Project Acronym: PLAMINPACK

Project title: PLAnt-based antiMIcrobial aNd circular PACKaging for plant product

Deliverable D6.1: Training/information activities related to the different project knowledge

Responsible beneficiary : UOI

Date of delivery: December 2024 (M6)

Period covered by the Deliverable D6.1: from 01/07/2024 to 31/12/2024

Periodic period: 1st

Outline

Executive Summary

Students, farmers and companies will be involved in training and informative activities related to the different project knowledge and disclosable results. The aim is spreading the principles of a sustainable and circular packaging exploiting the beneficial properties coming from PWR, in the integrate contest of a circular farm model. A training plan, including at least 2 activities for each partner will be planned. PRIMA Internship program 2024-2027 will be promoted among students. The activities will be monitored and elaborated in terms of participation and impact. Participating companies will be interviewed and invited in the Advisory Board (AB) of PLAMINPACK: An international on-line seminar about processing techniques for biobased functional packaging will be organized in the last year of the project. The videos and slides will be available on the project website so that they can be used by researchers and companies.

I. Strategic training plan for sustainable and circular packaging.

Importance: A strategic training plan is crucial for implementing sustainable and circular packaging. Major reasons for conducting such a plan are presented below:

1. **Environmental Impact**: Reduction of waste and pollution by promoting the use of recyclable and biodegradable materials. Training ensures the importance of these practices and how to implement them effectively.
2. **Regulatory Compliance**: Current trends introduce more strict regulations on packaging waste. Businesses could be helped to stay compliant with new regulations, and to improve market acknowledgement.
3. **Cost Efficiency**: Circular packaging can lead to cost reduction by minimizing material usage and waste management costs.
4. **Brand Image**: Nowadays, consumers are increasingly aware of environmental issues and prefer products that demonstrate a commitment to sustainability.
5. **Innovation and Competitiveness**: Training fosters innovation by encouraging scientists, professionals and companies to think creatively about the development of novel, more sustainable packaging designs that give a competitive edge.
6. **Stakeholder Engagement**: Effective training programs involve collaboration across the supply chain, from suppliers to producers and consumers. This holistic approach ensures that all stakeholders are aligned with the sustainability goals.

The strategic training plan for addressing sustainable and circular packaging in target groups such as students as well as farmers and companies will include the following generic components and key-steps.

1. Setting out Objectives and Goals

- **Sustainability Goals**: Reduce environmental impact, increase recyclability, and use renewable materials.
- **Circular Economy Goals**: Design for reuse, recycling, and recovery.

Sustainable and circular packaging objectives and goals have been described within the project (part 2 IMPACT). The contribution of project activities to the accomplishment of the 17 Sustainable Development Goals (SDGs) set by United Nations (UN) will be demonstrated and highlighted. Research and technology implementation activities contribute to SDGs such as : 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture; 3. Ensure healthy lives and promote well-being for all at all ages; 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all; 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation; 12. Ensure sustainable consumption and production patterns; 13. Take urgent action to combat climate change and its impacts; 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss. Additionally, training and dissemination activities contribute to SDGs such as : 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all; 5. Achieve gender equality.

The circular economy key goals will be considered:

- Enhancement of the Design for the Circular Economy: Encourage the development of packing products that are ideally durable, reusable, repairable and recyclable.
- Improved Management of Resources: Developing products and materials in use for as long as possible, maintaining their highest value. This involves promoting business models like reuse (in-industry or off-industry) and remanufacturing.
- Implementation of methodologies that make circular practices economically viable.
- Investment in Innovation, Infrastructure, and Skills: Support research and development in circular technologies, build the necessary infrastructure, and train the workforce (students, professionals, farmers, stakeholders) to support a circular economy.
- Collaboration for current status change: Foster cooperation between scientific, producers and business communities to create a new approach based on circular economy practices.

2. Stakeholder Engagement

The training activity will also involve stakeholders. In particular:

- **Internal Stakeholders**: Involve scientists and researchers on all aspects of production and processing of materials (production, processing, reuse, environmental impacts etc).
- **External Stakeholders**: Collaboration with farmers, producers, recyclers, and packaging companies.

3. Training sectors

Training sectors and activities will be presented in detail in next section. In brief, major components will include:

- **Introduction to Circular Economy**: Principles and benefits.
- **Sustainable Materials**: Selection of recyclable and biodegradable materials.

- **Design for Circularity**: Techniques for designing reusable and recyclable packaging.
- **Lifecycle Assessment**: Evaluating environmental impacts at each stage.
- **Food safety aspects**: Interplay action of packing materials and food components for assuring food safety.

4. Workshops-seminars (2 per partner, 1 closing international seminar)

- **Material Selection**: Procedures to choose sustainable materials.
- **Design Thinking**: Creating modular and recyclable packaging.
- **Case Studies**: Analysis of successful circular packaging initiatives from the project.
- **Continuous Learning and Development:** Create forums, websites for sharing best practices and innovations.

5. Metrics and Evaluation

- **Sustainability Metrics**: Incorporate environmental, social, and economic impacts.
- **Continuous Improvement**: Regularly update training based on feedback and new developments (end of project).

II. Training plan for students on sustainable and circular packaging.

A training plan for students on sustainable and circular packaging is important for several reasons:

1. **Environmental Awareness and Social Responsibility**: Knowledge about the environmental impact of packaging waste and the importance of reducing it. This awareness can lead to more environmental-friendly behaviors and decisions in their personal and professional lives.
2. **Future Workforce Preparation**: As the demand for sustainable applications of packing materials grows, professionals who can apply circular economy principles and promote sustainable packaging will be competitive for future job market demands in several industries.
3. **Innovation**: Training can lead to innovative designs that reduce waste, use renewable materials, and improve overall sustainability.
4. **Economic Benefits**: Knowledge on cost-saving opportunities through material efficiency and waste reduction.
5. **Regulatory Compliance**: Create professionals that are knowledgeable about sustainable practices and compliance with new regulations or future trends in packaging material requirements.

Training activities of the project for the students (postgraduates, PhD candidates, post-docs, 20-30 persons) will be organized by each partner and will follow the general structured approach below involving key components such as:

1.Introduction to Circular Economy and Sustainability

- **Objective**: Knowledge of the principles of the circular economy and its importance in packaging.
- **Content in brief**:
  - Definition and principles of circular economy.
  - Environmental impact of traditional vs. circular packaging.
  - Case studies of successful circular packaging initiatives.

2. Material Selection and Design

- **Objective**: Selection criteria for sustainable materials and design packaging that minimizes environmental impact.
- **Content in brief**:
  - Overview of sustainable materials (e.g., biodegradable, recyclable, compostable).
  - Design strategies for reducing material use and enhancing recyclability.

3. Lifecycle Assessment (LCA) and environmental Impacts

- **Objective**: Conduct lifecycle assessments to understand the environmental impact of packaging from production to disposal.
- **Content in brief**:
  - Introduction to LCA methodology.
  - Steps to perform an LCA.
  - Interpreting LCA results to make informed decisions.

- Tools for evaluating the environmental impact of packaging materials.
- Weathering and deterioration of materials
- Lab-demonstration experiments on determination of packing materials physicochemical properties and persistence on weathering

4. Food Safety aspects

- **Objective:** Understand the role of packing material in food preservation but also in food contamination

- **Content in brief**:

  - General food safety aspects and analytical techniques for monitoring food safety (chemical and microbiological)
  - Properties of food packing materials for preservation and storage.
  - Migration of contaminants form food packing materials

5. Regulatory Frameworks and Standards

- **Objective**: Familiarize with the regulations and standards governing sustainable packaging.
- **Content**:
  - Key regulations (e.g., EU Packaging and Packaging Waste Directive).
  - Industry standards and certifications (e.g., FSC, ISO 14001).
  - Compliance strategies.

6. Implementation and Innovation

- **Objective**: Develop and implement innovative packaging solutions.
- **Content**:
  - Techniques for redesigning packaging to be more sustainable.
  - Case studies of innovative packaging solutions.
  - Research project design
  - Collaboration with stakeholders for sustainable packaging initiatives.

7. Evaluation and Feedback

- **Objective**: Assess the effectiveness of the training program and gather feedback for improvement.
- **Content**:
  - Post-training assessments.
  - Participant feedback surveys.
  - Review and update training materials based on feedback.

III. Training plan for farmers and companies on sustainable and circular packaging

In addition to students, a training plan for farmers, cooperatives (about 10-15 representatives) and companies on sustainable and circular packaging is also of vital importance for reasons previously mentioned but also for fostering collaboration within first ring-participants in supply chain, i.e. producers and distributors or food industries.

1. **Environmental Protection**: Training on practices that minimize the environmental footprint of packaging.
2. **Economic Efficiency**: Reducing costs by using materials more efficiently and reducing waste management expenses.
3. **Regulatory Compliance**: Compliance with legal frameworks, future requirements.
4. **Market Demand**: Training will enable farmers and companies to meet the increasing demands in green and sustainable materials, potentially increasing their market position and customer loyalty.
5. **Innovation and Competitiveness**: Training fosters companies to develop and adopt new, sustainable packaging solutions increasing competitiveness in the market.
6. **Supply Chain Collaboration**: Effective training programs promote collaboration across the supply chain, ensuring that all participants and stakeholders are aligned with sustainability goals.

Training activities of the project for farmers, cooperatives and companies with packing plants will be organized by each partner and will follow the general structured approach below involving key components such as:

1. Basics of Sustainable and Circular Packaging

Definition and Importance: Understanding what sustainable and circular packaging is and why it matters.

2. Materials and Design - Practical Implementation designs

Sustainable Materials: Exploring renewable, bio-based, and recyclable materials.

Global Trends and Regulations: Overview of current trends and regulations in sustainable packaging.

Circular Design Principles: How to design packaging that can be reused, recycled, or composted.

3. Business Strategies

Circular Business Models: Strategies for integrating circular economy principles into business operations.

Case Studies: Examples of successful sustainable packaging initiatives by industry leaders.

4. Packaging Lifecycle and environmental performance

Lifecycle Assessment (LCA): Understanding the environmental impact of packaging from production to disposal.

Carbon Footprint: Methods to measure and reduce the carbon footprint of packaging.

5. Regulatory and Compliance.

Food Safety and Hazards: Chemical and Microbiological Methodologies for assessing packaging compliance with food safety regulations.

Compliance with Local and International Standards: Navigating the regulatory landscape.

6. Innovation and Future Trends

Emerging Technologies: Innovations in sustainable packaging materials and technologies.

Future Trends: Predicting future developments in the field of sustainable packaging.

IV. Planning activity

In the framework of the partners team, it was decided that each seminar activity should be shorter than one day, so that the training activity can be easily participated by companies and students. Moreover, it was decided to define the topics and the provisional dates of the training actions, so that it can be granted that they will be spread on a wide time period and they will not overlap. Each partner will organize its own meeting considering mainly its own staff, but asking to other partners to make presentations, selecting them on the basis of the addresses given to the seminar.

Table 1. Proposed training activities of all partners within PLAMINPACK project.

	Seminar topics	Short description, expectations, involved partners and target	Delivery Month
UNIPI	PLAMINPACK: a research project funded by Partnership for Research and Innovation in the Mediterranean Area	Hybrid in presence and on-line seminar to explain circular economy principles, PRIMA goals and PLAMINPACK objectives and structure. It is expected to create awareness about funding programmes and project design. The on-line presence of all the partners will allow to briefly present all of them to the participants Addressed to general public, including students, in particular PhD students, researchers and companies	17
	Sustainable materials and compounds for fully circular packaging: PLAMINPACK approach	Hybrid in presence and on-line seminar to describe the different biomolecules that can be used in packaging as well as methodologies for their production and selection, showing the examples of the ongoing activities of PLAMINPACK It is expected to create awareness about biopolymers, as well as compounds extractable from plants. Moreover, it will promote the knowledge and spread of biotechnology. The support of APT, UNIBAS, UCA, ASU and NTT could be useful Addressed to companies (farmers, plastic producers, food packaging producers and users, etc.) but open to general public, including students and researchers, to favor cross-contamination	30
UCA	High added value biomolecules, bio-based products and bioenergy	4th International Congress of Biotechnology in Marrakech, Morocco, under the theme: "Biotechnology at the service of society: rational exploitation of bioresources for sustainable food and medical sovereignty". A session is dedicated to the theme: "High added value biomolecules, bio-based products and bioenergy". A conference on the same theme presented by Maria Beatrice Coltelli, University of Pisa, Italy entitled: "Renewable, biodegradable and circular bio-based materials for functional packaging. On the same occasion, the Prima PLAMINPACK project will be presented. target audience: researchers, professors, master's thesis students, socio-economic partners	5
	New strategies for developing a new concept of active and biodegradable food packaging based on biosourced polymers and	In presence seminar for PhD, engineering, and master's degree students to raise awareness about the problems related to petroleum-based packaging and additives application in the food sector and to	16-17

	bioactive compounds for improving the preservation of perishable foods	highlight the potential application of biopolymer-based materials enriched with bioactive compounds as a strategy to valorize natural by-products while replacing conventional plastic and synthetic additive	
	High added value biomolecules and bio-based products in the development of food packaging	a morning debate on high added value biomolecules and bio-based products in the development of food packaging in person. target audience: companies, researchers, professors, master's thesis students, public authorities (national office for food safety, ministry of industry, ministry of agriculture, ...)	21-22
NTT	The PLAMINPACK Project and its point of view on circular economy and sustainability	An on-line seminar regarding circular economy principles, sustainability, and bioeconomy. The PLAMINPACK Project is reported as an example. It is expected to create awareness on circular economy, bioeconomy and sustainability through concrete examples (such as the PLAMINPACK Project). Addressed to general public, including students, researchers, and companies.	17-18
	Sustainable and biobased materials for vegetable and food packaging: the PLAMINPACK Project	NTT can join the on-line seminar of UNIPI, supporting it with a contribution on biobased textile packaging for fruits and vegetables. State-of-the-art on commercial biobased materials used for the same application and improvements brought by the PLAMINPACK project. It is expected to create awareness about biobased materials usable for food packaging (especially for fruit and vegetable nets). Moreover, it will promote circular and more sustainable approaches. Addressed to companies (food packaging producers, plastic producers), but open to public, including students and researchers.	30
UNIBAS	Seminar on valorization of agri-food waste products through bioconversion process mediated by insects, particularly Hermetia illucens.	In presence. It is expected to create awareness about the circular economy principles. Addressed to bachelor, master's degree and PhD students.	12
	Seminar on secondary products of bioconversion process, particularly chitosan, its physico-chemical and microbiological characterization and its application in packaging industry.	In presence. It is expected to create awareness about biopolymers. Addressed to bachelor, master's degree and PhD students.	12

APT	Novel technologies and applications for bioactive extraction from mediterranean agro-industrial wastes	1st : A half-day seminar held in person to introduce college students to novel extraction technologies and their role in valorizing agro-industrial wastes. This session will combine theoretical insights with real case examples of various applications, highlighting sustainable approaches for bioactive recovery. The objective is to enhance students' understanding of how these technologies contribute to the circular bioeconomy and sustainable industrial practices. 2nd : A half-day event hosted at APT, where we will welcome a student group for an in-depth presentation of the PLAMINPACK project. This session will showcase the complete valorization pathway—from raw materials to extracted bioactives and their integration into functional packaging. The participants will explore real samples, visualizing the transformation process and gaining insights into the industrial potential of some innovative extraction and purification technologies.	24
UOI	Sustainable Food Packaging to preserve environment in a Circular Economy Context under the framework of Plaminpack project	Hybrid in presence and on-line seminar Principles of circular economy and environmental sustainability Overview of Plaminpack project Bioassays for toxicity assessment of precursors and materials Analytical techniques for monitoring food contaminants from packing materials Environmental implications for food packaging materials Examples of food packing materials in a circular economy context Addressed to PhD, MSc Students and researchers	12
	Sustainable Packaging Solutions from Agri-food Waste: Roles, Materials and environmental issues	Hybrid in presence and on-line seminar Plaminpack project presentation (UNIPI) Life cycle Assessment of packing materials (ASU) Weathering of packing materials and environmental aspects Bioactive compounds extraction from plants and agri-food waste, characterization (via Mass Spectrometry) and Applications Assessment of biological activity of plant extracts in food preservation and post-harvest protection Market requirements and practices Case studies for innovative packaging solutions	27

		The support from UNIPI, ASU, could be useful. Addressed to companies, farmers, students and researchers but open also to general public.	
SFAX	AI in Circular Bioeconomy for a Sustainable Agr-Food Industry	In presence seminar Addressed to general public, researchers, and companies. It aims to Explore the different applications of AI in the agri-food industry, related to resource management and the circular economy Prediction of agricultural yields. Optimized management of natural resources (water, soil, fertilization). Precision agriculture and IoT sensors to monitor and adjust practices. Agri-food waste processing: Using AI to maximize the reuse of organic waste.	16
	Workshop for biological data analysis to ensure that the conclusions drawn from your research are rigorous and relevant.	In presence seminar Adressed to PhD, MSc Students and researchers It aims to master data analysis methods and steps Data set: Identify the data sources relevant to the study. Variable identification Select the appropriate statistical tests based on the nature of variables and hypotheses. Analysis planning Use statistical software such as R, Python, SPSS, or SAS to conduct analyses. Interpreting results Analyze the results obtained against initial hypotheses. Discuss the biological implications of the findings and their limitations. Communicating results	27
ASU	Closing the Loop: Circular Economy and Sustainable Solutions for Agrifood Industry Byproducts and Waste	Basics of circular economy and its potential to reduce environmental impacts in the packaging industry Development of innovative active packaging materials on the example of PLAMINPACK Quantifying sustainability via LCA, LCC and sLCA Addressed to students, researcher, general public; hybrid or online	17-18
	Turning Agrifood Waste into Opportunity: Balancing Circular	Fundamentals of Circular Economy and Its Potential to Minimize Environmental Impact in the Packaging Industry	29-31

	Economy, Sustainability, and Regulations	Valorization of by-products and waste from the agrifood industry: Identification of suitable by-products/waste, extraction of valuable substances, development of packaging solutions using these substances. The PLAMINPACK project will be used as example Regulatory standards, frameworks and legislation in the packaging sector Use of LCA to transfer product portfolios towards more environmental and economic sustainability The support UNIPI, APT could be useful Addressed to companies, but also open for public including local government offices, students and researcher; online	
UHOH	New Foods Festival – Food System Revolution	The new food festival is set to showcase the latest innovations and trends in the food industry, bringing together experts, retailers, and entrepreneurs from across the sector. This event offers a platform for exploring new technologies, sustainable practices, and cutting-edge research that are shaping the future of food production and distribution. As part of this event, we will present advancements being made in the PLAMINPACK Project. The presentation will focus on predictive modeling for food shelf life. Thereby explaining machine learning concepts to enhance the precision of shelf-life prediction, which is crucial for optimizing supply chain operations and minimizing waste. Addressed to: Companies, Food Start Ups, Retailers, general public	9
	Digital Twins for Food Shelf-Life Prediction	During the open day of the University we will demonstrate in presentations and talks how digital food twins can be utilized to enhance predictive analytics for shelf-life estimation. Addressed to: Students, General Public	13