



POSITION PAPER FROM THE COST ACTION FP1003 BIOMATPACK

Impact of Renewable Materials in Packaging for Sustainability – Development of renewable fibre and bio-based materials for new packaging solutions

RENEWABLE PACKAGING INNOVATION NEEDS FURTHER SUPPORT

Forest based packaging counts for around 35-40% of the global packaging market and 40% of the paper and board production is used in the packaging market. Hence, the packaging market is of enormous importance for the forest based sector.

To give the forest industry a competitive edge this Action has focused on packaging solutions based entirely on renewable resources in order to remove the serious disadvantages associated with future paper and board packaging solutions that continue to rely on non-renewable materials. The Action has explored possibilities that the forest itself could offer as a raw material base for different components within a given package, thus exploring the full potential of the fibres.

The main objective of the Action has been to enhance the knowledge concerning packaging from the forest sector and thus identify potential new renewable packaging solutions. Since a sustainability approach is the scope of this COST Action, aspects related to technical, environmental, economic and societal outcomes has been addressed taking the whole packaging value chain into account.

The Action has included partners from 19 European COST countries, New Zealand and CEPI.

COST is an intergovernmental organisation supporting the collaboration of nationally funded science and technology research through the creation of networks. Also known as Actions, these networks allow scientists to grow their ideas by sharing them with their peers and thereby give impetus to their research, career and innovation.



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INTRODUCTION

This position paper is the researchers' perspective regarding the recognition of renewable packaging as a cornerstone and a very obvious symbol for the bio economy. Packaging is a top ten global industry, it is involved in our everyday life, it could improve the daily life of millions of people and it could prevent food waste. One of the many ways that it can decrease climate stresses and carbon dioxide emissions is its ability to make our supply chains more efficient and sustainable.

The EU is consistently driving for a change towards a bio based economy and here packaging, being a large global business, effecting sustainability in resource and energy use, supply chain, consumption and food losses, has an important role to play. There are a number of broad drivers in the packaging sector that are shaping innovations in product and process development. These drivers include decreasing material and energy usage, reducing packaging weight, delivering increased food safety and quality (through improved performance, additional functionality), and enhancing recyclability or biodegradability. The use of renewable materials in packaging is a very appealing solution towards such objectives. But if we want to take the next step and make our packaging systems truly sustainable by building on a renewable materials platform, more research, enhanced implementation and increased innovation within the industrial sector is essential. Collaborative ventures between research and industry are crucial.

Behind this appeal stands the European Research Area in fibre and bio based packaging manifested through the COST Action FP1003 – BioMatPack with its focus on renewable lignocellulose packaging. Researchers from 19 European countries and overseas including many universities and institutes focus the spotlight on the knowledge base and innovations needed to effectively combine the bio economy and packaging, a journey where support and funding from the European Community are essential.

WHY IS THIS IMPORTANT?

Forest based packaging, paper and paper board, amounts to about 35-40% of the total packaging market but often paper packaging needs to be enhanced with fossil based materials for barrier reasons. Over the last decades consumption of bio-based packaging in the form of paper and wood has been stable or grown. Glass and metals has lost part of the market. The big increase in packaging consumption has been in plastic packaging. Almost all this plastic packaging is produced from oil. The market share of bio plastics, apart from paper, are extremely small, representing around 1 percent of the total plastics market today and there is no sharp growth in sight. *A more obvious way to increase more rapidly the share of renewable packaging available on the market would be to build solutions based on existing forest fibre materials. Enhance their range of properties and provide support by using other bio based materials for specific purposes.*

World population is projected to grow from 6.1 billion in 2000 to 8.9 billion in 2050 ¹. Food packaging value is forecast to reach \$248.5 billion in 2020. Western Europe is the largest consumer of food packaging,

¹ *World Population to 2300, United Nations*



followed by North America and Asia.² Growing population combines with increasing demand for food packaging as well as other type of packaging. Food packaging accounts for more than half of the total packaging waste. Packaging consumption in the developed countries is stable or even declining. Food losses are high amongst consumers and partly in retail. In developing countries losses are exacerbated due to inadequate packaging. The global increase in packaging consumption arises mainly in emerging countries due to changes in wealth and life-style and will lead to a reduction in extreme food losses. As food production has the largest impact on the environment (70-90% of the total environmental impact) this increased use of packaging is positive. However carbon foot print of packaging materials has also to be decreased in order to develop really sustainable solutions.

A demand for novel bio based packaging solutions development is linked with the drive towards sustainability. The need for a conversion is very well in-line with EU policies towards a resource efficient economy and a bio economy where the following areas cover the most important issues.

Climate change

The plant sources used for the production of forest and bio based materials are renewable. The production of forest and bio based materials is more environmentally friendly due to a lower CO₂ production which contributes to a lower global warming effect than the traditional, oil-derived plastics. Novel fibre and bio-based materials and the associated technological improvements are combining to achieve better sustainability. The Sustainability Packaging Coalition (SPC) links the following attributes to sustainable packaging²:

- Beneficial, safe and healthy for individuals and communities throughout its life cycle
- Meets market criteria for performance and cost
- Sourced, manufactured, transported and recycled using renewable energy
- Maximises the use of renewable or recycled source materials
- Manufactured using clean production technologies and best practices
- Made from healthy material
- Physically designed to optimise materials and energy
- Effectively recovered and used in biological or industrial cradle-to-cradle cycles.

Moreover, the important role of packaging in optimizing distribution and reducing losses will significantly contribute to a more sustainable solution. Forest fibre based packaging is also an environmentally neutral solution. Carbon dioxide is absorbed in the forests through photosynthesis and converted into sugars; the storage materials from which cellulose and lignin are built.

Competitiveness of European industry

² *The Future of Packaging Long-term Scenarios to 2020, PIRA 2009*

Fibre based industry plays a key role in the future emission reduction scenarios arising out of European Commission modelling. Furthermore, the latest innovations in the fibre-based sector, clearly identifies it as the industry of the future, even though it has been around for hundreds of years. The CEPI roadmap 2050 has clearly shown that the key to a sustainable economy is a more efficient use of natural fibres and their use in the production of more value-added products

It is estimated that 2/3 of the fibre and bio plastics market will be associated with the food and packaging industry and improved technical properties and innovations are necessary to ensure the competitiveness of the European industry. Paper and plastics are the most used packaging materials worldwide, and of these two, paper packaging is perceived as the most sustainable by the consumers, who are becoming more and more aware of environmental issues caused by non-biodegradable plastics. The vast areas of plastic wastes floating on our oceans are becoming increasingly obvious to the public and the extent of the problem grows ever more evident. However, paper packaging alone cannot fulfil all the demands for packaging, a pertinent example are the poorer barrier properties compared to plastics. Therefore paper must be combined with coatings and laminates derived from oil. Obviously, these combinations are less sustainable, and result in less sustainable solutions which contrast with customers and consumers who recognise the importance of the sustainability of packaging materials.

Combining fibre based materials with biomaterials and thus creating completely bio-based fibre based packaging materials is essential if the industry is to sustain its future and grow more competitive.

Companies currently focus on sustainable packaging solutions for several reasons:

Many consumer groups see packaging as negative and seek more sustainable packaging solutions. Companies realize that oil is a limited resource and anticipate supply-problems and increased prices in the future. Other companies select bio-based packaging in order to stand out from competitors. Lots of companies are creating CSR statements and strive to show how sustainable their company is. Using bio-based, renewable raw material for their products reveals their thinking about the future. In addition the industry can have an environmental benefit, not only benefit in packaging manufacture but also in its disposal. The cost for new bio-based materials and processing is higher than the current alternatives, but in the near future this could cause a significant reduction in the price of raw materials arising out of increased production volumes as well as avoiding the price volatility that has characterised the politically charged petroleum markets. Bio-based packaging research could help industry in finding ways to use renewable/recyclable resources, and also help the industry to make defensible claims of operational efficiencies e.g. in term of carbon foot print, material consumption, recyclability, sustainability, etc. As biodegradability and compostability become increasingly important factors around packaging materials, the industry will benefit from bio-based alternatives. There are several factors that will contribute to the commercial attractiveness of bio based packaging alternatives and help the industry make the choice:³

- Lower greenhouse gas emissions

³ *Forecasts of Disruptive Technologies in Consumer Packaging to 2019, PIRA 2009*



- Conservation of non-renewable resources
- Physical recycling of plastics soiled by food and other biological substances is often impractical and undesirable, so reuse and recycling become problematical;
- Reduction in landfill requirement;
- Increased production of renewable resources;
- Sustained employment in the agricultural sector;
- Improved brand profiles for the manufacturers and retailers of consumer goods ;
- Potential for increased differentiation and added value among the manufacturers and retailers of consumer goods.

Opening up a market for bio based renewable fibre and bio based packaging brings opportunities for the European industry in the fibre and biopolymer areas.

Europe trade imbalance

Europe has a negative balance in import of resources which needs to be changed: Europe is one of the most important markets for oil-derived plastics but this needs to change and Europe needs to build its packaging resources from indigenous forests and increasingly support bio-based materials.

Scarcity of non-renewable materials

Plastics for packaging are manufactured from products of the fossil fuel processing. Fossil fuels are limited, non-renewable and will not be available in the future. Bio-based materials for packaging are materials produced from biomass sources, to a large extent forest based. Biomass sources are renewable and are generally perceived as more environmental friendly than the current sources for plastic production and offer a possible solution for the future. Bio-based polymer materials will likely play an increasingly important role in society as it moves towards a sustainable and environmentally responsible materials base.⁴

Consumer needs, wishes and behaviour

Concern regarding environmental impact is also growing amongst consumers. There is mounting public pressure on brand owners and retailers to reduce the environmental impact of packaging. Increasing oil prices, tightened legislation on the treatment of packaging waste (disposal, incineration, compostability and recyclability), extended retailer and producer responsibility and the need to reduce the discharge of greenhouse gases are some important issues. Bio-based and renewable materials are potential solutions to these challenges.

Consumer's associate positive outcomes with bio based packaging but it does not always affect the consumer's behaviour: Consumers are becoming increasingly interested in sustainable products, and many would purchase a product that has an environmental benefit. Unfortunately, however, the public at large is

⁴ *Forecasts of Disruptive Technologies in Consumer Packaging to 2019, PIRA 2009*

confused by the various bio based-related terms and definitions. Higher prices for sustainable products are also a barrier.

The arguments above strongly support a change to bio based packaging and to ensure a secure and sustainable supply. There is a great bio based resource in our forests and this will create a platform for packaging material supply that does not compete with resources for food.

RESEARCH GAPS NEED TO BE BRIDGED TO GRASP THE ADVANTAGES

There are (at least in short to medium term) no technological (functional) or cost based impetus to change to bio based packaging alternatives. Innovation actions are needed to bridge the gap to industrial implementation and new business models are needed to support the change. The bio based solutions must deliver against some very high demands from both industry and consumers to really make an impact on the market. Fibre based packaging solutions must expand their property range to access new market areas. Thus, there are some really important tasks for the packaging research community, together with the industry, to solve in order to overcome the barriers to introduction of existing and innovative bio based solutions.

Some recent studies have cast doubt on the perceived environmental incentives and worries related to competitions with resources for food production. Confusion among the general public over the real environmental impact of new bio based packaging applications creates obstacles for the further development of these alternative packages. *The advantages of fibre and bio based packaging alternatives and their functional shortcomings must be more clearly defined in order to convince industry to adopt these new solutions.*

Packaging technologies (including bio-based technologies) in general have evolved considerably over the past few decades and will continue to develop. *However, the introduction of new technologies does not remove the need to understand the complex interactions between product and packaging materials (e.g. permeation, sorption, migration) as well as the effect of (and on) the surrounding environment. As a consequence, the current lack of the knowledge in this area often results in showstoppers and prevents commercialization of the technology.*

In the development of new functionality for paperboard, the use of bio-based polymers is an important aspect, particularly for achieving the required barrier properties. However, further research is needed to reach the minimum requirements established for all types of functional properties as well the need for material availability, processability, suitability for food contact, etc. However, the cost versus performance issues need to be addressed especially when attempting to replace the plastic film or aluminium, essential in



demanding packaging applications, with environmentally acceptable, bio-based polymers or dispersion polymers.⁵

The priority for the forest industry has to be to replace synthetic or non-renewable components in their packaging solutions with new bio-based alternatives in order to maintain and enhance its position must be to improve its own materials and combine them with other renewable components. A key challenge for the forest industry is to prove the complete degradability of the packaging alternative and to use and promote bio-based components in their packaging solutions.

Some gaps that need to be overcome to give the fibre based packaging a really new position on the market:

- Achieve similar or better strength properties in paper and paper board with less material and less resource-intensive processing
- Use of micro fibrillated cellulose to improve strength and barrier performance.
- Achieve more stretchable paper or the ability to form paper board more freely to create new packaging solutions
- Create new plastic like shapes, e.g. bottles
- Increase the property range of the paper packaging by incorporating water soluble polymers during the production of the paper or paperboard for packaging applications.
- Develop of bio plastics from the fibres themselves.
- Develop transparent packaging as it is important in sale and marketing.
- Implement more intelligent and active capability at the fibre level.

Besides development of the paper itself it is probable that barrier solutions will be found in other renewable resources. Most products need high barriers to gasses, aromas and vapour. Most bio-materials are generally permeable to one or more of such compounds, but researchers are currently developing sustainable solutions with usable performance. However in many cases we are still far from industrial applications. It is therefore of high importance to continue the research in the field to further improve bio materials, to make them more competitive and appealing for real applications in the packaging industry.

Many of the difficulties lie, besides price, in applying the new material solutions in large scale production and forming-filling-sealing in packaging operations.

The bio-based materials on the market today are often more expensive and with higher production costs than normal oil based plastic packaging. For this reason we need research to develop even more inexpensive bio-based packaging for applications on a large scale. There are a lot of novel bio-based technologies available, but most of them still need to be demonstrated on a large scale or they are either too expensive or unknown to industry.

⁵ *New Ways to Enhance the Functionality of Paperboard by Surface Treatment – a Review: Caisa Andersson, Packag. Technol. Sci. (2008). DOI: 10.1002/pts.823*

An important obstacle to the introduction of new bio-based packaging materials relates to the existing packaging lines, which represent extreme investments for the companies making them extremely cautious about introducing new materials if the new material does not work on the existing packaging line. Further research is needed to overcome this bottleneck to the industrial implementation of bio-based materials. How do we manage to take the new solutions through the FFS (form-fill-seal) chain? In most cases, the same FFS chain can be used with some modifications of the processing parameters; for example, the different processing temperatures and time scales need to be optimized for the new products and applications. However, this is not a real barrier to the introduction of the bio based packaging applications.

Consumer safety is another crucial issue and legislation defines a number of rules for packaging materials in contact with food which new materials must also comply with. Packaging for food contact must have a known and safe past in order to prevent toxic and unhygienic transfer from packaging to food. This forces food packer to use virgin packaging materials because of the uncertainties associated with recycled materials. Bio-based virgin materials may also lack a certified safe history and thus cannot be approved for food contact. Hence, it is important to invest in more research in order to develop packaging systems in which these risks are controlled.

Finally, how do we recycle the new alternatives and reuse the material safely? Biodegradability and compostability of candidate packaging materials are becoming important criteria for many manufacturers and users. However some of most common bio plastics cannot be recycled in normal recycling plants and this limits their acceptance as substitutes to other completely recyclable materials. New research in the field of LCAs are needed in order to understand real impact of renewable materials, identify and remove possible criticalities and clearly show their superior environmental performance with respect to oil based solutions. Also new end of life studies are needed and new technologies need to be developed in order to ensure recyclability and minimize the global impact of bio-based packaging solutions.

FURTHER NEED OF RESEARCH AND INNOVATION INVESTMENT

To take the existing paper and paper board packaging to a higher competitive level and pave the way to a truly bio based packaging market there is a growing need for investment in the new bio based packaging solutions that can make a difference.

The large investments in European research in Horizon 2020 and in the Bio based JTI are very important and overall change to a bio-economy is present to a large extent. From a forest industry point of view the investments are very much directed towards completely new uses of forest raw materials.

To convince a global market as large as packaging to move into the use of bio-materials there is a need to foster an even more developed European Research and Innovation Area. It is important to invest in a strong research, development and innovation programme for use of fibre and bio-based materials in this sector.

This is even more important to reach towards truly long term sustainability.



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