected by the COVID 19 pandemic. This risk falls into the category of policies and government and a medium probability of occurrence is indicated, with a low level of impact. The response measures to prevent or mitigate this risk are reorganization of training activities, meetings, and diffusion from face-to-face to virtual or mixed modality if possible. Before and during implementation the DTM with the counterparts, PMO and TOs will propose a virtual or mixed modality of the activities. The DTM, counterpart coordinators, PMO and TOs are responsible for complying with this. 5. Difficulty finding experts to perform the RTCs. This risk falls into the category of institutional capacities and a low probability of occurrence is indicated, with a low level of impact. The response measures to prevent or mitigate this risk are that the DTM, counterparts, PMO and TOs will coordinate the design of the training activities previously. Before and during the implementation the DTM, counterparts, PMO and TOs will decide the training activities experts. The DTM, counterpart coordinators, PMO and TOs are responsible for complying with this. 6. Not enough end-user and beneficiaries interested in applying radiation technology for waste recovery. This risk falls into the category of parties involved and a low probability of occurrence is indicated, with a low level of impact. The response measures to prevent or mitigate this risk are that the counterpart coordinates in advance with the interested parties in the process the conditions of the project. Before and during implementation the counterpart are committed to inform end-users and actively communicate the events. The counterpart coordinators are responsible for complying with this.

CORE FINANCING										
Year	**Human Resource Components** (Euros)						**Procurement Components** (Euros)			**Total** (Euros)
	Experts	Meetings/ Workshop	Fellow-ships	Scientific Visits	Training Courses	**Sub-Total**	Equipment	Sub-Contracts	**Sub-Total**	
2022	31 500	68 250	0	0	158 025	**257 775**	0	0	**0**	**257 775**
2023	5 250	84 000	0	0	161 700	**250 950**	0	0	**0**	**250 950**
First Year Approved : 2022										

Non-Agency FINANCING										
Year	**Human Resource Components (Euros)**						**Procurement Components (Euros)**			**Total (Euros)**
	Experts	Meetings/ Workshop	Fellow-ships	Scientific Visits	Training Courses	**Sub-Total**	Equipment	Sub-Contracts	**Sub-Total**	
2022	0	5 250	0	0	0	**5 250**	0	0	**0**	**5 250**
2023	0	43 050	0	0	0	**43 050**	0	0	**0**	**43 050**
First Year Approved : 2022										

Logical Framework Matrix (LFM)

	Design Element	Indicator and Baseline	Target	Means of Verification	Assumptions
Outcome	Demonstrated the feasibility of radiation technology for the modification of different polymer wastes.	# of projects related to the development of value-added products developed from polymer waste by the MSs in Q4 2023. Baseline (BL) 0, Q1 2022.	At least 6 projects related to the development products through agreements with end-users / stakeholders.	PPARs, PAR.	Enough presence of research centers and professionals in the region with the capability to apply radiation technology in the development of materials. Commitment of the countries with the end users. Trainees remain in the institution performing their expected duties.
Output	1 Project team established, and project implemented within scope, time, and budget.	# of MSs participating in the project in Q1 2022. BL 0, Q4 2021. # of project team and partner meeting in Q4 2023. BL 0, Q1/2022. # of output achieved in Q4 2023. BL 0, Q1/2022. # of PPARs completed in Q4 2023. BL 0, 1Q/2022. # of communication material elaborated (article, social, media, videos) in Q4 2023. BL 0, Q1/2022.	At least 6 MSs in the project. At least 4 project coordination meetings. 4 outputs achieved. 2 PPARs (Q4 2022-Q4 2023) At least 2 articles published, 1 video elaborated, 1 communication network established.	TCReport, PCMF, PPARs. Internet articles, social media of counterpart, ARCAL and IAEA webpage.	Senior management of official laboratories provide continued support and facilitate the cooperation with external actors.
	2 Staff trained in methods of reducing polymer residues with radiation.	# of participant (Ps.) trained in natural polymers waste modification in Q3 2022, BL 0, Q1 2022. # of Ps. trained in of synthetic polymers waste modification in Q3 2022, BL 0, Q1 2022. # of Ps. trained in scale-up technology in Q4 2022, BL 0, Q1 2022.	At least 5 Ps. trained in natural polymers waste modification in Q3 2022. At least 5 Ps. trained in modification of natural polymers waste in Q3 2022. At least 1-2 Ps./MS trained in scale-up technology in Q4 2022.	Certificate of attendant / approval issued. Program of RTC.	Regional experts available to carry out the RTCs.
	3 Technical and economic feasibility study of a value-	# of Ps. trained in technology transfer and technical-economic	At least 1-2 Ps./MS trained in technology transfer	Certificate of attendant / approval	Enough end-user willing to apply radiation technology

	added product developed	feasibility in Q4 2022, BL 0, Q1 2022. # of technical-economic feasibility study for a specific polymer waste in Q2 2023, BL 0, Q1/2022.	and technical-economic feasibility implementation plan elaboration in Q4 2022. At least 1/MS technical-economic feasibility plan Q2 2023.	issued. Program of RTC. Report of technical-economic feasibility study.	in value-added products on industrial level.
	4 Communication of alternatives for the reduction of polymer waste with radiation technology enhanced.	# of Ps. trained in strategic communication in Q2 2023, BL 0, Q1 2022. # of national events for the dissemination of project results in Q3 2023, BL 0, Q1 2022.	At least 1-2 Ps./MS trained in strategic communication in Q2 2023. At least 1 national event/MS for the dissemination of project results in Q3 2023.	Certificate of attendant / approval issued. Program of RTC. List of participant and program of the national events.	Enough end-user and beneficiaries interested in applying radiation technology for waste recovery.
Activity	1.1 To set up cooperation mechanisms for efficient and effective project implementation.				
	1.2 To monitor project progress and report on project achievements.				
	1.3 To elaborate communication and outreach strategy and material (webarticles, video, social media).				
	2.1 To train in modification of natural polymers waste with radiation for products and advance material development and characterization.				
	2.2 To train in modification of synthetic polymers waste with radiation for products and advance material				

	development and characterization.				
	2.3 To train in scale-up of the technology from the lab scale to the pilot scale plant.				
	3.1 To train on technology transfer and technical-economic feasibility.				
	3.2 To develop technical-economic feasibility studies applied to the selected product.				
	4.1 To train in strategic communication.				
	4.2 To hold national events for the dissemination of project results.				
Input	1.1.1 MT1_First Regional Coordination Meeting (1 counterpart per country, TOs, PMO)				
	1.1.2 MT2_Final Regional Coordination Meeting (1 counterpart per country, TOs, PMO).				
	1.2.1 Local_Elaboration of the first Project Progress Assessment Report (PPAR) by DTM in coordination with all project counterparts, PMO and TO.				
	1.2.2 Local_Elaboration of the second PPAR by DTM in coordination				

	with all project counterparts, PMO and TO.				
	1.2.3 Local- Elaboration of the final Project Achievement Report by DTM in coordination with all project counterparts, PMO and TO.				
	1.3.1 HBA1_Home-Based Assignment on the development of outreach materials related to the use of irradiation technology for the generation of new products.				
	1.3.2 HBA2_Home-Based Assignment on the development of outreach materials related to project results and proposals for new value-added products.				
	2.1.1 RTC1_on modification of natural polymers waste (1 Ps./MS, 3-days e-learning + 5-days in-person, 1 expert).				
	2.2.1 RTC2_on modification of synthetic polymers waste (1 Ps./MS, 3-days e-learning + 5-days in-person, 1 expert).				
	2.3.1 RTC3_on scale-up of technology (1 Ps./MS, 5-days, 1 expert).				
	3.1.1 RTC4_on technology transfer and techno-economic feasibility for new product generation (2				

	Ps./MS Technical and end-user institutions, 3-days e-learning and 7 days on-site, 2 experts).				
	3.2.1 HBA4_to review technical-economic feasibility studies (1 Expert: 1 day a week in total 30 days).				
	3.2.2 Local-Submission of technical-economic feasibility document.				
	4.1.1 Virtual RTC5_ on new product marketing and communication strategies (2 Ps./MS technical and end-user institutions, 5-days, 1 expert)				
	4.2.1 Local-National events to disseminate project progress and results to stakeholders and end users.				