EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Brussels, 24 March 2020

COST 027/20

DECISION

Subject: **Memorandum of Understanding for the implementation of the COST Action "RETHINKING PACKAGING FOR CIRCULAR AND SUSTAINABLE FOOD SUPPLY CHAINS OF THE FUTURE" (CIRCUL-A-BILITY) CA19124**

The COST Member Countries and/or the COST Cooperating State will find attached the Memorandum of Understanding for the COST Action RETHINKING PACKAGING FOR CIRCULAR AND SUSTAINABLE FOOD SUPPLY CHAINS OF THE FUTURE approved by the Committee of Senior Officials through written procedure on 24 March 2020.

MEMORANDUM OF UNDERSTANDING

For the implementation of a COST Action designated as

COST Action CA19124
RETHINKING PACKAGING FOR CIRCULAR AND SUSTAINABLE FOOD SUPPLY CHAINS OF THE FUTURE (CIRCUL-A-BILITY)

The COST Member Countries and/or the COST Cooperating State, accepting the present Memorandum of Understanding (MoU) wish to undertake joint activities of mutual interest and declare their common intention to participate in the COST Action (the Action), referred to above and described in the Technical Annex of this MoU.

The Action will be carried out in accordance with the set of COST Implementation Rules approved by the Committee of Senior Officials (CSO), or any new document amending or replacing them:

a. "Rules for Participation in and Implementation of COST Activities" (COST 132/14 REV2);
b. "COST Action Proposal Submission, Evaluation, Selection and Approval" (COST 133/14 REV);
c. "COST Action Management, Monitoring and Final Assessment" (COST 134/14 REV2);
d. "COST International Cooperation and Specific Organisations Participation" (COST 135/14 REV).

The main aim and objective of the Action is to organize a food specific, focused pan-European action network of actors involved in all aspects of food packaging, to provide harmonized solutions to current scientific and technical sustainability challenges of food packaging in future circular supply chains. This will be achieved through the specific objectives detailed in the Technical Annex.

The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 104 million in 2019.

The MoU will enter into force once at least seven (7) COST Member Countries and/or COST Cooperating State have accepted it, and the corresponding Management Committee Members have been appointed, as described in the CSO Decision COST 134/14 REV2.

The COST Action will start from the date of the first Management Committee meeting and shall be implemented for a period of four (4) years, unless an extension is approved by the CSO following the procedure described in the CSO Decision COST 134/14 REV2.

OVERVIEW

Summary

Food packaging is designed to protect the food through its supply chain, communicate to customers, and to ensure food quality, safety and optimal shelf life. Progress is now needed to secure its circularity, minimize food waste and improve sustainability. CIRCUL-A-BILITY will go beyond the state of the art by jointly addressing the major technical and non technical hurdles for implementation of sustainable food packaging solutions within future circular food supply chains. **A food specific, focused action is critical amongst the ongoing debate in sustainable packaging. It is important to share data on the consequences of specific food product - package interactions and to keep the behavior of consumers as a critical focus.** CIRCUL-A-BILITY will organize a pan-European network of actors involved in all aspects of food packaging, including material scientists, food scientists, industry end-users, consumer scientists and policy makers. The network will actively work to harmonise and integrate food packaging related research, share information, support industry in the implementation of sustainable packaging systems, create authoritative working groups able to give science based recommendation to consumers, user groups, policy makers and industry. It is expected that such COST action activities will 1) valorize the current technical advances, 2) speed the preparation of prototypes beyond the interest of single stakeholders and to the benefit of the European landscape; 3) avoid duplication of efforts in research in adjacent fields; 4) accelerate technology transfer and entrepreneurship; 5) elevate the scientific capacity and research ranking of the COST working members.

Areas of Expertise Relevant for the Action	Keywords
● Other engineering and technologies: Food science and technology ● Industrial biotechnology: Sustainability	● food ● sustainable packaging ● waste ● circularity ● consumer

Specific Objectives

To achieve the main objective described in this MoU, the following specific objectives shall be accomplished:

Research Coordination

● Analyse state of the art, evidence gaps and opportunities for change in the current supply chains, and re-think current best practices to optimize their circularity respecting needs for distribution, perishability and shelf life of food products.

● Identify common opportunities to implement biobased materials in food packaging, coordinate the collection of robust knowledge on novel materials and their safety, and collect data on the interactions of the product with the package.

● Develop recommendations, based on strong measures of sustainability, on improving the circularity (bio-based, recyclability and reusability) of the food packaging materials for end users (i.e. producers, retailers, food processors, municipalities, legislators, etc.).

● Create strategies to link interdisciplinary fundamental research to applications, engaging industry stakeholders to test new solutions, resulting in expediting improvements of the utilization of food packaging and ensure early testing of circularity of the value chain.

● Understand the role played by the various actors, including the consumers and end users in the implementation of the new packaging solutions, and co-create safe, high quality solutions, focused on circularity and minimization of food losses.

Capacity Building

● Bridge separate fields of science and technology to create a strong talent pool, providing knowledge across the value chain, and entrepreneurial approaches towards novel solutions in sustainable food packaging.
● Foster and coordinate short term scientific missions, industry collaborations, exchanges and training schools to harmonize practices, towards the research coordination objectives of the action.
● Create goal oriented workshops and conferences in ITC and NNC Countries, to enhance capacity and stimulate participation and decision making of young and early career investigators, promoting a culture of inclusiveness and cultural diversity.
● Give management responsibility to ECI and ITC researchers creating equal opportunities to grow professionally, helping establish a new generation of research leaders, a talent layer with innovative mindset looking at the problems with a holistic approach. Promote gender balance and inclusiveness.
● Develop a communication platform to empower consumers, media and public policy makers. Provide a source of reliable information and a trusted reference point.

TECHNICAL ANNEX

1 S&T EXCELLENCE

1.1 SOUNDNESS OF THE CHALLENGE

Food packaging solutions need to be re-evaluated and re-invented, to focus on circularity. According to FAO, losses at almost every stage of the food chain can be reduced by using appropriate packaging solutions (1). This includes food losses and waste. In developing regions, where food systems are in need of appropriate preharvest and postharvest stages before retail. In developed Countries, new packaging designs need to decrease food waste in retail, food service and in the household (2). There are environmental, societal, and economic needs to revise the current use of packaging for food products, not only in retail, but also with other distribution chains, such as food service and e-commerce. As supply chains change, material optimization and reduction will have to become a more prominent topic, to safeguard non-renewable resources, and to decrease environmental impact by circularity. **There is now the need/opportunity to re-think the way we package our food to store, process, deliver and consume it.** Solutions have to be consumer centric to ensure success.

Although much has been accomplished in the past decades in relation to food safety, food quality and improved shelf life, many of the current solutions do not measure well in terms of circular and sustainable supply chains. This is an area of growth and development with many solutions becoming available, but also with misconceptions, consumer demands, legislative push for change, and an industry faced with a continuous need to react, often with not enough information, or with different solutions in different regions.

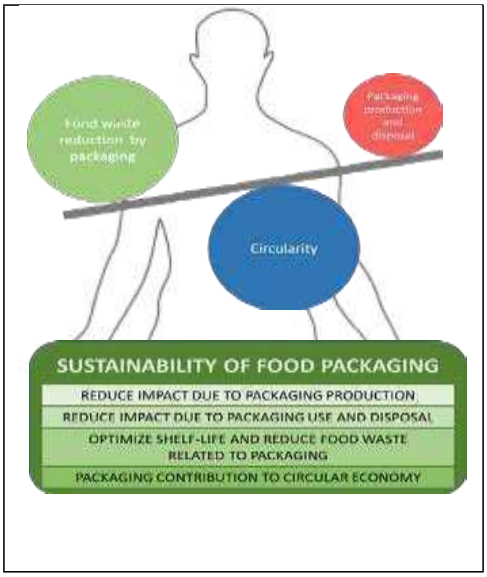

Figure 1. CIRCUL-A-BILITY. Sustainable food systems need to focus on circularity, and with consumers as key to success.

Collaboration will give optimal and efficient utilization of available competence and technology across borders. Science and technology needs to take the lead to deliver harmonization, and engage academia, government and industry **in a collaborative science and technology COST ACTION focused on sustainable food packaging in circular and sustainable food supply chains. CIRCUL-A-BILITY** (Fig. 1) responds to the need for knowledge sharing and to establish an open, science based discussion platform that will consider all aspects of material science, food processing, food material interactions, logistics, shelf life and recycling, as they pertain to packaging of the food. Figure 1 illustrates the proposed CIRCUL-A-BILITY COST Action, where the circularity of the opportune material needs to be identified and studied (red circle), keeping food quality in focus (green circle), to minimize waste by creating new packaging solutions. The activities will be multidisciplinary in nature, considering aspects such as food safety, risk assessment, food waste, recyclability, reusability, biodegradability, processing, with consumers (through behaviour analysis and education) and end users taking center stage. The Action will engage diverse stakeholders to achieve economically competitive and feasible solutions, at a fast pace, across Europe.

1.1.1 DESCRIPTION OF THE STATE-OF-THE-ART

In Europe, policies have been put in place to move towards a more sustainable circular economy (3,4). These include legislation and reccomendations on waste management practices, promotion of increased recycling, and use of recycled materials, whenever possible and safe. In the circular economy, the best package derives from renewable or recycled materials, and, after its use, is recycled or composted (5). Specifically, in the context of **food packaging** the package needs to be designed:

- With materials designed for circularity,
- Food Specific,
- Ensure food safety and deliver best quality,
- Meet demands of end user,
- Enable efficient logistics and for diverse supply chains,
- Minimize waste.

Leading brands, retailers, professional organizations have all shown commitment towards a circular economy, pledging to reach measurable targets (i.e. see for example (6)). However, EU and national food safety regulations/standards, shelf-life, or insufficient data on safety or food specific quality still limit the fast implementation of alternative packaging materials.

The research focused on sustainable food packaging solutions is evolving at a rapid pace. Development of **biobased and biodegradable packaging materials** ((7), BIOBARR BBI JTI –IA 2017 – 2021), **modified atmosphere and active packaging** for shelf life extensions ((8), RefuCoat BBI JTI (RIA 2017 – 2020), **intelligent packaging** for shelf life control and optimising logistics (GLOPACK H2020 – IA 2018 – 2021) are some of the popular areas of research of the past decade. Shelf life prolonging by active packaging developments is also an active area of research, as in the case of the NanoPack project (H2020 (IA) 2017 – 2019) and YPACK (H2020 (IA) 2017 – 2020), for example, finding means of encapsulating antimicrobial agents in the packaging films. Furthermore, food waste can be prevented by applying sensors based intelligent packaging. These technologies can also provide information on the actual conditions of the food or enable quality controlled logistics (9). Multilayer packaging materials (BIOCOMPLACK H2020 – FTI 2016 – 2019), are also proposed as means to extend shelf life, minimize food waste and packaging waste. Some of the most recent successes have been documented and promoted through the ActInPak COST Action 2015-2019. Multilayer solutions are praised as they optimize the material properties while decreasing the weight of the package; however, they currently show very limited recyclability and at times, extra consumption of diverse fossil-based barrier materials (10). Empowering the consumer to dispose the food only when it is really no longer fit for purpose is also becoming important (11, 12), instead of setting a fixed “best by” date that is not well understood by consumers. Those fast advances have not been efficiently shared within the various food communities/stakeholders, across disciplines and commodities, or across supply chains.

In addition to the needs related to an increased use of renewable resources in plastics, recyclability and compostability arise important food waste issues and consumer behaviour, intimately linked to Food Packaging. It is estimated that the World’s food waste is reaching about 1/3 of the total mass of agricultural crops, with important social and ethical implications (13). This has been clearly addressed by UN SDG goal 12.3, which aims to “by 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post harvest losses” (UN, General Assembly, 2017). In a recent report (14) it was highlighted that since 2005, there has been both an increase in food waste and in food packaging utilization. Projects like CIRC-PACK (H2020 CIRC 2017 – 2020) that aim to transform plastic packaging waste into a resource, show the way forward. However, considering how packaging needs to be food and supply chain specific, **only multidisciplinary, harmonized efforts can result in effective and fast implementation of sustainable solutions**.

1.1.2 DESCRIPTION OF THE CHALLENGE (MAIN AIM)

The **aim** of CIRCUL-A-BILITY is to organize a **Food Specific, Focused** pan-European action Network of actors involved in all aspects of food packaging, including Material scientists, Food scientists, Food Packaging Manufacturers, Food Companies, Food Retailers, Waste Collectors, Consumers Associations & Consumer scientists, Policy makers and Local and Regional Authorities, to provide harmonized solutions to current scientific and technical sustainability challenges of food packaging in future circular supply chains. **The focus is material circularity without compromising on the primary functions of the food package, therefore food quality systems, decrease waste and end use have to also take center stage. This is the novelty of CIRCUL-A-BILITY, and breakthroughs will derive from the focus on selected models, that will create consensus, harmonized methodologies and**

best practices. A coordination of the results from processing, food material - package interactions studies, as well as end user research is critically important for redesigning our supply chain. **A redesign of what we praise as convenient and high quality to enable circularity may be needed.** CIRCUL-A-BILITY ambition is to become a "go-to" science and technology network to support decision makers in industry and government to implement the most sustainable food related packaging solutions, and a reference to media, consumer groups, NGOs and policy makers. Thereby, **CIRCUL-A-BILITY** facilitates that, together, we can build a more sustainable European Circular Economy.

The **COST ACTION** will address the following challenges:

1. How can the sustainability of food packaging (in connection to the food it protects) be best assessed?
2. What industrial packaging solutions fit best for circularity, and how to measure the best fit (see Fig.2)
3. Are current practices best practices? Are changes needed to food processing and distributions? Should "food supply chains" change to implement more sustainable packaging solution?
4. Which consensus and data are needed to ensure appropriate legislation and facilitate the application of sustainable solutions?
5. How can we increase consumer trust by improving transparency and guaranteeing food safety of the food, package, and their interactions?
6. How can we engage with consumers in the co-creation of a more sustainable food packaging circular economy?

There is **no "one size fits all" in the case of food packaging**, and the network will create and share best practices across communities often not interacting with one another, by engaging into multidisciplinary discussions and Short Term Scientific Missions (STSMs) with shared expertise, focused on food specific model systems which will create consensus of methodologies, results, best practices, that will be published in review articles, refereed research papers and technical reports.

Fig. 2 Important criteria to determine best fit of packaging material to a specific food. But "no one size fits all".

This is the right time for such action. The impact of high plastic consumption and its accumulation on land and oceans needs to be addressed. Consumers and policy makers pay enormous attention to alleged environmental burden of packaging materials (15). Food waste reduction because of packaging can play a significant role (e.g.(16)).

Sustainability challenges are high on political agendas (e.g. UN goals on sustainability) thus, the time is right for systems change to address food packaging challenges such as:

- Consumers longing for high quality fresh, organic, clean label food, resulting in the need for more advanced packaging to continue to provide safe and well preserved food.
- A growing number of convenience foods, with fresh mixed commodities bring new food safety and spoilage challenges.
- Some food waste challenges can be reduced by proper food packaging design (16), and packaging changes can have high impact on life cycle of food products (18).
- Challenges connected to inadequate municipal waste management programs and not harmonized practices for recycling and the use of recycled material.
- Much better packaging concepts are becoming available (see for example (17)), but research is highly fragmented and a better coordination would result in faster implementation.

Clearly packaging for food has tremendous environmental impacts and needs to be urgently addressed. Acting now will allow choices to be made based on scientific debate, and will lead to improved ways of packaging food, novel packaging concepts and to communicate the sustainability improvements effectively to policy makers and consumers.

1.2 PROGRESS BEYOND THE STATE-OF-THE-ART

1.2.1 APPROACH TO THE CHALLENGE AND PROGRESS BEYOND THE STATE-OF-THE-ART

In the past, food packaging was designed to protect the food through its supply chain, communicate to customers, and ensure food quality, safety, optimal shelf life and convenience. **ActInPak** COST ACTION -with focus on new fibre-based packaging materials with active and intelligent features- has shown the potential of optimizing material functionality. **Progress is now needed in securing circularity, minimizing food waste and improving sustainability.** CIRCUL-A-BILITY will aim at moving beyond the state of the art by jointly addressing the major technical and non-technical hurdles in the implementation of sustainable food packaging solutions within future circular food supply chains, building on the experience of the ActInPak Network. Focus will be given to the added value of international cooperation and networking, support the joint development of breakthrough solutions, in material science, food specific biomaterials applications, recyclability testing, and consumer-centered packaging design.

THE APPROACH

CIRCUL-A-BILITY will address the technological barriers, specific to product categories and supply chains by creating a network with four technical working groups dedicated to harmonization, and one to communication to improve decision making processes and coordination of research efforts. A successful harmonization network on food packaging for future circular and sustainable supply chains requires to cover all aspects and be food specific. Namely, the environmental impact of the materials and their circularity, the recycling (and recyclability) of plastics, the food losses and waste in the supply chains, the implementation at the end-user (i.e. customer) interface. The large variations in material types and combination in e.g. laminates, the needs which depend on food product properties and its supply chain, and the habits of the end users are a challenge, but they all need to be addressed to improve chances of success in the implementation of novel solutions. **This holistic approach lacks at the moment, and this will be addressed in CIRCUL-A-BILITY.** Best practices need to be shared, robust methodologies need to be developed, and validations carried out in different settings, with different model systems, keeping European cultural diversity in mind.

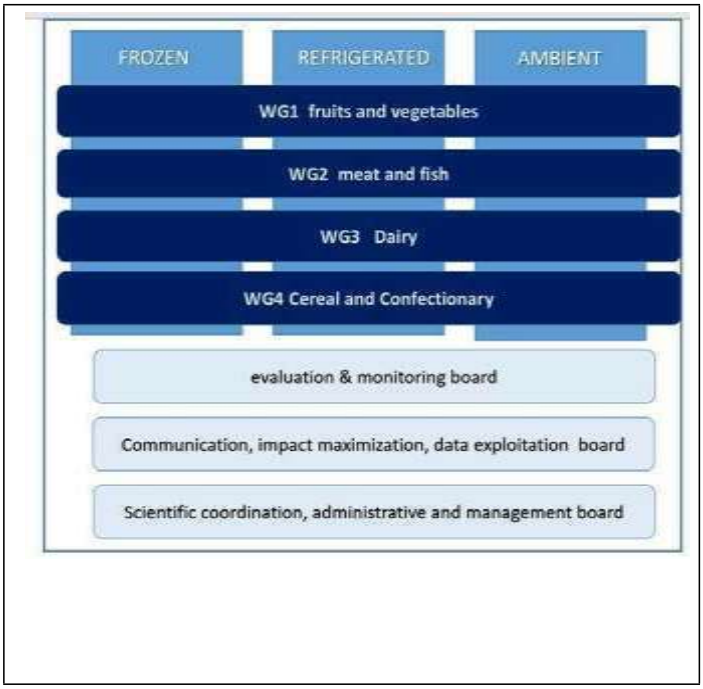

Figure 3: Schematic representation of CIRCUL-A-BILITY COST ACTION approach: 4 Working Groups (WG), with subgroups being considered across food specific problems (consensus-building model systems), mindful of the different needs of each supply chain.

CIRCUL-A-BILITY will operate through four technical Working Groups (WG), with three subgroups linking the various supply chain types: **frozen**, **refrigerated**, and **ambient** (see Fig. 3). Indeed, this will create breakthroughs, as often similar solutions are proposed, in spite of differences in supply chain or shelf life requirements. A fifth WG will be dedicated to the dissemination tasks of the Action to ensure optimal coordination of activities. It will be the ambition of every working group to consider consumer attitudes and understand legislative demands and to engage the entire supply chain for the design and implementation of new packaging concepts. This will allow for interconnection between disciplines, bringing together the five challenge pillars identified in the next paragraphs (circularity, waste, material properties and the interface with food, the consumer behaviour). **Each working group will tackle specific challenges, and evaluate different types of materials, their CIRCUL-A-BILITY, the barriers, such as modified oxygen and moisture barriers, barrier to light (UV and visual), moisture barrier, hydrophobicity or moisture sorption, as those are key to achieving long,**

short and medium shelf life stability. This approach will foster innovative thinking across disciplines and applications.

CHALLENGE PILLARS

1. Consumers and end users (i.e. food service customers and municipalities) need to be co-creators. Consumers demand a more sustainable food product, but their perception is often not based on scientific evidence, usually linked to packaging attributes, recyclability, impact on life cycle assessment, and direct environmental impact of the package (16). **In CIRCUL-A-BILITY the studies of end user attitudes, sustainability perception, habits and behaviours are as important as the studies on the technical packaging attributes in a food product value chain.**

2. New packaging materials need to be validated, documented and harmonized, to expedite consensus building. Bio-based packaging still presents technical hurdles, which hinder large market uptake and limit scale up, such as raw material variability or narrow processing windows compared to common oil-based counterparts. **The action will consider state-of-the-art in biobased- and bio-materials, and determine best practices, identify gaps and create consensus by testing and validating model systems in STSMs.** Processing approaches may need to change to ensure the same quality products of today, in future supply chains – consensus building is critical to facilitate decisions on capital investments.

3. Solutions need to be optimized to minimize food waste at all stages of supply chain, and become more product specific, since "one size fits all" is not possible. Packaging is a central element to food quality preservation, to controlling exchanges with the external atmosphere, contributing to preserving food quality during storage, preventing food safety issues (prevention of food-borne diseases and food chemical contamination) extending food shelf-life, and communicating with consumers. However, primary packaging may not be well adapted to the specific food needs and therefore does not efficiently and sufficiently contribute to maintain the shelf life of the food. **The action will focus on packaging-product interfaces, processing barriers to packaging and variations depending on supply chains, to understand the impact of safety and shelf life changes to adapt new material to current practices, modify them, or even develop new practices.**

4. Biodegradable packaging and bio-based packaging recycling are very different approaches to packaging materials, and both need to be part of circular solutions. However, biobased and recycled plastics are the important focus of development in food systems, and their application to food solutions will continue to be a challenge in the upcoming years. Materials are usually not recycled to food grade materials, and recycling is often not possible because of lack of coordination or affordability. For example, polystyrene trays commonly used to package meats are not recyclable due to the presence of food contaminants, while polylactic acid trays may be industrially composted but only if volumes justify it (19). Further, light weight may make collection and transportation unaffordable. Biobased polymers, produced from renewable sources, or plastics which are biodegradable or compostable have been developed. Not all bio-based polymers degrade, for example, it is possible to synthesize “green” polyethylenes or polyethylene terephthalates from renewable resources, and hence not depleting fossil fuels, but these materials are chemically identical to their conventional counterparts. On the other hand, biodegradable polymers prepared from polylactates, polysaccharides (e.g. starch, celluloses or glycogen) or proteins such as zein, soy, gluten, casein etc. (i.e. (20)) should be evaluated to expand their application in food systems, wherever possible, especially when waste resources are used. **Different solutions to recyclability, and where/what/how will need to be assessed and evaluated in light of end user practices.**

5. The COST action is to create the required stakeholders network which in turn will provide evidence to sustain circular economy decisions and policies. **Life Cycle Assessments (LCA)** will be used as supporting tool to the development on new solutions, as well as a design tool supporting choices and directions to more sustainable food products and packaging solutions. The **value chain modelling of the systems** needs to be considered for the whole life cycle of the product: 1) use and origin of the raw materials, 2) production of the packaging material, 3) processing, warehousing and distribution inputs and 4) end of life of packaging and food waste.

1.2.2 OBJECTIVES

CIRCUL-A-BILITY will create debate and support high quality research to build better, more sustainable supply chains with the following Objectives:

O1. Generate a multidisciplinary network for knowledge sharing; this will be achieved by coordinating meetings and comparing results and best practices between disciplines. This will also **contribute to the promotion of EU cultural diversity** by fostering networking between different researchers, diverse in age, experience, and geographical provenience, type of research institution, industry background and cultural heritage.

O2. Develop a common understanding, harmonize methodologies, identify gaps for knowledge creation and create scientific consensus, facilitate adoption of best practices. This will also bring to the co-creation of new sustainable solutions, as the Action will raise a new, holistic approach to circularity and sustainability of food products.

O3. Coordinate development/ training of Early Carear Investigators (ECIs) **with a new, circular approach to food packaging design.** The gender balance will be ensured.

O4. Become a hub for policy makers and end users, by establishing a communication platform that will link science, producers, industry, SMEs, NGOs, media policy makers through strong science based solutions. Create long-standing, collaborative research and industrial teams. This will include a web site, posting position papers and model systems available to all network members.

1.2.2.1 Research Coordination Objectives

CIRCUL-A-BILITY will consist of 4 intervention platforms (dairy, fruits and vegetables, fish and meat, cereal and confectionary), mindful of product specific needs (by subdividing the activities considering supply chain demands: ambient, refrigerated, frozen), as those also require completely different processing and product characteristics, which influence the material properties specification, packaging product interaction, shelf life and waste. The COST working groups will create research opportunities amongst WG with the following Research Objectives:

RO1. Analyze state of the art, evidence gaps and opportunities for change in the current supply chains, **and re-think current best practices to optimize their circularity** respecting needs for distribution, perishability and shelf life of food products. This could be done, for example, by setting up an inventory of various materials used in food products, share knowledge on their functionality, provide evidence to validate the implementation of circular scenarios on food models, to build consensus.

RO2. Identify common opportunities to implement biobased materials in food packaging, coordinate the collection of robust knowledge on novel materials and their safety, and collect data on the interactions of the product with the package.

RO3. Develop recommendations, based on strong measures of sustainability, on improving the circularity (bio-based, recyclability and reusability) of the food packaging materials for end users (i.e. producers, retailers, food processors, municipalities, legislators, etc.).

RO4. Create strategies to link interdisciplinary fundamental research to applications, engaging industry stakeholders to test new solutions, resulting in expediting improvements of the utilization of food packaging and ensure early testing of circularity of the value chain. Short term missions will be a critical tool to coordinate such activities.

RO5. Understand the role played by the various actors, including the consumers and end users in the implementation of the new packaging solutions, and co-create safe, high quality solutions, focused on circularity and minimization of food losses. To do so, we will need to evaluate consumer habits, identify misconceptions needing to be addressed, attitudes towards change, identify opportunities for consumer education towards new circular sustainable solutions.

1.2.2.2 Capacity-building Objectives

CIRCUL-A-BILITY will build multidisciplinary capacity across Europe, accessing talent from academia, R&D, research institutes, industrial manufacturers of plastic and bioplastics and equipment, engineering, consumer associations, packaging users, B2B, B2C and retail, policy makers, focusing on the following Capacity-building objectives:

CO1. Bridge separate fields of science and technology to create a strong talent pool, providing knowledge throughout the value chain, and entrepreneurial approaches towards novel solutions in sustainable food packaging. Form complementary teams to enable the flow of information and joint collaboration towards a better use of packaging for safe food. Engage with industrial partners, both SMEs

and large producers, NGOs and media, in ongoing and future research projects towards efficient transfer of technology and information.

CO2. Foster and coordinate STSMs, industry collaborations, exchanges and training schools to harmonize practices, validate potential solutions, study model food systems, implement strong measures of sustainability, test circularity of materials.

CO3. Create goal oriented workshops and conferences in Inclusiveness Target Countries (ITC) & Near Neighbor Countries (NNC), to create capacity and stimulate the participation and decision making of young and early career investigators, promoting cultural diversity and harmonization.

CO4. Give management responsibility to ECI and ITC researchers creating equal opportunities to grow professionally, helping establish a new generation of research leaders, a talent layer with innovative mindset looking at the problems with a holistic approach. Promote gender balance and women leadership in this field of research.

CO5.Develop a communication platform to empower consumers, media, and public policy makers. This should enable policy makers, media and stakeholders by providing them with a source of reliable information and a trusted reference point.

CIRCUL-A-BILITY Measurable Indicators of transnational coordination and capacity building objectives:

I1. Participation in European, National, and regional events (seminars, congresses, presentations, workshops).

I2. Attendance to face-to-face COST Action meetings, on line COST learning events, COST Action training schools.

I3. Collaborative research work, industry collaborations with academics, number of STSMs and student exchange programs.

I4. Joint patents and publications with more than one COST member Country, as open access manuscripts, white papers brochures, e-neswletters, submission of international research proposals.

I5. Number of web site visits, YouTube channel visits

I6. Network dimension and growth: number of countries participating, gender and career diversity number and type of industries participating, research centers and other institutions, new members countries.

2 NETWORKING EXCELLENCE

2.1 ADDED VALUE OF NETWORKING IN S&T EXCELLENCE

2.1.1 ADDED VALUE IN RELATION TO EXISTING EFFORTS AT EUROPEAN AND/OR INTERNATIONAL LEVEL

Consumers are increasingly aware of the challenges brought forward by climate change, and they are demanding solutions towards a way of their being. Packaging, its use of plastic and recycling is an area that is loudly questioned, and circular, sustainable solutions are needed in food systems. Sustainable food packaging research is multidimensional and multidisciplinary, and extremely fragmented. Many of the existing solutions are compromises between legal requirements and best economical solutions**. It is time to harmonize the fragmented reality in Europe**. Many industries are implementing measures to improve the environmental sustainability of their packaging as part of their overall sustainability goals; **consensus building would accelerate progress**. Smaller industries are slow to react, and often not optimizing their solutions because of volumes or costs, and do not have robust data to make business decisions. Recyclability, reusability, compostability are options that apply to different food products, or within the same product, in different distribution chains. Currently there are no European or open international networks or societies through which researchers in the food – packaging material – end user interactions can collaborate and communicate. CIRCUL-A-BILITY would complement the efforts of the Food and Drink Europe Association and their communication strategies on food packaging sustainability. Innovative packaging solutions and strategies that tackle systemic issues and have high social, environmental and economic impact will play an essential role in the period 2021-2027, according to the latest EU RTD Horizon Europe[21] orientation document. The key message from the aforementioned policy paper is that **we need to rethink packaging**.

Table 1 summarizes the added value of CIRCUL-A-BILITY COST ACTION. No coordinated networking project within the scope of the CIRCUL-A-BILITY is currently funded within the COST Program. Nonetheless there are a few research projects in Europe that are "FOOD Focused" and thus, relevant and complementary to this COST action (i.e. BIOSMART BBI –RIA 2017 – 2021). The intent of COST Action is to be as inclusive as possible to include key capacity partners in CIRCUL-A-BILITY, and create a seamless interaction with these complementary initiatives as well as, with the 3 earlier packaging related COST Actions (which were less focused on food supply chains, shelf life and waste and consumer perception and behaviour). The establishment of the links with leaders of European projects, other cost actions and networking platforms will be high in the management committee agenda.

Table 1: Added value of CIRCUL-ABILITY Action in relation to existing efforts and challenges at EU and international level.

Specific challenges	Importance of CIRCUL-A-BILITY networking
Fragmentation of knowledge and practices, consensus need and little access to knowledge for SMEs.	WGs share knowledge between communities, across commodities and supply chains. Multiactors across borders.
A new generation of food packaging experts is needed, possessing a more holistic approach related to a circular economy.	A new talent layer, engaged in high impact and state of the art research with academia and industry, training schools, writing of publication and reviews, STSMs, entrepreneurship training.
A variety of biobased materials and properties are becoming available at a fast rate.	Harmonization of methodologies, data assessment in reviews, discussions on model systems to build consensus on material challenges and benefits, and their validation.
Intelligent packaging and active packaging opportunities are growing but often tested only in one particular application.	Sharing across platforms will lead to innovative solutions find cross over applications in other areas and their validation.
Technology gaps hinder the utilization of certain materials, inability of new solutions to maintain the current quality or shelf life. Processing tools may need to change. Novel materials require rigorous testing and validation, including safety, analytical methodologies need to be based on EU policies and regulations.	Sharing of resources, STSMs allow fast collection of data to close gaps; Creation of prototypes, testing of model systems. WGs will have means to communicate with policy makers. Gaps identification will instigate the creation of new industries, and create entrepereurship opportunities across Europe.
Consumers have to be included due to their preference, as well as end users of the package, their attitude on re-using, recycling or food waste habits are critical to robust circularity.	Opportunity for pan-European consumer studies and enhanced communication. A YouTube channel will be created to communicate with consumers.
Supply chains are changing. Warehousing, food service, ecommerce, do not have the same needs – wants as the traditional retailer related packaging.	Evaluate use and needs of primary and secondary packaging. Put into question current supply chain practices.
We need to develop robust measures of sustainability which include challenges in circularity, recyclability, packaging related food losses and waste.	Harmonize testing protocols, use model systems, and create consensus on LCA assessment methodologies.

2.2 ADDED VALUE OF NETWORKING IN IMPACT

2.2.1 SECURING THE CRITICAL MASS AND EXPERTISE

At the preparation stage of CIRCUL-A-BILITY, the initial critical mass of expertise has been created to expedite the expansion to a wide, inclusive network that will cover all required expertise of the action. The network of CIRCUL-A-BILITY Action, at submission, had participants from **broad geographical areas inside Europe** with **26 COST member Countries**, **4 Cost international partners**, with 50% of ITCs, as well as 1 **from Near Neighbour Countries and 1 International Organization**, allowing to have a **critical mass with a wide range of experiences** that will be a benefit to accomplish the proposed objectives. Furthermore, the already established partnership has the **potential to continue to be inclusive by involving other players and Countries able to contribute to the specific areas of sustainable packaging**. It possesses great gender diversity (>50% Female) with about 30% being

ECI. The expertise of the 64 proposers (at the submission stage) covers material scientists and engineers interested in waste and circularity of packaging, food quality, chemistry and processing experts, post harvest physiologists, toxicologists, biomaterial developers, equipment manufacturers, end users (food companies), consumer scientists and marketing-business experts. The current proposers have a multidisciplinary expertise and will intend to serve as catalysts for further growth of the consortium, which will include additional industries, government organizations, SMEs, and international organizations.

2.2.2 INVOLVEMENT OF STAKEHOLDERS

Due to the rapid expansion of the field, and the interdisciplinary nature of food packaging, the research community working in this field is very fragmented, with large communication gaps between food scientists and material scientists and with an industry often occupied to react to regulators and consumers demands. CIRCUL-A-BILITY will integrate academic/research community working in Food Packaging, Food Science and Engineering, Materials Science, and Circular Bio-Economy; Food industries; packaging manufacturers; retailers; waste collectors and Policy makers (National authorities for biobased legislation), by engaging with external collaborators wherever and whenever needed. It is considered critical to involve material scientists who belonged to other R&I initiatives across Europe and internationally, but also manufacturers of novel sustainable and intelligent packaging solutions, food processors, food developers, consumer scientists, environmental experts, communicators and policy makers. Only by creating a strong multidisciplinary network which will include scientists from government, academia and industry (start ups, SMEs and larger corporations), it will be possible to understand the difficulties and assess the impact of implanting new sustainable solutions.

A multidisciplinary approach and the wide array of complementary partners from public and private sectors, but with a strong base in science and technology (including social sciences) will ensure the achievement of the project objectives. Wherever necessary, CIRCUL-A-BILITY will also engage with local municipalities located in strategic areas, to create a culture inclusiveness necessary for feedback on harmonization protocols and identify gaps and opportunities towards the implementation of the circular economy stragegies.

Fostering leadership roles for ECIs will be of focus. There is a knowledge gap and we require a new generation of experts, with a holistic approach to circularity and sustainability of food products. The network practices will enhance personal development and transferrable skills by the participation in e-workshops, Training Schools, working group meetings and conferences, and STSMs. A special focus on the communication, networking skills, team work, entrepreneurship, leadership, problem solving entrepreneurship and management skills will be provided along the action for all participants. **Industrial partners** will be actively engaged in training schools, roundtable meetings and in STSMs to foster synergies. The participation of industrial partners will promote the production of new products arised from the collabotarion of the academic partners by the exploitation of patents. Science and Technology will always be leading discussions, to avoid setting of commercial agenda (especially in the material side of packaging and equipment). Intellectual Property Rights management agreements will be signed between the parties generating the results with market potential.The cross-cultural experiments will create societal cohesion amongst EU scientists, will develop common views, and result in harmonized policies.

2.2.3 MUTUAL BENEFITS OF THE INVOLVEMENT OF SECONDARY PROPOSERS FROM NEAR NEIGHBOUR OR INTERNATIONAL PARTNER COUNTRIES OR INTERNATIONAL ORGANISATIONS

The current multiactor network will connect, in a unique manner, the whole food supply chain, with the goal of being as inclusive as possible, as this will result in evaluating various culture based solutions and best practices, and ensure early and wide adoption. Since the inception, international players from Brasil, Canada, South Africa, US have been engaged but it is expected larger participation over the tenure of the COST ACTION. The importance of involving international partners and NNCs lies in the fact that this is a global problem and technical solutions are available across the World. By the involvement of NNCs in the Action CO3 is fulfilled. Furthermore, this will allow for cultural differences amongst consumers to be considered, as well as different best practices. It is indeed critical to adopt global solutions. The network will also engage the participation of industry and consumer groups, regional, national and international such as the EFSA (who has expressed interest, but can not join at the proposal stage), the Food and Beverage Association, IAPRI and ISTA.

3 IMPACT

3.1 IMPACT TO SCIENCE, SOCIETY AND COMPETITIVENESS, AND POTENTIAL FOR INNOVATION/BREAK-THROUGHS

CIRCUL-A-BILITY aims at identifying GAPS in Science, Technology and Innovation, and to develop and foster the implementation of new packaging solutions across the entire system. Breakthroughs in research and innovation are needed in the food systems to create a more sustainable economy in Europe (21).

This will be accomplished by addressing the needs specific to food products within specific supply chain, focusing on consumers and society, aiming at improving the circularity of the solutions. The breakthrough will occur across the entire food product systems, and will reduce the environmental impact of our food supply, not only by reducing the direct environmental impact of the packaging material, but also by optimally using the benefits brought by packaging, e.g. reducing food waste by an increased shelf life, or re-designing logistics. Even though the relation between shelf-life and food waste is not straightforward, a large part of food wastage is related to the short shelf-life of the raw material (i.e. fresh produce), due to the biological origin or food and the changes occurring during storage and handling. CIRCUL-A-BILITY will highlight opportunities for decreasing food waste, with specific focus on the changing supply chains, the consumer behaviors and attitudes and by creating consensus on best practices by studying model food systems.

Plastic materials are still the most widely used in packaging of food and consumer products, due to the light weight, cost, and material properties (mechanical strength, transparency, permeability, heat sealability). In Europe, about 40% of the plastic produced is used for packaging, and about 40% of this plastic is recycled (22). To decrease the impact of packaging on the carbon footprint of food products, the industry has initiated a series of measures, which include removal of excessive packaging and packaging weight reduction.

3.1.1 SCIENTIFIC, TECHNOLOGICAL, AND/OR SOCIOECONOMIC IMPACTS (INCLUDING POTENTIAL INNOVATIONS AND/OR BREAKTHROUGHS)

CIRCUL-A-BILITY will operate at various TRL levels (4-8), in the food packaging sustainability innovation space, in various areas, from the material to the package design, to supply chain whole solutions, with consumer centric approaches. The innovations will be from putting existing solution into practice in other areas, creating synergies (low risk) to further addressing white spots of innovation in the knowledge and technology area (those may be with higher risk potential). To mitigate the risk the network will have to be inclusive, establishing linkages with former COST actions (mentioned above) and various players (non profit and industry) in the sustainable packaging field. The harmonization efforts of the network at the European and international level will create an impact far beyond the action itself. The outputs and objectives of the four technical working groups will relate to the following socioeconomic, scientific, technological and economic impacts:

SCIENCE AND TECHNOLOGY

- Create consensus on methodologies, by interlaboratory screening tests of materials, or studies on post harvest stability, agreement on methodologies (i.e. LCAs)
- Transferring new and existing knowledge into innovative, disruptive and competitive solutions, through mobility programs, STMS and open access data.
- Share state of the art facilities, and perform cutting edge research by expanding collaborations, and identifying gaps, together with industry. Develop strong research proposals for advanced research.

SOCIOECONOMIC:

- Optimize food packaging environmental foot print, reduce food waste and improve circularity of materials. The food specific solutions proposed will improve shelf life, develop and optimize methodologies for example, for the separation of packaging films, or to decrease end user waste.
- Create support for a harmonized approach to EU food waste legislation and improved national implementation.
- Build consensus, and contribute to advances in social and policy issues.
- •Contribute to increased communication with wide stakeholder community by acting as a science and technology knowledge hub on social media.

- •Contribute to the development of new standards.
- •Contribute to achieving the European policy target for reducing food waste by 50% by 2030.
- •Strengthen EU economic position, by creating intellectual properties, start up opportunities, develop of innovative ideas, foster entrepreneurship and new business models.
- •By sharing consensus data, strengthen current industrial realities. For example, the knowledge generated by the network will enable the industry to implement change and mitigate risks linked to new capital investments for technologies

3.2 MEASURES TO MAXIMISE IMPACT

3.2.1 KNOWLEDGE CREATION, TRANSFER OF KNOWLEDGE AND CAREER DEVELOPMENT

Knowledge creation: Compared to earlier COST networks on packaging sustainability (ActInPak, EcoSus PNFP) focused on novel materials and their potential to optimize supply chain, CIRCUL-A-BILITY will bring forward a complete review of state of the art and harmonization based on model systems operating within product categories (hence Food Specific - addressing Food Waste, Shelf Life, Consumer perception) and across distribution chains (far reach markets, long shelf life, perishable foods). The integrated and complementary expertise of the network will generate new research ideas, identify and fill knowledge needs, and develop new partnerships within and across the 4 WGs. By fostering cross Country collaborations, cutting edge research methodologies and infrastructure will be accessed by a wider community.

Knowledge transfer: The presence of industry and governmental organizations will allow to create upscalable plans, validate solutions and avoid shortcomings. The management committee will focus on increasing the non-academic participation in the network over its tenure, as the involvement of participants from all areas of food community including material production sector, food processors, development researchers, retailers and consumer stakeholder groups will be critical to ensure relevant approaches and expedite knowledge translation. Associations of consumers, retailers, industrial SMEs and large companies active in sharing and implementing new green solutions into their market place will be included. It is envisioned a strong involvement of industry from the different sectors, agrofood processors, biobased polymer formulation and processing, retailers. The solutions brought forth by CIRCUL-A-BILITY will offer opportunity for innovation, and boost industry competitive edge with new business models.

Career development: The network will address the deficit of young researchers with sufficient skills in the circularity of food packaging sustainability and engage young talents and will provide them with the opportunity to structure their future career by improving their research skills with a holistic approach paying attention to various aspects of the circular economy, pursuing best practices in their respective fields, and becoming opinion leaders at the international level. Ambition of the Action is to develop four technical schools (based on the 4 working groups), with specific content derived from the activities of the Working groups.

3.2.2 PLAN FOR DISSEMINATION AND/OR EXPLOITATION AND DIALOGUE WITH THE GENERAL PUBLIC OR POLICY

The following CIRCUL-A-BILITY dissemination actions will be implemented as means to involve and invite to the Action more stakeholders:

Communication measures: creation of the CIRCUL-A-BILITY website and network association in which stakeholders will be invited to register. The results generated from the CIRCUL-A-BILITY activities will be communicated and disseminated to maximize impact to the relevant sectors resource. The web site will be regularly updated by the dissemination manager and will be used as a universal communication and dissemination platform. The website will contain information on the background and objectives of the action, as well as link to policy documents and fact sheets, and events, and location expertise of the action members. Twitter and LinkedIn will also be used as means to communication with the general public on fact sheets. A YouTube channel will be created with videos highlighting consumer interests and linking science to public knowledge and perception.

The results generated from the CIRCUL-A-BILITY activities will be communicated and disseminated to maximize impact to the relevant sectors resource; The different stakeholders will be informed with different means, including dissemination activities, training activities, educational materials, dedicated workshops, matchmaking events, presentations at international conferences and symposia, contribution to peer-reviewed scientific papers, publications in more popular scientific and technical journals, social

media. CIRCUL-A-BILITY will also partner with existing conferences in the FOOD Community to disseminate the most important results and insights (for example with a workshop during EFFOST).

Capacity building, training and networking: The CIRCUL-A-BILITY network will provide a coordinating platform for these activities, causing more interconnections between the WGs, industries, and all parties involved. Several events are planned during CIRCUL-A-BILITY (such as, two Conferences, and six Workshops/Training Schools targeting to 60 – 80 participants) will be open to all members and stakeholders, contributing to networking and interconnectivity between individual WGs, but mailnly to training of ECIs. The collaboration results obtained during the CIRCUL-A-BILITY Action will be presented during these events, with emphasis on the STSMs outputs. Young investigators will take leadership positions and be key in the development of the training schools, together with more senior members of the network. This will ensure training and mentoring at all stages and level of the career.

4 IMPLEMENTATION

4.1 COHERENCE AND EFFECTIVENESS OF THE WORK PLAN

CIRCUL-A-BILITY will promote circularity and new packaging solutions by first analysing current practices, determining gaps and opportunities for change and new practices, creating consensus by focusing discussions, reviews and testing on food and supply chain specific model systems. For rapid and effective decision making, a Core Group will be formed, in accordance with the best practices of the COST ACTION community. It will comprise, Chair, Vice Chair, WG leaders and vice leaders, a science and communication manager, STSM and training coordinator. The communication manager will play a critical role in coordination of all communication activities, including web site and social media.

The Action is organized in five WGs that build upon each other to develop a global framework. In addition to the WG dedicated to dissemination, there will be 4 technical WGs, focused on the challenges of the Action, to ensure the highest possible specialization and relevance (i.e. food, process and consumer centeredness), and on the other hand, the highest level of harmonization of methodologies and approaches. The 4 main WGs are specialized in particular food products types, as these types have some unique needs/features thus the WGs are named after those. Beverages have not been included at this stage, as there seems to be a higher level of harmonized practices in this category.

To ensure that focus will be also given to the wide variety of supply chain models, the WGs will be further subdivided in 3 working subgroups (SWG) based on distribution and logistics (see Fig. 4). SWG1: Packaging/Logistic for Frozen Food (sub 0C); SWG2: Packaging/Logistic for Refrigerated Food (above 0C); WG3: Packaging/Logistic for Ambient temperature Food (no control). The adoption of circular practices optimized for shelf life, logistics and supply chains will create opportunities for significant breakthroughs in this Action. It is indeed the case that different problems are at the forefront of the same product category depending on the logistics, transportation, and distribution and of course this also has implications related to shelf life and waste. Most of the time, these subdivisions, within a product, relate to similar applied technologies, processing intensities and relate well to process and food packaging interactions.

4.1.1 DESCRIPTION OF WORKING GROUPS, TASKS AND ACTIVITIES

Within each WGs, the participants will select model systems (ModelX, Figure 4) which will reflect specific problems which need addressing, as well as represent many of the common challenges in that category. The same model system will be evaluated in separate, coordinated studies within the WGs, to ensure multidisciplinarity and multiactors evaluations. For example, a model system of a sausage with a specific composition and process could be used, to evaluate various packaging materials and their interaction, as this will create consensus on shelf life and quality within the complexity of supply chains and processes. Literature reviews identifying all current knowledge on a particular system may also be performed in a similar way, for example, on mixed ready to eat greens, frozen peas or cheddar cheese slices of a particular chemical compositon and ripening stage. It is clear that product specificity is currently causing confusion and fragmentation, and this action will be focused on creating evidence based consensus. This will also initiate breakthroughs in harmonization of testing methodologies or life cycle analyses. The model systems will be selected depending on the members' interests and on impact selection criteria (e.g. economic importance, potential impact, public perception, etc.) to be representative according to one or more criteria, and will be designed depending on the resources

available to the membership. Figure 4 gives examples of the cross disciplinary activies carried out in the various WGs as they will relate to chosen model systems.

The activities of the WGs who will report the main findings to the entire CIRCUL-A-BILITY community, will have enhanced specialization and relevance, but also will force multidisciplinarity by coordinating the research between scientists with different backgrounds (i.e material scientists, environmental scientist, microbiologists, consumer scientists) through STSMs, review and proposal writing.

Figure 4: The distribution of the technical working groups (WG), and working subgroups (SWG), tasks and model systems at the foundation of CIRCUL-A-BILITY.

The WGs will be able to engage regulators and end users, and ensure that everyone will speak the same language. The model systems approach will necessitate assorted expertises and will ensure that the project will really be intersectorial. The 4 WGs will be commodity specific, as the scientific methodologies and problems (i.e. texture, flavour, post harvest, processing, physical chemical changes, enzymatic and microbial) are indeed quite different depending on food type. Each product presents its unique set of challenges, from safety and risk assessment, to post harvest physiology, sensory, with obvious differences in perception and expectations depending on supply chain and processing steps. However the methodologies used to reach the COST action objective and deliverables will be common between the WGs. The short term missions will be critical to the success of the tasks below.

For each of the chosen model systems the following Tasks (T) will apply:

T1. To develop an inventory of state of the art practices, materials used, and share knowledge related to their functionality. To assess international state-of-the-art as a reference to support European business development.

T2. To set up an inventory of market application requirements: Create a matrix of best practices related to major product categories, identify gaps and opportunities for improvement, with particular attention to environmental remediation, renewability, recyclability or compostabiilty of the materials.

T3. To include options for use of biobased or renewable materials, identify gaps in development, and assess potential risks in safety and product loss and waste. This may include the establishment of testing protocols to study the interactions between the packaging and model food products.

T4. To evaluate the potential to use intelligent or active packaging, and state of the art technologies, and evaluate the relevance of their technology readiness levels.

T5. To gather information on end users attitudes, and perform consumer studies across Europe, identify opportunities for better practices.

T6. To identify the different actors in the value chain, create round tables, develop collectively new scenarios, taking into consideration various supply chain models (i.e. B2B, B2C, and e-commerce), determine appropriate test food models and build consensus on potential new solutions.

T7. To develop robust and quantitative measures of sustainability, define boundaries for life cycle analysis, and collect data which include circularity and packaging related food waste.

WG1: Fruits & Vegetables: Example of possible model systems: strawberries spinach, peas, blueberries (frozen, fresh, or shelf stable); ready to use fresh cut salads, citrus or tomatoes (chilling sensitive). Tasks to be delivered within WG1: as described above. Research coordination Objectives applied RO1 to RO5: with focus to determine best circular food packaging solutions that ensure food quality (specific to system), maximize shelf life and decrease waste and improve consumer experience.

Material interactions, validation studies on quality and shelf life. WG1 Actions will be documented through Deliverables D1.1 and D1.2, for details please refer to Table 3 and the Gantt chart.

WG2: Fish & Meat: Example of possible model systems: hamburger meat, tuna fish, bacon, sausage or meat alternatives. Tasks to be delivered within WG2: as described above. Research coordination Objectives applied RO1 to RO5: with focus to determine best circular food packaging solutions that ensure food quality (specific to system), maximize shelf life and decrease waste and consumer experience. Material interactions, validation studies on quality and shelf life, WG2 Actions will be documented through Deliverables D2.1 & D2.2

WG3: Dairy products: Example of possible model systems: yogurt, milk, mozzarella or yellow cheese in various sizes or compositions. Tasks to be delivered within WG3: as described above. Research coordination Objectives applied RO1 to RO5: with focus to determine best circular food packaging solutions that ensure food quality (specific to system), maximize shelf life and decrease waste and consumer experience. Material interactions, validation studies on quality and shelf life. WG3 Actions will be Deliverables D3.1 & D3.2.

WG4: Cereal & Confectionary: Example of possible model systems: cookies (and cookie doughs - frozen), breakfast mixes, snacks, mixed cereal, candies and snacks. Tasks to be delivered within WG4: as described above. Research coordination Objectives applied RO1 to RO5: with focus to determine best circular food packaging solutions that ensure food quality (specific to system), maximize shelf life and decrease waste and consumer experience. Material interactions, validation studies on quality and shelf life. WG4 Actions will be Deliverables D4.1 & D4.2.

WG5: Dissemination, Communication and Stakeholder Engagement: This WG will be devoted to disseminate the scientific activities to ensure visibility of the Action at international level. This will be achieved through open access research articles in peer reviewed journals and 'Commentary-style' articles that report on the activities performed by different WGs. The WG will also be responsible for the establishment and maintenance of a dedicated website, with open and member only content. Stakeholders will be engaged and the final target of deliver the tools and guidelines produced by the Action.

As illustrated in the Chantt Chart, CIRCUL-A-BILITY will organize 4 training shools, 4 Annual Action workshops, 5 MC meetings and 8 WG meeting (either physical or via Skype) 1 conference, and up to 12 STSMs.

4.1.2 DESCRIPTION OF DELIVERABLES AND TIMEFRAME

	Deliverables	**Date**
WG1: Fruits & Vegetables	**D1.1**Reviews or co-authored papers on at least 2 model systems of choice (Based on Tasks 1-7)	**M28**
	D1.2. Summary reports or publications based on STMs activities	**M48**
WG2: Fish & Meat	**D2.1** Reviews or co-authored papers on at least 2 model systems of choice. (Based on Tasks 1-7)	**M28**
	D2.2. Summary reports or publications based on STMs activities	**M48**
WG3: Dairy products	**D3.1**. Reviews or co-authored papers on at least 2 model systems of choice. (Based on Tasks 1-7)	**M28**
	D3.2. Summary reports or publications based on STMs activities	**M48**
WG4: Cereal & Confectionary	**D4.1.** Reviews or co-authored papers on at least 2 model systems of choice. (Based on Tasks 1-7)	**M28**
	D4.2. Summary reports or publications based on STMs activities	**M48**
WG5: Dissemination	**D5.1**. Functional and implemented Website with Action description, protocols, social media accounts; measurable deliverables: • 100 followers in the 1st year and 250 by the end of the project • 20 participations in conferences • 20 videos on Utube channel • 4 technical schools • 1 summer school on packaging innovation	**M3**
	D5.2. Stakholder engagement plan, including representation in EU stakeholder meetings and involvement in EU policy working groups.	**M6**
	D5.3. White paper on best practices on sustainable food packaging material and general reccomendations from WGs	**M32**
	D5.4. Final report with a compilation of scientific and technological results and impact indicators (I1-I6).	**M48**

4.1.3 RISK ANALYSIS AND CONTINGENCY PLANS

Risk management will be a continuous process led by the Chair, the MC and the Core Group, and risks will be systematically identified at each workshop and mitigation measures will be initiated. In case of a dispute the Chair shall be immediately informed and will assess the potential effect of the dispute on the entire Action, and following consultation with the SC, will decide on the appropriate approach for resolving the dispute. The Chair will then assign the issue to a participant or a group of partners who will then actively work on a resolution. The status of the resolution will be tracked by the Chair. After resolving an issue, the process will be documented and shared among the Action members. In case of major problems or delays the Chair will immediately communicate with the members to ensure that corrective actions are agreed upon and implemented at an early stage.

Description of risk and its probability	**Risk mitigation and contingency plan**
WG leaders do not achieve their deliverables (medium)	Ensure a broad distribution of actors in WGs with at least 2 co-chairs per WG. Engagement of MC in the WG workshops and follow up.
Overlap and duplication of research effort (low)	Ensure high degree of communication and create inclusive network,
Number of participants from industry is low (medium)	Special attention given to involvement of industrial and SMEs and set up of a communication plan
Knowledge transfer between WG insufficient (low)	The chair of the management committee will act to improve communication between groups. Use a STSMs for fostering collaboration and communication.
Members or industry fail to provide access to resources (low)	Current proposal has already sufficient membership interested in the collaboration to create critical mass in the project, and MC will continue to communicate benefits of the collaboration to the stakeholders and potential new participants.
Budget constraints (medium)	The scope of the work will be adapted according to the budget. The risk of insufficient funding will be mitigated by complementing the activities using existing local, National and European sources, and this will ensure that the STMs will have sufficient operating funds.
Diversity and gender balance not achieved (medium)	Special actions will be taken to foster equal participation in the activities.

4.1.4 GANTT DIAGRAM

CIRCUL-A-BILITY	2021				2022				2023				2024			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WG1 Fruits and Vegetables																
Milestones: M1: inventory M2: Model systems chosen M3: training school material developed based on consensus work				M1.1	M1.2					M1.3						
D1.1 reviews or co-authored papers by WG									D1.1							
D1.2 Short term mission reports or papers								D1.2							D1.2	
WG2 Meat and Fish																
Milestones: M1: inventory M2: Model systems chosen M3: training school material developed based on consensus work				M2.1	M2.2					M2.3						
D2.1 reviews or co-authored papers by WG									D2.1							
D2.2 Short term mission reports or papers								D2.2							D2.2	
WG3 Dairy																
Milestones: M1: inventory M2: Model systems chosen M3: training school material developed based on consensus work				M3.1	M3.2					M3.3						
D3.1 reviews or co-authored papers by WG									D3.1							
D3.2 Short term mission reports or papers								D3.2							D3.2	
WG4 Cereal and Confectionary																
Milestones: M1: inventory M2: Model systems chosen M3: training school material developed based on consensus work				M4.1	M4.2					M4.3						
D4.1 reviews or co-authored papers by WG									D4.1							
D4.2 Short term mission reports or papers								D4.2							D4.2	
ACTIVITIES																
MC meeting	x			x		x				x				x		
WG meeting	x		x		x		x		x		x		x		x	
Annual Action workshop			x				x				x					
Closing conference															x	
Final report																x
Web site updating	x		x		x		x		x		x		x		x	
Training schools										x		x		x		x

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