ENABLING

Enhance New Approaches in Biobased Local Innovation Networks for Growth

Deliverable

D3.9 40 best practices sheets in the EIP-AGRI format

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DISCLAIMER

The sole responsibility for the content of this publication lies with the ENABLING project and in no way reflects the views of the European Union.

Acronyms

BBI Biobased Industry
BBP Biobased Products
PA Practice abstract
WP Work Package
PF Preliminary Feedback

List of figures and tables

EXECUTIVE SUMMARY / ABSTRACT

The biobased industry (BBI) is moving faster than ever, proposing innovative and sustainable business models able to trigger economic, social and environmental benefits.
Rural areas retain a considerable growth potential based on the high availability of residues from agricultural practices which result in excellent input for the biobased processes.
Research and technology improvements are contributing to enhance understanding of biomass characterization and its application in the biobased industry, while creating new market opportunities for these residues.
However, this potential is held back by the lack of knowledge and systemic frameworks that prevent agricultural businesses and the biobased industry from interacting and promoting new collaboration schemes.

ENABLING will contribute to close the gap of knowledge between Research and practitioners, collecting existing best practices of Biobased products (BBP) value chains and make them accessible to stakeholders.
One of the proposed measures is to identify and share successful examples of how sidestreams from agricultural processes are finding new and profitable routes.
The deliverable will start with a short introduction about the mission of the ENABLING project and the aim behind the collection and communication of best practices for biomass valorisation.

Section 1.4 and 1.5 will provide information on the progress and results achieved in the implementation of Task 3.4 "Production of Best Practices Sheets", including organisation and coordination of the activities by the task leaders.
The Document will conclude with a table listing the practices collected in the second year of the ENABLING project, with information of the biomass and Biobased product identified for each business model.

SCOPE

The deliverable D3.9 "40 *best practices sheets in the EIP-AGRI format*", is aimed to present the results achieved in the collection of the practices for the second year of the ENABLING project.
While being a relevant outcome for the upcoming project activities, the Document aims to be a useful and inspirational source of information for practitioners and potential stakeholders of the bioeconomy sector.

1. Deliverable Description

The Deliverable 3.9 describes the activities implemented by the ENABLING partners in the identification, and collection of more than 40 business models in relation to task 3.4 "Best practices sheets in the EIP-AGRI format".
The Document illustrates the actions undertaken by task leaders to coordinate and guide the collection of the several cases identified by project partners. It also provides a list of the practices in the form of Best practices sheets that are ready for publication on the ENABLING and EIP-AGRI website.
The list of best practices is also available in Table 1, which outlines the main types of biomass identified in the business models, and the final biobased products or materials – columns "**Biomass source**" and "**Biobased product**", respectively. This would help the reader to have a quick overview of the main sources of biomass and the type of industry or process requiring them.
The Report will conclude summing up some of the main biomass sources or biotechnology processes identified by the project, main actors involved in the value chain, and benefits emerging for the main practitioners.

1.1 Project overview

The ENABLING initiative is based on the consortium's vision that the biomass to BBPs value chains can enhance economic growth while contributing to a sound management of local and natural resources.
Recent experiences across Europe provide good examples of how biomass for BBPs could represent a viable alternative or a differentiation to most traditional processes, which are typical of bioenergy supply chains.
Research results and technology improvements are contributing to enhance understanding of biomass characterization and its application in the processing and manufacturing industry. In some cases, residues from agricultural, forestry and fishery activities require sophisticated treatments to be converted into value added products. In others, a simple procedure or treatment allows them to be (re)used in the same production process or be addressed towards new markets.
Both approaches aim to create marketable conditions for those residues that would be otherwise discarded, preventing practitioners to make value out of them, while contributing to a negative environmental impact.
New market opportunities are achievable through multidisciplinary structures to enable knowledge exchange and creation of synergies amongst different actors in the value chain.
In this framework, the regional dimension plays a crucial role for innovation uptake, "*it is at this level that networks and clusters of SMEs, industries and research institutions are able to develop and trigger knowledge spill-over.*"[1]
Yet, this dimension struggles to elaborate systemic frameworks where key actors such as agricultural businesses and the Biobased industry could interact and promote new schemes. The lack of optimized value chains tends to penalize small rural businesses, repressing the commercial and social potential on both sides.

While new and excellent practices are emerging across Europe, their impact on the economic sustainability and opportunities for replication are limited by their small and local configurations. Such arrangements restrain circulation of ideas, with less chances to promote knowledge and networks for the deployment of innovative practices.
It is in this context that ENABLING will act to bridge the gap of knowledge between research and practitioners, scouting and spreading best practices to communicate how sidestreams of agricultural processes are finding new and profitable routes.

[1] Matteo de Besi and Kes McCormick, Towards a Bioeconomy in Europe: National, Regional and Industrial Strategies, Lund University, 2015.

1.2 Best practices to enhance knowledge

The ENABLING project responds to the "Thematic Networks" scheme, which asks partners to take actions against the lack of knowledge and structures affecting a specific agricultural sector in Europe.
ENABLING adopts an identifying-and-sharing approach to collect and divulgate numerous best practices, with the aim of sharing innovative business cases and main factors of success.
The practices identified in the ENABLING project will promote successful business models regarding the valorisation of biomass streams as input for biobased processes.
This activity will contribute to raise awareness on new market opportunities for residues of agricultural activities, providing information on the type of biomass sources and their final industrial/market application.
A specific focus will be given to (but not limited to) rural areas. The high availability of biomass from agricultural operations makes them as a natural target for the identification and communication of gainful value chains.
At this level, the ground to establish successful business models appears still fertile, with opportunities to trigger economic, social and environmental benefits for the whole territory.

The best practices are not only an awareness-raising activity but also an inspirational input for the deployment of structured networks to encourage entrepreneurial endeavours.
All the Practices will be made available in the ENABLING and EIP-AGRI websites as well as shared by project partners during workshops, webinars and coaching services.

1.3 Identification of Best practices – II year

ENABLING's WP3 aims at running a comprehensive identification of best practices across Europe through the criteria established in the proposal. This would result in the collection of high-impact sustainable cases of biomass residues inputs for the BBPs industry. The overall objective is to generate easily replicable models in many different contexts, well beyond the current operational horizon of ENABLING.

During the first six months of the project, the WP3 focused on producing the executive handbook on the identification of best practices (D3.1). 16 partners from different countries and regions undertook a challenging process. They brought up several ideas and opinions and followed the most appropriate methodology, as it had been outlined in the project proposal, to deliver, after 6 months, a handbook that won the support of all the project partners. The handbook was finalized in M7.

A detailed description about the handbook development phase and the adaptation of the practices to the EIP-AGRI format, is available in the Deliverable 3.8 published on the ENABLING website.

1.4 Collection of best practices – II year

The second year of best practices collection has been built on the basis of the successful methodology developed during the first year of project implementation.
Yet, additional adjustments and supporting activities have been integrated to make the process more efficient in terms of time and organisation.
To this end, in M14, partner EUKNOW (Task leader 3.4) and partner ZLTO (WP3 leader) have met to evaluate the methodology already in place, and plan potential adjustments.
As a result of the meeting, the two Partners agreed on adding the Preliminary Feedback measure (PF) in the collection of future practices.
The PF supports partners in two ways:

- Partners receive a confirmation that the practice they have identified is admissible for the Project
- Partners receive support and guidelines on the type of information they should focus on for each practice.

The solution has been welcomed and widely used by the consortium, which managed to work in a well-established framework of collaboration and supporting guidelines.
The consortium has successfully identified numerous and excellent cases of circular business models from different European countries. Yet, several examples from other regions of the world have been also included as long as they could show the potential of being replicated or inspire new business models in European regions.
The integration of the PF procedure enhanced the communication flow between task leaders and the rest of the partners in charge of collecting the practices.

All best practices collected during the second year have been reviewed by partners EUKNOW and ZLTO, summarized into Practice Abstracts, and transferred into the EIP-AGRI format by partner EUKNOW.
Each practice, was then sent to the original partner for a final review and translation into the native language of the organisation.

1.5 Results of the best practices – II year

In the second year of project implementation, ENABLING has successfully identified 43 best practices of circular business models, which generated a total of 69 best Practice Abstracts (PAs) in the EIP-AGRI format.
The majority of the business cases have been gathered from partner countries. Yet, numerous and interesting examples have been found in other regions of the world, as a confirmation of the consortium's commitment to cover a wider geographical area, and share innovative solutions for Europe.
The business models have been collected from 17 different countries: Italy, Belgium, Norway, Ireland, Austria, Bulgaria, The UK, The Netherlands, Switzerland, The Czech Republic, France, Germany, Finland, Israel, Croatia, Romania, Spain.
The practices propose a wide range of biomass sources from farming and fishing practices[2], and their application in biotechnology processes.
This can be read as a positive result as it contributes to address a wide range of stakeholders, such as farmers or fishermen producing same or similar agricultural residues as those identified by the project.

Practices show how biomass originates, either as a direct consequence/outcome of an initial process, or as side-streams of an industrial process or treatment (by-products).
Residues such as straw, leaves, rotten fruit and vegetable, and other small detritus fall within the first category as a side effect of harvesting and farm management operations.
Others, such as whey, spent peat, wood sawdust, or animal feathers are the result of a first or secondary industrial process.
The new practices confirm that a single type of biomass can be used for the production of different biobased products following either a cascade or individual biotechnology process.
For instance, one of the best practices of the ENABLING project describes the valued added products derived from residues of wine production. The pomace, the main biomass obtained after pressing the grapes, contains grape seeds with many valuable substances. The grape oil obtained from drying, cleaning and crushing the seeds is compressed cold under high pressure. This procedure generates by-products in the form of oilcakes, which can be used as cattle feed, but can also serve as a source for high quality gluten-free flour. No additional additives and preservatives are used in order to preserve valuable polyphenols, vitamins, lecithin and other bioactive substances. The third by-product of wine production is pellets. These are made from partially grape marsh waste after the separation of the grape seeds, and partly from the vine cut in the maintenance of the vineyard.

[2] See Figure 1. *List of practice Abstracts*

A similar approach is followed in the process of refining silage and animal manure. The process mixes the two sources of biomass for biogas production through anaerobic digestion. The by-product of the digestate (solid fraction of fermentation) is composted and offered as a biobased fertiliser.

Innovative biotechnologies are unleashing huge potential to produce a wide range of products from the same source of biomass. Wool, for instance, is one of nature's most amazing 'smart fibres', with a complex structure and natural properties that cope with extremes of cold and heat. The practices identified by the ENABLING project provide examples of how its unique characteristics are suitable to produce high value products such as biobased materials for the building sector, packaging, absorbents, or soil conditioner.

Algae and marine biomass are proposing interesting business opportunities for communities living in coastal areas. An Irish company, is proposing a new approach to process Ireland's seaweed (Ascophyllum nodosum) for domestic and export uses. The company is known for its finest value-added seaweed products to boost the quality of animal feed, crop nutritional products and soil conditioners. Algae are also being tested in the production of natural vaccine in fish farming. While in Greece, a start-up invested in the idea of commercialising dead seaweed from Posidonia Oceanica for the production of furniture, accessories and packaging.

ENABLING is also contributing to shed a light on the valorisation of biomass streams from rare or less conventional cultures such as Rattan, Saffron and several aromatic herbs. Extracts and properties of these plants propose excellent ingredients and products to be applied and sold in niche or high specialised markets such as pharmaceutical, cosmetics and Orthopaedics.

Although it is not always easy to quantify the financial benefit for farmers or biomass suppliers, it is possible to say that there is an economic advantage when the biomass is addressed toward added value processes.
This depends much on the type of collaboration in the value chain and the economic relationship between the biomass suppliers and the industry. In some case, the benefit is a direct financial compensation for the amount of biomass sold to the processing industry; in others, the economic benefit is given by the possibility for the biomass supplier to find a company interested in using those residues. In that event, is the processing company that will take care of collecting the biomass from the farm, unburdening the farmer from bearing the costs of getting rid of the biomass.
Excellent examples are represented by those practices that are implementing a circular business model "From Farmer to Farmer". Numerous types of biomass are used to produce items or ingredients that are required in the same agricultural sector, sometimes in the same farm originating those residues.
For instance, practice number 36 provides an example of how a fruit grower and a gardener use the residues of their farming and gardening activities to produce Bokashi, an organic material suitable for different soil applications and applicable in their daily operations.

The economic potential of circular business models is not limited to the suppliers (farmers) and buyers (biobased industry) only. Other actors, along the value chain, can benefit of these schemes, providing different skills and services to support and empower the whole business model. Research centres, logistics, technology advisors and retailers are all critical experts that play a decisive role in the value chain, highlighting how bioeconomy can trigger economic benefits in numerous and different sectors.

1.6 Conclusions

In the second year of project implementation ENABLING has identified more than 40 successful business models of biomass application to BBPs production, as foreseen and planned at the outset of the project.
The process behind the collection of the best practices has been refined with the integration of the Preliminary Feedback (PF), a measure aimed to support partners in the identification of a new practice and relevant infor-

mation related to it. This led to a better input provided for each practice, while speeding up the process in the collection of the material.
The Technology Readiness level (TRL) of the practices ranges between 7 and 9, proposing business models which processes and products are commercially viable and offer good potentials for scalability.
Task 3.4 of the project is also contributing to enhance knowledge of biotechnology processes requiring types of biomass that are less known in the market such as Rattan, Saffron and spent peat. On the other hand, numerous business models are confirming the market opportunities of more conventional sidestreams from hemp, livestock, and crops farming.
The cases identified by the project represent a useful source of information to communicate how several business models are contributing to create added value products from biomass streams of agriculture and marine origin. In addition, they are emphasising how the collaboration between different actors such as Research, extension services, biotechnology experts and farmer associations is a crucial strategy when developing a new product and setting up the value chain for commercialization.
The practices will be made available and accessible on the ENABLING and EIP-AGRI websites as well as used for the upcoming project activities such as workshops, webinars and coaching services.

1.7 List of Practice Abstracts

The following table provides an overview of the Practices collected during the second year of the project.
Starting from the column on your left, the table gives information about the code of the practice (n. Practice Abstract), the name of the practice (Name of the practice), the type of biomass source produced or used in the business model (Biomass source), and the final biobased product, ingredient or material produced by the biotechnology or the process (Biobased Product/material).
A summary of each practice is available in section 1.8 of this document (Best Practices Sheets in the EIP-AGRI format). While a more detailed description about each business model will be available on the best practice ATLAS in the ENABLING website.

Note: in this Deliverable, Practice Abstracts start from PA28. Practices from 1 to 27 can be found on the Deliverable 3.8, available on the ENABLING website.

Table 1: List of Practice Abstracts

n. Pratice Abstract	Name of the practice	Biomass Source	Biobased Product / material
PA28	From marine biomass to agriculture nutrients I The business model	Pig manure and sewage	Bio stimulants, Biopesticides, Biofertilizers
PA29	From marine biomass to agriculture nutrients I The process	Pig manure and sewage	Bio stimulants, Biopesticides, Biofertilizers
PA30	Bio-textile from Pineapple	Pineapple residues	Non-woven fabric
PA31	Orthopaedic Biomaterials	Rattan	Orthopedic solutions
PA32	Handbags from apples	Apple farming residues	Fashion Bags

PA33	Edizero I The business model	wool, cork, hemp, straw, rennet	Building materials
PA34	Edizero II The business model	wool, cork, hemp, straw, rennet	Building materials
PA35	Biobased vegetable oils for industrial application	Microorganisms	Biobased vegetable oils
PA36	Bokashi I The collaboration	Residues of fruit farming and gardening	Biobased organic material
PA37	Bokashi II The process	Residues of fruit farming and gardening	Biobased organic material
PA38	Bokashi III– The application and benefits	Residues of fruit farming and gardening	Biobased organic material
PA39	Hemp in a Box I The background story	Hemp	Biobased building materials
PA40	Hemp in a Box II The business model	Hemp	Biobased building materials
PA41	Hemp in a Box III The crop	Hemp	Biobased building materials
PA42	Hemp in a Box IV The actors involved	Hemp	Biobased building materials
PA43	Reuse of spent growing media 1 - The business development	Spent peat and perlite substrate	Biobased growing media
PA44	Reuse of spent growing media 2 The process	Spent peat and perlite substrate	Biobased growing media
PA45	FuturePack	Wood and straw residues	Bioplastic packaging
PA46	Bioska	Wood cellulose and lignin	Bioplastic products
PA47	Bio cosmetic products I The business model	Shrimp shells	Chitosan for pharmaceutical and cosmetics products
PA48	Bio cosmetic products II The product	Shrimp shells	Chitosan for pharmaceutical and cosmetics products
PA49	Algae for fish vaccine I The business model	Microalgae	Biobased vaccines
PA50	Algae for fish vaccine II The industrial benefits	Microalgae	Biobased vaccines

PA51	Biomass to Biochar I The business model	Rushes, bracken, furze, hazel, heather	Biochar
PA52	Biomass to Biochar II The process	Rushes, bracken, furze, hazel, heather	Biochar
PA53	Biomass to Biochar III Successful factors	Rushes, bracken, furze, hazel, heather	Biochar
PA54	Grass Biorefinery The business model	Grass	Biobased proteins
PA55	Grass Biorefinery The process	Grass	Biobased proteins
PA56	Seaweed to BBPs products I The business model	Seaweed (Ascophyllum nodosum)	Soil nutrients, Soil condition-ers and Animal feed
PA57	Seaweed to BBPs products II The final products	Seaweed (Ascophyllum nodosum)	Soil nutrients, Soil condition-ers and Animal feed
PA58	Seaweed to BBPs products III The value chain	Seaweed (Ascophyllum nodosum)	Soil nutrients, Soil condition-ers and Animal feed
PA59	Seaweed to BBPs products IV Economic benefits	Seaweed (Ascophyllum nodosum)	Soil nutrients, Soil condition-ers and Animal feed
PA60	Fasal wood I The business model	Wood sawdust from spruce and fir trees	Several applications for injection moulding processes
PA61	Fasal wood II The process	Wood sawdust from spruce and fir trees	Several applications for injection moulding processes
PA62	Lignoloc I The business model	Beechwood	Wood nails
PA63	Lignoloc II The product	Beechwood	Wood nails
PA64	Biobased materials for the toy industry	Wood flour from spruce and fir trees	Biobased materials for the toy industry
PA65	Organic cosmetics	carrots, kale, artichokes, fennel and chillies	ferments, vegetable oils, extracts and enzymes
PA66	Biochemistry products from biomass	seeds of rape, soya and sunflower	Fatty acids
PA67	RosaImpex	Several biomass source – see Practice Abstract 67	Cosmetic products
PA68	Biofertilizers from agricultural residues	Silage and animal manure	Biofertilizers

PA69	RoseRio	Rose, lavender, mint and other aromatic herbs	Cosmetics products
PA70	Natural plants as radioprotectors	Geranium Sanguineum	Pharmaceutical products
PA71	Bioproducts from Saffron I - The business model	Saffron	Cosmetics products
PA72	Bioproducts from Saffron II - The product	Saffron	Cosmetics products
PA73	Wool to biobased packaging	Wool	Packaging
PA74	Construction pole I - The product	Grass, wood, and plant residues from Greenhouses Horticulture	Building materials and infrastructural items
PA75	Construction pole II – The business model	Grass, wood, and plant residues from Greenhouses Horticulture	Building materials and infrastructural items
PA76	Hanskamp – cow toilet	Cow urine	Biofertilizer
PA77	Newfoss I – The business model	Grass	Paper, insulation material, and agri substrate
PA78	Newfoss II – The process	Grass	Paper, insulation material, and agri substrate
PA79	Bioplastic Granulate I The product	Potato residues	Bioplastic products
PA80	Bioplastic Granulate II The business model	Potato residues	Bioplastic products
PA81	BBPs from Posidonia Oceanica	Posidonia Oceanica	furniture, interior design, accessories and packaging
PA82	Natural and compostable straws	Wheat	Biobased straws
PA83	Fatty acids from Algae	algae, organic detritus or vascular plants	Fatty acids
PA84	Bioactive substances from grape residues	Grape processing residues	polyphenols, vitamins, and lecithin
PA85	Ecopanels I The business model	Straw from rice farming	Building materials
PA86	Ecopanels II The process	Straw from rice farming	Building materials

PA87	Chicken feathers Hydrolysis I – The business model	chicken feathers	amino acids, low molecular weight protein, free fatty acids
PA88	Chicken feathers Hydrolysis II – The process	chicken feathers	amino acids, low molecular weight protein, free fatty acids
PA89	Bioplastic from food and organic residues	Food and other organic residues	Bioplastic products
PA90	Hemp for the automotive industry	Hemp	Automotive elements
PA91	Biobased insultation materials	Meadow Grass	Insulation materials for the building sector
PA92	Biobased Diapers	Potato and corn starch	Diapers
PA93	Biobased Ethanol	Corn and cereal straw	Ethanol
PA94	Grass Paper Labels I – The business model	Grass	Paper labels
PA95	Grass Paper Labels II – The process	Grass	Paper labels
PA96	Insulation materials from cereal straw	Straw from different cereal crop	Insulation packaging

1.8 Best Practices Sheets in the EIP-AGRI FORMAT

The following pages provide the list of the best practices in the EIP-AGRI format. The summaries are available both in English and the native language of the partner that collected the best practice.

PA28 - From marine biomass to soil nutrients – The business model	Andalusia, Spain

The project originates by the need of improving the safety and sustainability of agriculture and aquaculture practices as to provide a technical solution to:

- the unbalanced mix of different nutrients in agricultural and aquaculture practices
- the scarcity of some essential nutrients such as phosphorous
- the willingness of different stakeholders to reduce greenhouse gas emissions generated during agricultural and aquaculture practices, such as waste water and flue gases.

By making use of marine water and nutrients from wastewaters rich in Calcium, Nitrogen and Phosphorus coming from sewage and pig manure, the project SABANA has developed a large-scale integrated microalgae-based biorefinery in the proximity of the University of Almeria (Spain) for the production of bio stimulants, biopesticides and feed additives, in addition to biofertilizers and aquafeed.
The project has opened its first DEMO plant that can produce 1 hectare of microalgae from agricultural and aquaculture waste.

The process can be summarized as follows:

1) Collection of pig manure and sewage collection
2) Production of Microalgae
3) Harvesting and processing of microalgae
4) Biorefinery of the microalgae crops
5) Creation of aquafeed additives & Bio stimulants/biopesticides (high value) and aquafeed and biofertilizers (low value).

PA29 - From marine biomass to soil nutrients The process	Andalusia, Spain

The process developed in the SABANA project allows recovering of essential nutrients otherwise lost during agricultural and aquaculture operations.
The new integrated biorefinery concept can produce microalgae biomass which is economically profitable and environmentally sustainable, e.g.: up to 1 kg of microalgae biomass can be produced from 1 m3 of sewage, up to 10 kg can be produced per m3 of concentrate from anaerobic digestion of activated sludge, or up to 100 kg can be produced per m3 of pig manure from livestock.
Farmers providing the biomass (sewage and pig manure) can take back the refined product and apply it for further agricultural/aquaculture activities. The final biomass contains valuable compounds such as proteins, carbohydrates and lipids, in addition to specific valuable biomolecules. These can be used for recognized applications like bio stimulants and biopesticides in agriculture, and feed additives in aquaculture, both as extracts/pure chemicals or included in adequately processes.
The business model requires the involvement of different professional profiles such as farmers, logistic companies, companies (in this case the University) producing microalgae, the processing industry (the biorefinery), technicians and experts in biotechnologies. The interdisciplinary scheme contributes to create new and high-quality jobs in the Region.
The practice promotes an environmentally sustainable approach for processing sewage and pig manure that would otherwise represent a taxable and polluting biomass waste.

PA30 - Bio-textile from Pineapple	The UK

Dr. Carmen was inspired by natural resources and weaving techniques to create a sustainable non-woven textile from pineapple residues.
The Ananas Anam company has created Piñatex®, a natural, non-woven textile made from pineapple leaf fibres. It is a soft, versatile, lightweight and durable material, making it suitable for use across fashion, soft interiors, automotive and other applications.

It hits all the sustainability buttons at once: it is a material that is completely cradle to cradle (Cradle to Cradle Certified™), it substitutes leather that has a very heavy environmental and welfare impact, and it brings new income streams to subsistence farmers, allowing them to fully utilize their crops.
13 million tons of waste are created from global pineapple agriculture every year. This provides the basis that the same practice has a great potential to be replicated in several regions of the world.
The current practice is already offering the following benefits and results to farmers and local communities:

- New source of income for farming communities who otherwise rely on a seasonal harvest;
- High profitability of reusing an otherwise discarded product (plant leaves);
- The leftover biomass (after decortication) is retained to use as a natural fertiliser or biofuel, offering a further economic prospect;
- 13 pineapple plants/480 pineapple leaves generate 1 square metre of Piñatex®
- Lower environmental damage from a monetary worthy activity of leaves processing.

The entrepreneurial vision of the founder to connect people, ecology and economics resulted determinant to create a vibrant new industry that is both socially and environmentally responsible.

PA31 - Orthopedic Biomaterials	Faenza, Italia

GreenBone is a patented technology proposing a bone substitute solution. It is a synthetic, acellular, reabsorbable, new generation bone graft, sourced from rattan (a bamboo-like plant), which was developed to reconstruct bone defects caused by diseases, traumas or presence of non-unions.
This wood-based product is suitable for surgical reconstruction of bone defects, repairing large bone gaps or voids. GreenBone can be produced in any size and shape to solve all the problems and medical needs experienced every day in bone grafting by orthopedic surgeons.
The process to convert wood hierarchical structures into new biomimetic hydroxyapatite scaffolds lists as follows: the raw material is harvested (rattan), and processes through Pyrolysis, Carburization, Oxidation, Carbonation, and finally Phosphatization.

The orthopedic solutions help to:

- Improve bone healing
- Complete regeneration of bone defects
- Improve quality of life
- Prevent future amputations
- Reduce healthcare & social costs.

Farmers involved in the value chain are gaining new source of revenues from trading rattan and other raw materials necessary to the GreenBone creation, and which products represent a high market value.

PA32 - Handbags from residues of apple farming — Switzerland

A swiss brand has developed a new business model to produce environmentally sustainable fashion bags, produced and sourced locally from apple farming residues.
The innovative process lies in making use of otherwise discarded material (apple waste) for the creation of a product of appeal (high design).
The value chain is organized as follows:

- Apples producers providing apple waste;
- Laboratory processing hard and liquid waste material
- Logistics and transport for shipping throughout all the process
- Industry transforming the material
- Manufacturing to create the handbags

Farmers gain economic benefits from selling or addressing the waste created from their apple's production and processing. Furthermore, they have the opportunity to foster their network with other industrial/manufacturing/selling sectors, enhancing visibility and opening new market opportunities.
On the other hand, retailers and logistics can claim of belonging to a sustainable production value chain that respond to the principles of sustainability, locally sourced and produced, fair trade, and circular economy.
The key factors that contribute to the success of this business model are:

- Large apple production in nearby regions
- proximity with the different industrial steps
- skills, tools, machineries, and knowledge needed for the transformation.

PA33 - EDIZERO – The business model — Sardinia, Italy

EDIZERO is a successful business model of circular economy based on a strong synergy between the agricultural and the industrial sector. EDIZERO produces highly efficient technical materials for green building, starting from the use of a multiplicity agricultural and zootechnical residues.
Most of the biobased raw materials (wool, cork, hemp, straw, rennet, etc.) are produced in Sardinia, bringing an excellent example of short supply chain in the regional bioeconomy. Furthermore, all the material is processed without hot fixing and without thermo-ties to obtain excellent products with maximum energy savings and environmental respect.
The supply chains created by EDIZERO are a benefit for farmers and breeders who can avoid the costs of managing and disposing residues of agricultural activity. The connection between the industry and the agricultural sector is facilitated by "Coldiretti" the most important farmer association in Sardinia.
The business model is contributing to create new and renewable natural matrices as well as innovative agro-industrial and economic networks in rural areas.
The use of residual biomass is an advantage for both, those who transform it (avoiding the purchase of expensive and polluting raw materials) and those who supply it (avoiding the cost of disposal).
The main strength and success of this practice is its compatibility with the market recent requirements, which is increasingly interested in the sustainability of raw materials and final products. The experience gained by

EDIZERO in Sardinia can be transferred to many other places in Italy and in the world. The company has never received public funding and it has grown by combining innovative ideas with the ability to develop technological research and synergy between multiple actors.

PA34 EDIZERO – Biobased products from local resources Sardinia, Italy

The company EDIZERO, in the region of Sardinia, has activated several production lines that transform around 120 residues materials into various biomaterials with a high degree of efficiency and sustainability.
The brand "EDILANA" produces materials for bio-building such as: renovation, acoustic and thermal insulation, historic architectural restoration and eco-design for internal and external design. All made with scraps of wool, cork and hemp.
The brands GEOLANA and ORTOLANA produces materials for: environmental remediation, depollution, environmental engineering (containment, restoration, re-naturalization of landfills), agro-technics (soil protection and regeneration) made with renewable, certified and traceable raw materials from sheep's wool and plant derivatives.
The brand EDILATTE produces building materials such as skimming, sanitizing, anti-spasm and water repellent paints obtained from agrifood processing waste (fruit, vegetables, beer, wine, vinegar, olive oil, milk, etc.)
All bioproducts have Environmental Ethics Certification.
The recovery of local renewable resources prevents waste and disposal costs of large quantities of biomass. The motto of the company is to transform the waste into raw materials and the surplus of productions into technological excellence. To reach this goal, the company has undertaken years of research and experimentation activities for technological innovation. The productive chain activated by *EDIZERO* - due to the positive effects on the territory in environmental and social terms - constitutes a valid model to be replicated.

PA35 - Biobased vegetable oils for industrial application Liguria, Italy

"A&A Fratelli Parodi S.p.a." is specialized in the production and refining of vegetable oils, esters, waxes and butters, vegetable-based products that are used in the cosmetic and industrial sectors (lubricant, metal-working fluids, plasticizers, natural solvents). In addition, the company has activated a line dedicated to the biomass production from microalgae. To this end, the company collaborates with "Archimede Ricerche Srl", member of EABA (European Algae Biomass Association), the first Italian enterprise entirely dedicated to the production and marketing of microalgae.
The process generates high quality biomass (up to 10 t/year) of different species of algae such as Nannochloropsis, Isochrysis, Tetraselmis and Chaetoceros.
The business model retains a great economic potential, in fact, these autotrophic microorganisms constitute a promising source of high added value raw materials, with employment in the cosmetic, nutraceutical and pharmaceutical sectors. Parodi S.p.a. has developed not only an industrial photo-bioreactors system (in collaboration with Archimede Ricerche and the University of Florence), but also an integrated and sustainable process: energy comes partly from sunlight, thanks to the algae photosynthetic function, and partly from the heat of an endothermic co-generative station, powered by vegetable oil (e.g. oil track sustainable soy, rapeseed oil).
The participation in European Research and Innovation projects such as "SaltGae" and "Biofat" have contributed to the realization of this Research, while encouraging the development of the current industrial

plant.

PA36 - Bokashi I – The collaboration — Flanders, Belgium

Mario (fruit grower) and Raf (gardener) teamed up to create a biobased organic material (Bokashi) suitable for different soil applications, including in orchards and gardens.
Mario has been constantly looking for a solution to create value from residual flows generated by rotting unsold apples and pears. Due to the fact that spreading this fruit in the orchard causes soil acidification, the unsold apples and pears are currently being sold to a local farmer and used as animal feed and/or plowed in the field. However, only a portion of this fruit can be used for these applications, and Mario, as many others fruit growers, is faced with the problem of getting rid of these residues.
From its activity of gardening, each day Raf generates huge amounts of green waste, paying an average of € 50 per ton to dispose them in the container park.
Mario and Raf started their collaboration making Bokashi from unsold apples and pears, and from the green waste of garden maintenance. It is a product that can be used by both companies as a soil and plant improver in orchards and gardens, as well as sold to external users.
Mario found a solution to his waste and is not 'vulnerable' to the uncertainties of external customers. He does not have to pay for the processing of his waste and can create a better yield using Bokashi on his own orchards.
Raf has a solution for his green waste as a gardener (loses the cost of €50/ton green waste). On top of that, he can use the bokashi on the gardens of his customers.
The partnership required some initial investment for the Innovation campaign (€2500 + communication) and the support of Innovatiesteunpunt, an extension service organisation operating in the Flemish region.

PA37 - Bokashi II – The process — Flanders, Belgium

Mario (fruit grower) and Raf (gardener) teamed up to create a biobased organic matter (Bokashi) suitable for different soil applications, including orchards and gardens.
During an info evening organized by Agriton (Belgium), Raf learned about the "Bokashi" method as an alternative to the conventional process to compost green waste of its gardening activity.
In the conventional practice, the temperature rises to 70°C, then drops again to 40°C. The "combustion process" releases CO_2 and the amount of mass is reduced to 40%.
The Bokashi method (from the Japanese word that refers to "fermented organic matter"), is a good alternative (or a supplement) to compost. In the process, organic matter is stored airtight and digested by effective micro-organism during fermentation, contributing to form additional metabolic products.
This preservation technique detains the energy in the product and creates a compound with higher nutritional value than non-fermented organic substances (such as sauerkraut).
Bokashi is obtained by adding 10 kg of sea shell lime, 10 kg of clay minerals, 10 kg of volcanic rock and effective microorganisms to $1m^3$ of grinded green waste.
The process does not include burning phases and is done in an oxygen-free room that will raise the temperature to max. 40 ° C, and quickly drops back to 20°C. After 8 weeks, the result is a good fermented product with 95% preservation of mass. Adding Bokashi to the soil means adding organic matter and microbial life, which enhances plant growth resistance to plant diseases.

PA38 - Bokashi III – The application and benefits Flanders, Belgium

In this practice, Bokashi is a fermented organic matter obtained by the combination of rotting apple and pears and green waste from gardening operations.
When integrated in the soil, the fermented compound increases the microbial diversity and provides plants with bio-active nutrients, such as vitamins and organic acids. The application of Bokashi in the soil provides essential energy and a great resistance to harmful bacteria and fungi. In fact, the Effective Micro-organisms (EM) present in the soil, multiply and can dominate the harmful bacteria, fungi and viruses. In addition, the neutral micro-organisms that will first choose the predominant harmful micro-organisms in a pathogenic soil, will now join the Effective Micro-organisms of EM, promoting a sustainable natural balance.
Almost all organic matter is suitable for making Bokashi and it can be done at a very low cost.
In this practice the main actors (a fruit grower and a gardener) produce Bokashi in big bags rather than following the conventional production in heaps. This procedure makes the compound more practical to store and more convenient to move and apply in small areas such as orchards and gardens. However, the big bags are not airtight and require a plastic inner bag that is sealed after filling.
Bokashi can be used anywhere in the garden. Plants benefit from including extra nutrients, enriching humus and soil structure. For example, the fermented material is suitable to maintain the lawn (3 kg / m^2), or as a litter in the borders or between the stems of hedges (1-3cm thick). The pH of bokashi is rather low and you may need a few days after the treatment before sowing or planting. In this way, the acids are neutralized and the soil is ready to hosting new cultures.

PA39 - Hemp in a Box I – The background story Flanders, Belgium

Mathieu, a former mixed arable-dairy farmer, took the chance to grow hemp on part of his cultivation area to enter new national and international markets on biobased solutions for building materials. As a result of the milk price evolution in 2014, he decided to sell the cows to a friend in Wallonia and undertake a new business for the production of biobased products.
Following the suggestion of a buyer of straw who had experience with lime hemp as a building material, He started to grow hemp in 2015.
Together with 5 partners, Mathieu flew to England to learn how lime hemp is produced and used, acquiring the basis to develop their current products.
Mathieu indicates that his energy is currently mainly devoted to Hemp in a box – from production operations to maintaining contacts with architects, contractors, study offices, government bodies and others. Of course, he also has to ensure that his farm keeps running. Around 90% of his time is invested in hemp in a box and he considers farming as his hobby and Hemp in a box as his company. Nevertheless, he says that farming is his passion and would never stop doing it.
The transition from farmer to 'producer of natural (insulation) material' (as he calls himself), was not an easy road. The development of the new company has been a challenge in different ways. For starters, he had to stop with his cattle, which was a difficult decision. Next to this, as a farmer he was used to work alone, while now he had to discuss his ideas with partners and investors, he has to look for new opportunities, and he's

invited to give pitches on events. Yet, He embraced the change with determination and he's now happy with the step he took. Hemp in a box is now his main occupation and represents his main source of income.

PA40 - Hemp in a Box II – The business model — Flanders, Belgium

As an arable farmer, Mathieu works around 70 hectares. Of this, 27 hectares of grass are organic, which he sells to a neighbouring organic goat farmer; 8 hectares are dedicated to peas production and 16 hectares to grain. Mathieu is also a recognized straw supplier, selling certified straw bales to the construction sector.
With the decision to enter a new market with the Hemp in box brand, Mathieu devoted 10 ha of its land to hemp production (Cannabis Sativa).
The number of hectares for this culture can shift from year to year, depending on the hemp seed prices.
In the past, hemp was a common agricultural crop. It was mainly grown to make ship ropes. Mathieu again engaged in the cultivation of hemp and came up with "Hemp in a box", an ecological building system with hemp lime. Their building materials are based on hemp lime and can be used for new construction, renovation and insulation. Both for the professional and the do-it-yourself. The old hemp lime process was way too labour intensive. The conventional operation requires around 3 hours to build 1 m^2 of building materials, the process created by Mathieu and Co. produces prefab materials and takes 1 week to build a complete house.
Hemp in a box is not a contractor or builder, but a supplier of natural building materials. The company needs to buy extra hemp shives from France and the Netherlands with no big difference in price from the one produced by Mathieu.
The company also applied for a patent for the production process of the lime hemp, as it is unique and much more efficient than the old known process. In the future, if patent is granted, they aim to apply their process abroad and sell their product to make extra income.

PA41 Hemp in a Box III – The crop — Flanders, Belgium

Mathieu grows 10 ha of hemp. Technically it is not a difficult crop. The soil must be fertilized and sow must be done with a temperature of around 15°C. After sowing there is almost no work to cultivate the crop. There is no need to spray it because as soon as it grows sufficiently, it suffocates the weeds, but it requires some fertilization. The harvesting process consist of cutting the hemp and leaving the roots in the field as a carbon source. Actually, roots can't be harvested as they are quite big and strongly rooted in the ground (as hemp can grow to 4m in height this is quite logic). Also leaves from the plant stay on the field as a source of organic matter.
After harvesting, the hemp remains on the field to 'ret', to loosen the pectin. In dry weather it is pressed and taken to the factory in Marche-en-Famenne, where it is wrapped like flax. The hemp straw, the "hemp shives", are returned to Mathieu and stored in the slot silo. Hemp straw is one of the two components for the lime hemp that they manufacture. The cultivation of hemp is not labour-intensive at all compared to, for example, outdoor vegetables or potatoes. After the hemp, wheat or a cover crop can still be sown. Hemp can also be used as post-cultivation, for example with peas. However, it is not possible to cultivate hemp after hemp because then the crop is susceptible to diseases.
Thanks to no tillage farming Mathieu can do a lot of work in a shorter time. However, with no tillage practices he has to wait longer in spring before the field is dry enough and ready to work on it.

PA42 Hemp in a Box IV – The actors involved — Flanders, Belgium

In the process of establishing "Hemp in a box", its manager Mathieu was able to participate in Birdhouse, a Belgian accelerator for and by entrepreneurs to support and guide start-ups. It was a great opportunity to develop its business and to open the doors towards foreign markets.
The collaboration with different experts and partners was an essential strategy to implement a successful business plan:

- Partner Stefaan, responsible for the finances
- Taste invest NV: co-financier of Hemp in a box. Taste Invest is an investment company that invests in start-ups and small-sized companies with the intention of generating social and environmental impacts.
- Mathieu with 6 partners founded Hemp in a box in 2015. The search for investors was a difficult challenge. Investors are mainly interested in the story you have to tell = Product & People. The financial plan is of course important, but not the main factor to convince investors!

VITO a Belgian research institute, carried out the following activities for Hemp in a box:

- performed an LCA that showed a minimal impact of the products on the environment and that they are recyclable
- measured the correlation between inside and outside climate: almost a constant inside climate, even at high temperature and humidity fluctuations
- performed an emission test that shows no emissions by the Hemp in a box products.

The isolation value was measured and fixed by WTCB on 0;067 W/mK
Warrington Fire measured the fire resistance that proved that the lime hemp is almost fire-resistant (REW 60).
By the end of this year the company will have a total of 6 people employed, both workers, a draftsman, sellers, and the integration of other profiles is under consideration.

PA43 Reuse of spent growing media I — Flanders, Belgium
The business development

Joluplant is an ornamental grower of Chrysanthemums, which developed a process to add value and re-use spent peat and perlite substrates.
Although the use of peat is very common in horticulture, growers are aware of its environmental impact.
In fact, when spent growing media leave the grower's site, they are considered as waste and can only be transported or processed by a certified waste transporter and processor, respectively.
Spent growing media can be used as feedstock for steaming and reuse in 3 ways:
- by the grower owning the spent growing media
- by the certified waste processor
- by another grower which requires a "raw material" declaration for the spent growing media.

In order to tackle this issue, Joluplant developed a solution to give used peat substrates a longer life cycle.
The idea was completely developed by Joluplant itself, while the Research and Innovation was granted by

the Flemish program 'Vlaanderen Circulair', in which all types of projects related to circular economy can participate (not only in the primary sector).
The novelty behind this practice lies mainly in making a better use of the spent peat and perlite substrates. This was possible thanks to two main actions:

- The technology process (storage and steam treatment)
- The synergy with multiple actors: an ornamental grower that searches for a new opportunity, by connecting to fellow farmers and the existing research institutes.

In order to optimize the inhouse process, Joluplant required the support of additional experts:

- Boerenbond – Innovatiesteunpunt (a regional extension service)
- 'Proefcentrum voor Sierteelt (PCS)' (Ornamental Plant Research Center) and
- 'ILVO' (Institute for Agricultural and Fisheries Research)

PA44 Reuse of spent growing media II - The process	Flanders, Belgium

Joluplant is an ornamental grower of Chrysanthemums, which developed a process to add value and re-use spent peat and perlite substrates.
Joluplant collects these residues from the neighboring strawberry and cucumber growers. The process entails a steam treatment and storage at 70°C for an hour.
During the treatment, partners PCS and ILVO perform different research activities such as:

- Optimizing the steaming process in regard to testing for plant-pathogenic fungi and insects, as well for weed seeds
- Ensuring quality of the processed substrate by testing the physic-chemical and biological characteristics, and adjusting the fertilization and composition
- Assessing the need for blending the hygienic substrates with other materials (compost, bark, ...) or inoculate it with beneficial micro-organisms.

The final product has proven to work in the field, and to deliver the same quality of Chrysanthemums peat.
Thanks to this innovation Joluplant is achieving different benefits both technically and economically:

- The company will have to buy less new peat substrate, especially for growing plantlets, and can better plan its activities in the growing season
- The energy cost for steaming is at least in balance with the cost for buying new peat
- There is a potential reduction in the of fertilizers thanks to the presence of nutrients in spent media
- The other farmers (strawberry and cucumber growers) can drop off their used substrate as a resource without cost. Additionally, they can use their spent substrates on their own fields as a soil amendment (but there should be an added value for the soil), or have to pay a certified waste processor (gate fee).

PA45 FuturePack	Norway

Today, there are not enough recycling solutions for plastic packaging in Norway. FuturePack project was developed by Grønt Punkt Norge to contribute reaching Norway´s ambitious targets of increasing material recycling. It received funding from the Research Council of Norway.
The action started through a seven weeks campaign where rigid plastics packaging waste from households

was collected and addressed to recycling facilities.
In the process, plastics products are finely sorted, washed, shredded, and converted to plastics raw materials (granulates), which are melt and employed in industrial plastic operations.
The innovation implies a significant reduction of CO2 emissions thanks to a combined use of biomass and waste plastics, versus the conventional way of using fossil resources only for producing Polyethylene (PE) and Polypropylene (PP).
The process starts with the collection of used plastics from households and industry. This is combined with Norwegian biomass waste (wood and straw) supplied by farmers.
The type of feedstocks applied in the process are: 1) wood biomass, 2) straw biomass and 3) polyolefin plastic waste. Forest-based feedstock has the best availability for industrial use, while marine raw materials are not recommended for this process.
It is innovative to produce PE and PP from a combination of biomass and plastic waste, while contributing to reduce dependence of fossil materials.

PA46 Bioska Ylöjärvi, Finland

Bioska is a line of 100% degradable bioplastic products that are certified according to the European EN 13432 standard.
The practice offers an alternative to fossil-based plastics and uses residues from agro- and wood-processes.
The Bioska products are made from cellulose and lignin from wood grown in Finland. In addition, potatoes and other vegetables that are not suitable for the food market, can be streamed as bioresources to this process. The main biobased products derived from this practice include, but are not limited to, biowaste bags and sacks, food sample bags, transparent biodegradable packaging films, and others.
Farmers and other companies sell the biomass directly to the processing company, which takes care of collecting and carrying the material in their own facilities.
Farmers are responding positively to this business model. In fact, the price offered by the company for these residues is higher than what farmers saved in feed costs when addressing the same biomass as animal feed.
The innovation is well-established and the products are commercially available.
The business model is triggering multiple benefits in the Region, with farmers having the opportunity to enter a new market and being part of an additional value chain. It contributes to solve biomass waste problems, and it supports an environmentally-friendly approach, replacing fossil-fuel sources in the production of day-to-day products.

PA47 Bio cosmetic products I – The business model Northern and South-Western Norway

A Norwegian company started extracting chitosan from shrimp shells in Northern Norway in the late 1990s.
The success of this practice is driven by good business opportunities to extract and commercialize a high-value compound from marine resources.
The innovative aspect of the process is a better use of fishing residues, from previous dumping of shrimp shells into the ocean, to extracting, isolating, and utilizing a high-value component (chitosan) in high-value products (pharmaceuticals and personal care products).
Fishermen bring the shrimps to shore where the fish processing industries are located. Shrimp shells coming from the two largest processing facilities in Norway are then shipped and processed by Chitinor AS. The company in charge of picking up and shipping the shrimp shells to Chitinor premises, is chosen upon agreements with the processing industry, depending on the volumes and available logistics options.

In this practice the economic benefit goes mostly to the processing company that provides Nordic marine biomass to chitin extractors. Most of their products are MSC approved. The MSC stamp guarantees that the product comes from sustainable sources. (MSC stands for Marine Stewardship Council: www.MSC.org).
This is important because fish and seafood are strategic for the life of coastal communities in most parts of the world. However, there is a limit to the biological resources of the ocean and how much harvesting it can sustain. Many fish species are near to extinction because of over-fishing. These facts provide justification for the continued utilization of waste resources (e.g. shrimp shells) as a key ingredient of biobased products.

PA48 Bio cosmetic products II – The products — Northern and South-Western Norway

A Norwegian company started extracting chitosan from shrimp shells in Northern Norway in the late 1990s. Chitin, the structural scaffold polymer of protective shrimp shells is extracted by Chitinor AS and converted into the high-performing biopolymer chitosan. The extraction and conversion process include de-mineralization, de-proteinization and de-acetylation of the shells. Minerals and proteins are removed from the shrimp shells during the extraction step. The conversion from chitin into chitosan takes place through a treatment with balanced concentration of inorganic solvents and controlled temperature. The so-called deacetylation step results in chitosan that subsequently gets washed with pure fresh water. The process takes approximately 3 days and produce chitosan that is used in pharmaceuticals and skin/hair care products.
The increased value of the shrimp shells contributes to improve the economy of the shrimp processing industry, given the ability to provide a broad range of natural sources of chitin. However, in order to guarantee a defined and reproducible chemical grade of the finished products, only one species is processed for the extraction of high-quality chitosan. This is the case when chitosan is extracted exclusively from the shell of the cold-water shrimp *Pandalus borealis*.
Ample availability of this species in cold Northern ocean waters provide a secure bioresource for the activity.
As chitosan is a natural polysaccharide it is also biodegradable. Hydamer personal care products produced by showed more than 70 % biodegradability in the BODIS-Test (ISO 10634).

PA49 Algae for fish vaccine I – The business model — Cork, South-West Ireland

An Irish company is creating a platform algal and oral vaccine delivery technology to eliminate the use of harmful antibiotics in the fish we eat.
Aquaculture or fish farming is worth as much as $200bn globally and €149m in Ireland. Approximately 5% of the world's fish stock is lost to infectious disease at a cost of more than $10bn annually. The way the industry does disease management for most aquaculture farms is that antibiotics are used excessively, ending up in food and ultimately in the diets of people or expelled as effluents into the environment.
The innovation can reduce or eliminate the use of antibiotics, reduce fish mortality rates in aquaculture farms, prevent bacterial and viral diseases from wiping out entire fish stocks, and improve global food security.
The microalgal oral vaccines can be mixed with fishmeal and fed to the fish, mimicking the natural feeding process. The natural digestion process of the fish unlocks the vaccine and triggers an immune response. In addition, because the vaccine is inside the microalgae chloroplast, it is protected by a rigid cell wall and is stable in harsh environmental conditions.
By using microalgae as an oral delivery vehicle, the labour and post-processing production costs can be substantially reduced, allowing to produce effective vaccines that are much more affordable and user-friendly.
Aquaculture farmers will get immensely benefited with this new technology as conventional vaccine technologies such as injection vaccines are labour and cost intensive. While salmon, trout and sea-bass farmers can

justify the cost of injection vaccines, it is impractical for high volume, low-value sea food farmers such as tilapia, carp, cat-fish and shrimp which account for 80% of the sea food farmed globally.

PA50 Algae for fish vaccine II – The industrial benefits Cork, South-West Ireland

As fish farming continues to expand and intensify, the frequency and severity of disease outbreaks will increase if effective control measures such as vaccination are not in place. Disease can be catastrophic for the industry viability as high mortality rates ultimately lead to severe financial losses, site closures and redundancies.
This is currently causing approximately $10bn losses in aquaculture.
Developing an oral antigen delivery technology would address many of the problems associated with IP injection with the potential to:

1. Decrease the costs of fish vaccination,
2. Expand the window for vaccination,
3. Reduce losses associated with side effects and/or opportunistic infections, and as a result.
4. Improve animal welfare.

The current technology is still at validation stage. However, it is very clear that success of this project will help aquaculture farmers in several ways:

1. Reduced labour cost for vaccine administration
2. Reduced use of expensive antibiotics
3. Vaccine formulated in feed, so easy handling and dosage of vaccine
4. Micro-algae are natural source of feed for many fishes, which makes it a palatable vaccine
5. Maintain water quality (excessive antibiotic usage reduces water quality), which reduces the risk of outburst of diseases.
6. Reduce the risk of new antibiotic resistant diseases
7. Increase profitability due to reduced mortality rate and increased yields of high-quality fish.

Thanks to major advances in algal genomics and molecular biology, microalgae can be engineered to express inexpensive therapeutic proteins and vaccines of economic value. The cost of the synthetic biology tools has dropped, allowing effective vaccines that are much more affordable and user-friendly.

PA51 Biomass to biochar I– The business model Mid-West Ireland

In Ireland, biomass which is not utilised for livestock feeding occupies a large area of agricultural land. This biomass consists primarily of rushes (Juncus spp.), but also bracken (Pteridium), Furze (Ulex spp.), Hazel (Corylus) and heather (Calluna).
Every year, considerable expenditure is required to take care of these resources (i.e. cutting and disposal), either by chemical or mechanical means as to ensure compliance with EU grant schemes and for conservation purposes for the regional agri-environment scheme. This leads to the widespread use of chemical herbicides and the production of a considerable amount of biomass stream.
The Biomass to Biochar project (BBFB) promotes a process to create value-added products in the form of biochar from unutilised agricultural biomass and make direct use of this product in the farm itself.
In the BBFB process, farmers are both producers and end users, getting a direct benefit from this practice.
By producing biochar from this source of biomass, farmers gain three crucial benefits:

1. No use of chemicals to manage the unwanted biomass, so no unwanted costs in the farm.

2. Farmers get paid for each round bale of rushes produced
3. The biochar has multiple uses in the farm in improving the soil properties such as increasing soil water holding capacity and improving soil microbiome.

The Irish Biochar Co-Operative has successfully been awarded EIP funding to produce biochar from rushes and other materials of little agricultural use. The main actors involved in this initiative are: Biochar co-operative (mostly farmers), farmers involved in field trails, University College Dublin (UCD) and the Agriculture department for research and technology support.

PA52 Biomass to biochar II – The process Mid-West Ireland

Biochar is a charcoal-like product produced from biomass under slow pyrolysis process which is heating biomass in low oxygen conditions to 400 – 800 C°. At this temperature much of the volatile contents are removed leaving a stable, carbon-rich biochar with an open porous structure.
The Biomass to Biochar project promotes a process to create value-added products in the form of biochar from unutilised agricultural biomass. Biochar can be used for soil improvers and as an addition for animal feeds.
The project will build a Mobile Pyrolysis Unit (MPU) to turn the unwanted biomass farm into biochar in the farm itself. The biomass is baled and stored for biochar production. The bales will be pre chopped and then loaded into a hopper to pass through the pyrolysis unit. The final product will then be stored in bulk bags to be used by the land owners at a later date.
The biochar will be tested for its properties and any potential toxicity. Once shown to be safe, it will be used on farm as feed input, slurry additive or soil amender to reduce greenhouse gas emissions and improve soil fertility and long-term carbon storage.
Also biobased industries can purchase biochar and convert it into activated carbon, which has high value applications. The activated carbon demand in Ireland is estimated at 1,275 ton per annum and, with a price range of €2,000 to €3,500/ton (dependent on material type), a market value ranging from €2.8 million to €3.7 million is identified.
A market size of 8,000 tons in Europe is also estimated and, with a global average biochar price of €1,750/ton, suggests a European biochar market value of €14 million.

PA53 Biomass to biochar III– Successful factors Mid-West Ireland

The biomass to biochar practice proposes immense benefit from using biochar in farm operations. Because of biochar's ability to enhance the availability of plant nutrients, soil nutrient retention is improved. This means that less fertilizer needs to be applied, contributing to reduce the cost in crop production.
Moreover, char-amended soils have shown reduced runoff of phosphorus into surface waters and leaching of nitrogen into groundwater. So, pollution caused by fertilizer run-off into streams and rivers is reduced.
Biochar has been shown to reduce the soil emissions of nitrous oxide (as a greenhouse gas, it is 310 times stronger than carbon dioxide) and improve the uptake of methane (21 times more potent than carbon dioxide).
The markets and consumers using the crop produced from biochar practices for food or feed purposes can be sure that the product is produced sustainably in a circular economy approach and no harm is caused to the environment during the production process. This sparks consumer attention and trust because of the quality of the product and from the sustainability tag attached to it.

Indeed, it is possible to identify a number of factors that are essential to a successful development of such a practice. Specific actions should aim to:

1. Educate farmers on the benefit of biochar and demonstrate the reduced costs and increased productivity with the use of biochar
2. Give premium prices to the products produced by using biochar as soil amender instead of artificial products
3. Make cooperatives for biochar production and train them on the technology and usage of the product.
4. Create an online platform for trading the biomass and the finished product.
5. Make farmers the leading stakeholders and managers of the process.

PA54 Grass biorefinery I – The business model South-west Ireland

The Biorefinery Glas project is promoting farm-to-farm bioeconomy symbiosis and demonstrate new business models for farmers. The project builds on a strong existing co-operative structure to evaluate new routes to market for cattle farmers, generating additional co-products using small-scale bioeconomy technologies. For example, using co-op partners to upgrade the protein co-product into a finished and marketable compound feed for chickens and pigs.

Farmers are producers and end-users of the products. Grass farmers will get benefit from high resource efficiency from the abundant grass available in the farm and produce products with good market value.

The protein produced from the Grass whey can be supplied to the poultry and pig farmers. Symbiosis between grass producers, cattle farmers and pig and poultry farmers will make the supply chain logistics very efficient and ensure locally produced high quality products at low-cost.

An expected benefit of this approach includes a reduction in nitrogen and phosphorous losses (by 25%) and related emissions for the dairy sector by improving nitrogen use efficiency in dairy, whilst simultaneously reducing indirect GHG emissions through substitution of soybean imports for use in monogastric feed.

Farmers and farmer co-operatives are the main practitioners involved in the chain.

On-site production in the farm will solve logistics of shipping the feedstock to central location and considering that it is a mobile biorefinery, it can move from one farm to the other, so there is no need for small biorefineries at each farm.

This project is mainly focused on making farmers producers of high-quality products from biorefining the grass. This results in 40% increase in usable protein per hectare.

PA55 Grass biorefinery II – The process South-west Ireland

The Biorefinery Glas project will promote farm-to-farm bioeconomy symbiosis and demonstrate new business models for farmers. The process is one that integrates well within existing agriculture system, producing a press-cake feed that is high in resistant protein (nondigested protein) for cattle, while also generating additional high value co-products that can represent an additional revenue source for farmers. The model has a processing capacity of 2 tons fresh grass per hour.

Proteins are the main compounds delivered after the process. They are isolated from grass by mechanical pressing without addition of any chemicals, providing a high-quality product suitable for animal feed.

The isolated proteins are further separated in to protein fractions that can be efficiently utilised by ruminants and the crude fraction that can be used in pig and poultry industry.

This approach improves the efficiency of nitrogen use for milk production and allows to provide pigs and

chickens with grass protein, an indigenous source of protein concentrate.
An expected benefit of improving the nitrogen use efficiency for milk, includes a potential reduction in nitrogen loses and ammonia-related emissions for the dairy (and potentially beef) sector, while indirect emissions from soybean monogastric imports can also be displaced.
An additional value-added co-product in fructo-oligosaccharides (prebiotic sugars) will be extracted from the deproteinized grass whey. It has potential applications for the human and animal nutritional markets.
Finally, once the relevant products are extracted, large volumes of nutrient-rich whey can be used as a fertilizer or as a co-substrate for biomethane production through anaerobic digestion.

PA56 Seaweed to biobased products I **Ireland**
The business model

An Irish company has developed a sustainable approach to process Ireland's seaweed (*Ascophyllum nodosum*) for domestic and export uses. The company is known for its finest value-added seaweed products to boost the quality of animal feed, crop nutritional products and soil conditioners.
The company was acquired in 2014 by a world leader in marine plant products to humans, animals and plants. The company recognizes the importance of working with sustainable harvesting systems, as seaweed is the source of income for many people in the west coast of Ireland. Operations follow simple techniques of 4-5 years of fallowing and leaving sufficient material for regeneration, which allow harvesting for 5,000 to 28,000 wet tons per year. Indigenous seaweed harvesting by hand is a practice that has been carried out for generations. This practice has supported the livelihoods of coastal communities, playing an important role in shaping the local foreshore environment while adding to the unique heritage around the coasts of Ireland. Whilst exports for alginate production ceased in 2009, 5,000–6,000 dry weight tons are currently being produced for the animal feed, horticulture, aquaculture, and cosmetics markets.
Arramara is the major buyer of seaweed harvested in Ireland. It supplies the material for other industries and also makes high-value products for animal and plant nutrition. The producers get locally sourced, sustainably harvested and high-quality material for their products. Consistent supply of raw material is a great advantage for the producers, which can be achieved only through sustainable harvesting by experienced harvesters.

PA57 Seaweed to biobased products II **Ireland**
The final products

An Irish company has developed a new sustainable approach to process Ireland's seaweed (*Ascophyllum nodosum*) for domestic and export uses. Harvesting operations are carried out by local harvesters, following either traditional or alternative harvesting methods but ensuring that the product is always gathered with sustainability in mind.
Traditional hand harvesting is done using knives and sickles and, in recent years, an eco-friendly hand harvesting method using small boats and specially-designed rakes is being used.
The seaweed supplies many markets thanks to its organoleptic proprieties which can be used in the production of different biobased products, such as:

1) Soil conditioner produced from seaweeds. It is granular in nature and improves water intake and nutrient uptake of the soil. It can help to correct deficiencies in the soil for crops cultivation, acting at

physical, chemical and biological level.

2) Soil nutrients. They are a seaweed concentrate that provides balanced nutrients and trace elements to plants. It helps in overall plant growth and develops resistance to pathogens and pests.
3) Animal feed products from seaweed, which maintain clean and safe products for animals to consume. The product fortifies animals' enzymes, hormones and cells with an organic, more easily assimilated source of trace elements. It assists nutrient absorption, healthy growth and animal performance as well as maintains healthy intestinal functions by providing essential roughage.

PA58 Seaweed to biobased products III – The value chain Ireland

This practice presents an excellent example of synergy between several actors for the production of value-added products from marine biomass.
The company purchases seaweed from local harvesters and ships it to their facility to perform the drying and milling processes before sold to the biobased industry in Ireland and worldwide. It currently employs 20 people directly and purchases seaweed from over 300 harvesters.
Collaboration with Research organisations and universities is crucial to preserve the local habitat, manage the marine plant and plan a sustainable harvest.
The amount of seaweed available and ways to protect it is done by taking an alternative approach instead of assessing the weed on a weight-per-unit-area basis. The west coast resources of Ascophyllum were mapped using hand-held GPS (global positioning satellite) devices and Arc-Info, a software package to assist in mapping. This was done in collaboration with the Department of Geography & Coastal Resources Centre, University College, Cork.
The local seaweed buyers assess the production that an area can support. It was established that at least 130,000 wet tons of harvestable Ascophyllum are available annually on the west coast of Ireland, about 34,000 wet tons of which are being utilised at present.
Experienced harvesters in Connemara region, west coast Ireland, have made an art of making seaweed bundles, locally called climíní (literally, bundles). Bundles are tied off with ropes and allowed to float to the top of the shore. These floating climíní are then rowed to small harbours where the weed is collected by lorries and transported by road to the drying plant.

PA59 Seaweed to biobased products IV Economic benefits Ireland

In this practice, Seaweed is hand harvested sustainably by local farmers without using any mechanical harvesting equipment. This means more harvesters required per unit ton compared to mechanical harvesting. The processing company has increased its price to harvesters by almost €10 to €53 a tonne, which translates into an important additional source of income for local farmers.
90% of the Irish seaweed harvested is naturally grown and only 10% is cultivated.
Harvesters know by experience, how much to leave and how long for efficient regeneration. In some areas, it is possible to harvest on a 3-year cycle, but in most of the cases a 4-year cycle harvesting is followed.
The business model provides jobs for more than 400 people, and it is important to highlight that sustainable harvesting can ensure supply of seaweed for many decades, reducing provision risks and price volatility.
In the latest year the algae global market rise from 1-3% per annum and the demand is growing due to all the research and new products created from algae.

Also, in terms of product streams, seaweed is used for multiple products from animal feed to cosmetic industry which keeps the demand and industry ever growing.
Because the seaweed sourced from different regions of west coast is carefully recorded, consumer can track down the product to the source of origin.

PA60 Fasal Wood I – The business model — Vienna, Austria; Zagreb, Croatia

The processing of wood raw materials generates 40 percent by-products, including around 4 million cubic meters of sawdust. Most of this is a valuable raw material for the paper and board industry, and a lot of it is now also thermally processed in the form of pellets or briquettes.
The development of Fasal has opened up further market opportunities for this by-product in the form of an injection moulding granulate that can be processed on all conventional injection moulding machines. The name stands for the main component fibres and cereals, i.e. the compound consists of wood fibres and a carbohydrate-rich raw material like maize. Both must have a certain degree of comminution and moisture content.
Fasal is the only "biological" injection moulding granulate that can compete with conventional plastics in price. Other alternatives are two to three times as expensive. Fasal is also used for technical parts such as stacking boxes, closures, tool handles, etc. Due to its special acoustic properties, whole clarinets have recently been produced, which are not inferior in sound quality to wood clarinets. A high commercial potential of this product is seen in the market for ecological toys.
Fasal was developed over many years at the Institute for Natural Product Technology at the University of Natural Resources and Applied Life Sciences (IFA Tulln, Niederösterreich, Austria).
Thanks to this practice farmers have an additional opportunity to sell wood residues in the market and benefit of better prices for value-added products.
In Austria, its suitability for floor tiles is being explored, while Italian suppliers in the furniture and automotive industries are investigating the possibility to apply Fasal in their products.

PA61 Fasal wood II – The process — Vienna, Austria; Zagreb, Croatia

In the Fasal wood practice, all ingredients are mixed dry and sent through an extruder. This machine originally comes from the food industry, where it is used, for example, for creating pasta patterns. Today, however, extrusion is one of the most important processes in the plastics industry. Through heating, pressuring and shearing energy, the ingredients are disintegrated, combined and formed into granules (small cylindrical grains). The resulting thermoplastic material can be transformed into complex parts by injection moulding. The parts have a wood-like appearance and wood-like properties. Due to the isotropic structure, grain in the conventional sense cannot be achieved, but structures can be achieved by adding coarser wood fibres.
The material consists of about 60% wood flour from spruces and firs from sustainable forest management, the rest is high-quality recycled plastic or resins of biobased origin.
Plastic usually comes from returnable cups used at festivals and events. These are sterilised, ground and inserted into the process together with wood shavings.
The fibre content can be up to 60 percent. Resins and processing aids are added to achieve certain properties. The resins can also be of natural origin - this results in a fully biological variant - or of synthetic origin, i.e. from fossil sources.
The parts have high strength values and high surface hardness, and can be polished, painted or dyed with

colour granulates. The outstanding swelling and shrinkage behaviour are impressive compared to wood. Fasal bodies are subject to almost no dimensional change with changing air humidity, some formulations also show high form fidelity at high temperatures.

PA62 Lignoloc I – The business model — Mauerkirchen, Austria

Lignoloc wood nails is an improved and innovative solution in the market of wood connection systems.
The product is an example for the use of beechwood that is part of the natural biodiversity in mountainous central European tree population. Within the last 100 years, the population of beeches have been replaced by fast growing spruces and pines, leading to climate and biodiversity instabilities in the forest sites (e.g windthrow, bark beetles, etc.). This led to an annually growing amount of damaged wood and low prices due to decreasing quality.
The restoration of Beech trees in its natural environment is contributing to higher demand for hardwood which has a higher quality and can be sold at better prices. The model is also promoting a sustainable forest practice that requires lower maintenance expenditures due to the appropriate ecosystem where the trees are grown.
The transformation of forestry monocultures into sustainable mixed forest is also subsidized (between 1.700 - 3.500 €/ha) depending on the degree of transformation.
The value chain starts with foresters providing high quality beech wood for nail production to the wood processing industry, which produces the nails and standardized nail-stacks. The business model required the involvement of the pneumatic nail guns manufacturer which had to adapt the model of pneumatic nail guns.
The quality of the nails is equal to metallic nails and thus are of high value in the wood-construction sector.
The Lignoloc wood-nail technology is a new available technology on the market and allows dynamic designs in interior construction, wood building and furniture production.

PA63 Lignoloc II – The product — Mauerkirchen, Austria

The BECK Fastener Group is a family business founded in 1904. For over 80 years, BECK has been one of the world's leading manufacturers of innovative fastening solutions in the field of magazine staples and nails.
The company has enlarged its portfolio with production of wood nails, an innovative solution in the market of wood connection systems. The product was developed by the in-house research department in cooperation with the University of Hamburg as a result of continuous innovation and research efforts in order to stay on top of the market.
The wood nails are made of beechwood and shaped to fit the stack system of pneumatic nail guns. The special design of the nail tip and the large amount of heat generated by friction when the nail is driven in, cause the lignin of the wooden nail to weld with the surrounding wood to form a substance-to-substance bond.
The "Lignoloc" is the first type of a biobased wood connection system, based on the principle of lignin-welding and thus a new form of technique for wood connection.
The product carries a number of innovative solutions to end users, such as:
- Quick and simple processing with pneumatic nail guns
- Hardly any water absorption, so no expansion
- High holding power thanks to lignin welding

- Resistance to fungal infestation
- No streaking or bleeding on the wood
- More environmentally friendly than metal fasteners
- Installed significantly faster than wood dowels
- No pre-drilling
- No wood glue necessary
- Made of indigenous beech wood
- Better fire protection in wood structure than steel or metal fasteners
- No thermal bridges, so better insulation values
- Tensile strength similar to aluminum nails (~ 250 N/mm²)
- Less tool wear when cutting nailed wooden components subsequently

PA64 - Biobased materials for the toy industry — Niederösterreich, Tulln an der Donau, Austria

An Austrian company took the chance to launch a new brand in the toy market, following the growing demand for biobased products in the toy industry. The final item is similar to construction stones, which are 12 cm long, 2.4 cm wide and 0.8 cm high.
The toys are made from a new material called Bio-Fasal, which was developed by the Institute for Natural Product Technology at the University of Natural Resources and Applied Life Sciences (IFA Tulln, Niederösterreich), and specifically adapted for the toy brand.
Production takes place completely waste-free on energy-saving electric injection moulding machines with highly efficient multiple tools. At the end of their life cycle, the building blocks can be thermally recycled or ground and processed into new bioblocks.
The success of this business model is due by the economic relation that bounds the forestry sector with the wood processing industry.
Forestry is one of the key assets in Austrian agriculture activities and resource supply. The use of wood as a material accounts for 1.6 % of the total gross domestic product.
In this practice, the toy stones consist of about 60% wood flour from local spruces and firs from sustainable forest management, the rest is high-quality recycled plastic.
Farmers have the opportunity to sell their wood to additional competitors on the market. The higher the number of competitors for this resource, the higher the possibility to achieve better prices for the wood.
Wood can also be provided from farming, i.e. short rotation coppices (SRC), which has also higher yields/ha and suitable properties for application in the wood processing industry.

PA65 - Organic cosmetics — Steiermark, Austria

Hands on Veggies was founded by Nicole and Lisa who are specialised in the development of innovative natural cosmetic concepts. The practice aims at transforming various vegetables such as carrots, kale, artichokes, fennel or chillies in the form of ferments, vegetable oils, extracts or enzymes. The product is designed for the growing market segment for organic cosmetics and environment friendly products.
Processes and products are an outcome of in-house research and shows that it is possible to completely combine sustainable products and modern design with creativity and effort.
The aim of the business model development is to avoid the use of any synthetic preservatives, even those

approved for use in natural cosmetics.
The value chain is based on certified organic farming products, which creates a higher income in comparison with conventionally grown agricultural products. Organic farmers are having the possibility to sell their products outside the more conventional markets of food and feed.
Hands on Veggies has developed a new type of natural preservation for natural cosmetic products. For example, chillies, pumpkins or coconuts fermented with lactic acid microorganisms provide excellent properties for cosmetic applications. Other plant substances such as antimicrobial hop extract also have a preservative effect in the formulations.
Hands on Veggies is purely vegetable, so is its packaging. The tubes, made of biobased plastic from sugar cane are fully recyclable.
The higher production costs due to the biotechnology processing of the product components and the innovative packaging, are compensated by a commensurate price for this market segment.

PA66 Biochemistry products from biomass — Kozarevets (Veliko Tarnovo), Bulgaria

Rapid Oil Industry Co. Ltd. is a company founded in 2006 in accordance with national and European regulation for the production of ecologically clean energy biobased products for food, feed and energy markets.
A high percentage of rare fatty acids is contained in the sidestreams of biodisesel and food oil production, obtained by the vegetable oils of the seeds of rape, soya and sunflower.
In addition to food additive, the fatty acids are used in the cosmetic industries as stabilizers and foam suppressors. Sodium and potassium salts of the superior acids are used in the production of soaps and surfactants.
In the process of oil preparation, the sub-products containing fatty acids and their sodium salts are released and processed until receiving the commercial product.
One of the factors for the development of this good practice is the geographical position, which is convenient for the production of oilseed crops in the Region. In accordance with the current agricultural policy, the raw materials used in the production of biodiesel, may be grown on low-quality land, which would otherwise be classified as non-cultivable. This configuration allows a steady availability of biomass for the company, collecting the material directly from the farmers and storing it in the company facilities.
Partnership with other stakeholders (the Bulgaria NABB and in EU scale - the European organisation of biodiesel producers – European Biodiesel Board (EBB), Brussels, Belgium) has been a crucial step in the development of the business model.

PA67 RosaImpex — Yagodovo (Plovdiv), Bulgaria

ROSAIMPEX, has developed a high level technology to bring a wide range of bio-products to the cosmetic market. It takes advantage of the excellent properties of local herbals for the production of high value solutions for skin and hair care such as hand cream, face scrub, face lotion, face cream, micellar water, shampoo, hair colouring materials.
The aromatic oil is awarded with guarantied geographic origin certification and obtained by rose and lavender oil as well as from other aromatic herbs produced in Bulgaria (rose *Rosa Damascena*, lavender, grape seeds oil, wheat germ oil, sweet almond oil, walnut extract, marigold extract, melon extract).
Plants produced by farmers are distilled in distilleries that are owned collectively by farmer cooperatives. The obtained oils are certified and shipped to Rosa Impex's plant where they are stored in fridge-containers and kept under controlled temperature until transformation.
This structural approach is quite new for the region of Yagodovo, and is contributing to reinforce linkages

between farmers and the secondary sector.
Rosa Impex has its own laboratories for quality check, which monitors products at every stage of the process. Facilities and modern equipment have been purchased with the support of public funds.
A crucial factor in the success of this business model is the commitment of the company in providing continuous training for its employees, from manager to researchers and operators.
The company has the capacity to carry out in-house research thanks to high-tech laboratories for the development of new technologies and products.
The business model is also contributing to create high-quality jobs and boosting the development or enlargement of farming operations in the region, due to the increasing demand of this specific biomass.

PA68 Biofertilizers from agricultural residues — Plovdiv, Bulgaria

In order to address the environmental burden of unutilized residues from agricultural production, a new biorefinery was set up in the province of Plovdiv in Bulgaria. The development of the new process was prompted by a Bulgarian national regulation for waste management along with financial incentive to stimulate processing activities around agricultural waste and residues.
The process mixes silage and animal manure for biogas production through anaerobic digestion. The installation includes two thermophilic fermentation. The main residues required for this process are animal manure and plant residues. The by-product of the digestate (solid fraction of fermentation) is composted and offered as biobased fertilizer to a number of clients.
In this way agricultural waste is recovered for biogas and bio-fertilizers production instead of being discarded in dunghill.
The production of biogas and solid residual fraction (digestate) as a bio-fertilizer, are both new techniques for this Province. The innovation is the alternative and better use of these resources, that prior to this practice were considered as a waste to get rid of.
The business model is contributing to create better jobs in the territory with clear environmentally-friendly results. The alternative use of chemical fertilizer in favour of biobased ones which are rich in nutrients (contains K, P, N – macronutrients, carbon), represent an important benefit to soil fertility.

PA69 – RoseRio — Gabrovo, Bulgaria

STS cosmetics was established in 1990 in the town of Gabrovo, Bulgaria. It is a leading manufacturer and exporter of personal care products – toothpastes, hair dyes, shampoos, conditioners, hand creams, face creams, shaving creams and foams, aftershaves, and more.
As a result of intense Research at their own laboratories, the company started the Rose Rio beauty line in the production of cosmetic products using natural ingredients such as rose, lavender, mint and other aromatic herbs produced in Bulgaria.
The company has also the capacity to develop specific cosmetic series on request of the client (the so-called private brand).
Most of the products are based on organic aromatic oil ingredients produced in Bulgaria. The increasing demand of aromatic herbs is drawing a new source of income for local farmers., with opportunities to start productions in marginal lands.
The practice is also contributing to create high-quality jobs in the Region. Entrepreneurs and employees follow regular training, while in-house research for the development of new products and technologies is car-

ried out in their own laboratories.

PA70 - Natural plants as radioprotectors	Sofia, Bulgaria

The scientific research of the Botanical Institute of Bulgarian Academy of Sciences has recognized the *Geranium Sanguineum* as a natural product with radio protective effects. For Bulgaria this represents an important achievement following the Chernobyl disaster that has deeply affected the Country. The product (GSe) is standardized and already in the pharmaceutical market. The application of biologically active natural substances from natural products gives new opportunities for modern pharmacology, while being a new source of income for local farmers.
In fact, the country shows abundance of plants with strongly manifested medicinal properties.
GSe lyophilized substrate from Bloody Cranesbill roots (*Geranium Sanguineum)* is a complex of polyphenolic compounds. Extract is obtained after roots are dried to 12% moisture, grinded at 0.5 mm and then extracted through lyophilisation with ethyl alcohol. Because the biologically active constituents are thermally unstable, drying is carried out through lyophilisation at a temperature that ranges between 35-40°C. The obtained substance is a brown-red powder, which dissolves well in water and alcohol.
The practice is expanding the list of plant growing opportunities, enabling farmers to substitute highly distributed plants with added-value ones, with the capacity to be cultivated in marginal lands.
Recently, the food additives as well as the new pharmacological products are very popular and wanted.
Indeed, strong drivers to this business model have been the geographical position of Bulgaria, which assures abundance of natural plants with strongly manifested medicinal properties, together with the experience of the ethnic medicine in healing with herbs.

PA71 Biobased products from Saffron I The business model	Norfolk and Suffolk, UK

Norfolk Saffron and Nudge boutique started a business collaboration to create cosmetics products from residues of saffron harvesting.
The saffron flowers and threads are harvested once a year in October and November. It takes circa 200 flowers to yield 1 gram of threads due to the small number of threads on the flowers as such this is an intensive crop to harvest and the saffron threads are referred to as red gold as they are worth more than gold due to their rarity.
Both products developed in the process are made by blending the ingredients, however for the clay face mask the petals are first dried out turning from a pink colour to a bright blue colour. These are then crushed and mixed into the kaolin clay to form the mask.
For the production of the facial serum, the stamen (threads) are required. Whereas in the production of the Clay mask, the flower heads are used with the petals as main ingredients.
Selling the petals to Nudge Boutique has allowed for income to be gained from an otherwise waste product which only had a value as compost prior to this.
The threads themselves retail at £27 per gram which gives a value of £27,000 per ton. When these threads are incorporated into products such as the facial serum, the product is then worth £2000 per litre.

The key benefit to Norfolk Saffron has been income on what was a waste stream before. However, it has meant there is more processing as only good petals are desired by the customer Nudge Boutique to go into the Kaolin Clay face mask.
One of the key successful factors of this collaboration is that saffron is a specialist crop and as such there are limited growers within the UK. However, with an increasing demand of existing or future biobased products there are good opportunities that other businesses within the UK would enter the saffron market.

PA72 Biobased products from Saffron II	Norfolk and Suffolk, UK
The product	

Saffron is part of the iris family and has been used for several uses for millennia such as medical treatment of coughs, colds, uterine bleeding and other ailments. It has also been used for textiles dying and as a spice for cooking.
Dr. Sally started the "Norfolk Saffron" in 1997. Since then, the business has grown supplying saffron threads mainly for food supplying professional chefs and other customers with saffron to use in cooking.
Following some initial trials, Jo of Nudge Boutique who specialises in vegan friendly women's cosmetics to re-nourish skin and increase wellbeing, contacted Sally about working with Norfolk Saffron to create a facial serum. The business works on natural formulations using plant-based ingredients to create cosmetics solutions.
One product is "Saffron Glow Cleansing Clay Mask" made from Kaolin Clay which is mixed with tapioca starch and frangipani absolute and sweet orange essential oil as well as Simmondsia Chinensis Seed Oil mixed with dried petals from the saffron (Crocus Sativus).
A second product is the "Saffron Glow Facial Oil Serum", a blend of saffron threats, prickly pear oil, rosehip seed oil Jojoba oil Oat Kernel oil carrot seed extract, sweet orange essential oil, lemon essential oil, rosemary extract, olive squalene and blackcurrant seed oil.
The collaboration between the two businesses started when Jo approached Dr Sally where she had been experimenting with saffron threads and needed a consistent supply. As a result, they used the potential of the petals to develop new products. This was suggested by Sally, with the aim to create high value output for petals which were a waste product and only composted prior to the collaboration with Nudge Boutique.

PA73 Wool to biobased packaging	Staffordshire, UK

WoolCool is a pioneer British company expert in the production of packaging prodcuts from wool, which are compostable, recyclable and reusable.
Wool is one of nature's most amazing 'smart fibres', with a complex structure and natural properties that cope with extremes of cold and heat.
The process uses 100% sheep wool sourced direclty from farmers for WoolCool production. This is to ensure that there is no polyester or other foreign bodies within the wool, which could be detrimental to the final product.
After being washed and garneted, the wool is needle-felted and cut into strips. In order to preserve essential properties, the product is hygienically sealed within recyclable PE film with micro-perforations to allow the hygroscopic function.
Wool in the UK is a low value by-product for farmers and, as such, is usually disposed due to a lack of de-

mand for the product.
In this business model farmers have a guaranteed outlet for their wool, with the benefit to create a new source of income from this biomass while avoiding the costs of landfill taxes.
Wool is in constant supply in the UK due to the large sheep flock. In addition, WoolCool is central to the UK and close to Wales, which is a strategic area for sheep farming. Therefore, the potential to expand the business are high as sourcing more wool would not be an issue.
Other benefits include the superior insulative properties in comparison to polystyrene and plastic insulators. Packaging is suitable to transport temperature critical medicines and vaccines and the material outperforms conventional specialist packaging.
The washing and scouring processes provide additional by-products such as nitrate and mineral rich sludge which is used as natural fertiliser or transform into biodegradable slug pellets.

PA74 Construction pole I – The product — Raamsdonkveer, The Netherlands

Millvision is a Research & Development company specialized in the development of biobased products based on natural fibre technology. The company aims to realize a more sustainable society by processing agricultural and/or other natural residue streams into new fibre-based products. Among one of the new developed products by Millvision is a fibre-based construction pole: a composite product, produced out of roadside grass and plant residues from greenhouse horticultural crops. The fibre construction pole is introduced in the infrastructure and building sector. It is suitable for different applications such as outdoor benches, road side rails, wall protection and water timbering.
Collection of these natural streams is case-dependent and not centrally organized. In the next step the residue streams are grinded, refined or pulverized (based on the required properties of the end-product). In this way a raw material, rich of natural fibres is created. In a 3D heat press or compounder-machine the raw material is mixed with bio-polymers and processed into the requested form of the end-product.
The main benefit from the farmers' perspective is that they are able to create an economic value on an agricultural waste stream. Current greenhouse horticulture companies have significant costs for removing residue streams.
On the other hand, waterboards, municipalities/province and other governmental institutions (e.g. Rijkswaterstaat) are required to meet sustainable criteria in their purchasing processes. By choosing for a biobased construction material they achieve sustainability goals more easily. Furthermore, the fibre-based construction pole has a longer lifespan than alternatives and is completely free of fossil-based materials.

PA75 Construction pole II – The business model — Raamsdonkveer, The Netherlands

The fibre construction pole is a composite product based on natural fibres. The process starts with the collection of natural (residue) stream: pruning wood, recovered paper, grass, flax, hemp fibres but also co-streams from greenhouse horticulture, algae and water plants.
The company has specified knowledge on lignocellulos fibres, based on expertise and experience from both the paper and the building material industry. Based on this combined knowledge Millvision has been experimenting with different residual streams, creating a uniform raw material product and developed a pilot system for processing the raw materials into different composite products. With a focus on applied research, they are able to involve the whole supply chain (both farmers as end-users) in their innovation process.
The fibre construction pole has been already developed, and several prototypes have been produced.

Millvision is able to produce the product in small batches by using a pilot production facility.
Most important outcome is that the new product gains a market share by proving it is a reliable, sustainable and cost-effective product. Furthermore, it is required that production costs become lower by upscaling the production facility, this implies a stable supply of agro-residue streams. To this end, further optimisation and integration of different organisations along the value chain is needed to create a stable, reliable and sustainable business.
Millvision works with supporting clusters (e.g. Biobased Delta and Natuurvezel Application Centrum), allowing them access to knowledge, strategic partners, financing and R&D facilities.

PA76 - Hanskamp – cow toilet — Doetinchem, The Netherlands

The CowToilet is an automated urine collection system for livestock. Urine is separated from manure which results in less ammonia.
The CowToilet is installed at the feed-station. After eating, the cow is driven to use the CowToilet and to urinate. This is done by stimulating the natural nerve reflex which causes an urge to pee in the cow. The collection tray gently pushes the udder bands after which the cow will urinate. After the collected urine is stored, the CowToilet is flushed.
This innovative measure prevents urine contact with manure and thus avoiding ammonia development, while supporting animal welfare and sustainable dairy farming.
Ammonia emission is seen as one of the biggest environmental issues because:

- evaporates from farms and settles in the environment. Soil Nitrogen increases, but a surplus causes problem in vulnerable nature, decreases biodiversity and acidifies soil and surface water
- causes a bad smell
- ammonia emissions cause Nitrogen decrease, leading the farmer to increase manure application

When it comes to animal welfare, drier and cleaner floors help to increase hooves health
Cleaner air is better for the lungs and mucus membranes and contributes to better animal health.
Main benefits for farmers:

- Surplus companies (companies with little ground to spread manure) save on disposal costs
- Urine can be used as a replacement of manure for fertilization in farming fields
- Farmers in intensive livestock farm can comply to strict ammonia legislation without large renovations or new constructions
- Image: society sees ammonia emissions as a huge problem, the CowToilet can help prevent it.

PA77 – Newfoss I – The business model — Uden, The Netherlands

Newfoss focuses in particular on grass flows that do not enter the food chain such as grass from nature reserves, along roads (roadsides) and from dikes. The management and disposal of this residual flow is currently a cost item. Giving it a value is creating a new revenue model. There is an encouraging demand from the market as such an alternative isn't more expensive than conventional substrates. Application of this substrate reduces the footprint of agricultural products such as mushrooms and companies are willing to use more environmentally-friendly solutions due to the CO_2 taxes.
This product will be available on the regular market in 2019. Current alternatives based on flax and hemp are about 40% more expensive than conventional insulation material (glass and rock wool). The insulation material based on grass fibres is 10-20% more expensive than the conventional material.

Tests at (end) producers are currently in the final phase, after which the step to commercialization can be made.
A number of activities deserve to be mentioned that came in support of this practice:

- Subsidies were required at the start of the process. In particular for research and testing
- A strong organisation with sufficient resources is needed to be able to bear risk
- You have to look beyond your own process. You have to include the entire chain in the process to make the necessary adjustments (with the necessary investments, innovation DNA throughout the entire chain) and to create support for the product.
- A different driving force is needed than just sustainability and cost savings. The urgency towards sustainable alternatives to substrate accelerates the process.

PA78 - Newfoss II – The process — Uden, The Netherlands

Newfoss focuses in particular on grass flows that do not enter the food chain such as grass from nature reserves, along roads (roadsides) and from dikes. The possibilities for agricultural plant biomass such as vegetable residues are currently being investigated. Due to the high demand for sustainable substrate, upscaling to the regular market is possible.
The biorefining process allows large scale productions and in a sustainable manner as no chemicals are involved.
The cut grass is ensiled for sufficient availability all year round. The season and weather conditions influence the quality of the grass fibres. The biorefining process can be monitored and adjusted to ensure a homogeneous product with a constant quality.
With the patented biorefining process, NewFoss is able to separate the fibres and components from grass. The fibres are converted into semi-finished products that serve as raw materials for various industries: paper and cardboard, insulation material for construction and substrate for the agricultural sector (mushroom cultivation).
The substrate market is looking for alternatives to peat. While extraction from this raw material entails large emissions (methane, nitrous oxide), substrate based on fibres from grass is a more sustainable solution.
Ingredients from grass may be applicable as fertilizers, while the insulation material based on grass fibre offers perspective for the building materials market.

PA79 - Bioplastic granulate I – The product — Oosterhout, The Netherlands

Rodenburg Biopolymers (Rodenburg) has always been a family-owned company. Its founder Arie started to valorise agricultural residue streams right after World War II, starting by processing waste streams from the potato industry into cattle feed products. In the late nineties the business in cattle feed started to decline and from that moment the company started to look for alternative businesses. The company could rely on a strong and established network, availability of biomass/residual streams, and therefore took the opportunity to experiment with bioplastics based on potato waste streams. It kept on investing in innovative production processes and extensive R&D, and is now one of the experts in biobased (biodegradable) compound development and production.
Intensive R&D work has been realized in order to process potato wastes streams into valuable granulate. Besides the processing technology, also knowledge and R&D work is done to create a niche market in bio-

plastic products (same strength, lifespan, biodegradable characteristics etc.) Furthermore, by-products are valorised in other markets using extensive network and expertise of Rodenburg.
For the biobased company an increasing profit and turnover is realized since more and more consumers and plastic product companies are willing to use a non-fossil based granulate. A few years ago, Rodenburg was responsible for a 2 tonnes of biobased plastic products per month. In 2019 this has been increased to 30 tonnes of biobased plastic products per month.
With increasing scale, the costs of producing the biobased granulate lowers, but it has still a higher cost prices than fossil-fuel based granulate.

PA80 - Bioplastic granulate II – The business model Oosterhout, The Netherlands

Rodenburg processes residual streams from the potato industry into several semi-finished products. The main goal is the production of bio-granulate (bioplastic), processed from potato starch. The bioplastic can be used in industrial processes (extrusion/compounder) to produce all-kind of daily-life plastic products. Based on the characteristics of the end product, the granulate can be made for different product lifespans and/or in a biodegradable variant.
The business model sees the collaboration of two main actors: the potato industry, supplying potato residual streams, and Rodenburg, processing waste streams into bio-(degradable) granulate; valorising by-products into PET-food, wood- and paper binder, lubricate for drilling applications.
There is an increasing demand and supply of bioplastic products based on biogranulate (made out of potato starch). Any plastic product can be produced out of the different biogranulate semi-finished products of Rodenburg.
The potato industry, which is the main actor involved in the management of potato processing, has now a financial benefit in valorising a former waste stream (cost). While farmers have little benefits in this practice.
It has a production facility in Oosterhout (North-Brabant, Netherlands) and extended laboratory facilities.
The biomass comes from Belgium, The Netherlands and Germany, which supply potato residue streams from potato industry. Global network: sales of bioplastics and production of bioproducts.
A major strength behind this business model is the fact that Rodenburg had a reliable and well-established network in the agricultural waste stream industry and could therefore benefit from the supply stream.

PA81 - Biobased products from Posidonia Oceanica Achaea, Patra - Greece

The collection and disposal of accumulated dead seaweed tissue from the coastal Municipalities of Attica (25 in total) costs the Greek government €874,000 ca. annually. This sum can be reduced by recycling the dead leaves of left on the shores. PHEE is an innovative biobased company that invested in the idea of commercially exploiting the biomass of Posidonia Oceanica.
PHEE-board, is a biocomposite laminate material made from Posidonia and biological resins, that can be considered as a substitute to the widely used wood and plastic veneers.
The material is applied in the construction of furniture, interior design, accessories and packaging.
The company collaborates with Municipalities that every once a year are collecting the biomass from the most touristic and most easily accessible beaches.
PHEE is not removing on his own the biomass from the shores, they ask municipalities to deliver it in their production units to avoid that the product is burned or discarded in landfills, with clear environmental and

economic costs. With this practice municipalities avoid to pay the cost of disposing and wasting a valuable product. Indeed, regional/national regulation together with the strategic geographical position of the region have made possible a successful realization of this practice.
Yet, there is a huge need for municipalities, research organisations and end users to develop a protocol that will be followed strictly when removing this specific biomass from the beaches.
In addition, PHEEboard can be used as a raw material for different production processes and partnership with other stakeholders will be strategic.

PA82 - Natural and compostable straws — Kilkis, Greece

Last year's announcement by the European Commission that several single-use plastic products will be banned, has highlighted the need for alternative, more sustainable options. In this context, a social enterprise based in Kilkis (North Greece) is producing and marketing a single-use wheat straw that is 100% natural and compostable. The move may even help to lifting the economy of a region struck by the financial crisis.
Greek coffee-culture includes the daily consumption of up to three cups of chilled coffee, especially during the Spring and Summer months. Almost all chilled coffees in Greece are consumed using a plastic straw. Greek single use straw market is appx. 1 Billion straws per year.
"We thought of Staramaki as an alternative to the current agricultural output and it seems to benefit from the European legislation that bans single-use plastics around Europe. We came up with the idea because we are really interested in maintaining an economy in the area".
As the company has the capacity to process different type of biomass, they arrange special agreements in selling biobased straws with coffee shops that in turn provide coffee residue as a biomass input for further biobased products.
Wheat producers are involved from sowing until harvest. Expert profiles are involved in the sterilisation stage of the production. In general, the innovative business model has also a direct social benefit as it employs vulnerable groups in operations.
Coffee shops that buy Staramaki straws are given the option to receive additional straws if they send to the company coffee residues.
The value of wheat crops has been tripled as farmers obtain income from what was previously considered as a waste.

PA83 - Fatty acids from algae — Jihlava, The Czech Republic

Long chain unsaturated fatty acids (e.g., ARA, DHA, and EPA) are nutritionally highly valued. An industrial source of omega-3 fatty acids is fish oil that contains up to 30% EPA and DHA. However, the use of fish oil can be problematic for a number of reasons - unpleasant taste and smell, low product stability, high cost of for isolating the oil from a blend with other fatty acids. Environmental factors, like the risk of contamination of fish oils with toxic substances and overfishing are also important.
Microorganism "Japonochitrium marinum" can be an alternative source of these substances. It is a saprophytic species that occurs in salty waters on the surface of algae, organic detritus or vascular plants. The production strain was prepared by mutagenesis of the natural isolate - irradiation of the cells in the exponential phase of growth with UV light and subsequent selection of clones with high growth rate and DHA productivity. With appropriate culture conditions and limitation by key nutrient, the growing biomass can contain up to 16-25% of DHA in dry matter.

The dairy sector can gain important benefits from this process. In fact, the technology will allow further use of whey from milk processing, where waste salt solutions can form 50-95% of microalgae culture medium, leading to an efficient utilization of this problematic waste in the dairy industry.
At this stage of market development, it is difficult to quantify a direct benefit for farmers. However, a potential benefit can be seen in processes that entail large production of milk that generates high value-added by-products.

PA84 - Bioactive substances from grape residues — South-Moravian region, The Czech Republic

Most winemakers get rid of grape processing residues through composting practices. However, the production of derived products from this input can offer much more advantageous solutions. In cooperation with university, the Moravian winery has tested technological processes that allow the processing of almost all waste to derive products with higher added value.
In the production of wine, the pomace residue is produced after pressing the grapes. The pomace contains grape seeds with many valuable substances that can be drawn apart from the main pomace. From dried, cleaned and crushed seeds, grape oil is compressed cold under high pressure. It is made without any additives and preservatives to preserve valuable polyphenols, vitamins, lecithin and other bioactive substances. Wastes from this production are oilcakes, which can be used as cattle feed, but can also serve as a source for high quality gluten-free flour. The third by-product of wine production is pellets. These are made from partially grape marsh waste after the separation of the grape seeds and partly from the vine cut in the maintenance of the vineyard.
The innovative technology used in the winery allows recovery and use of almost all biomass from the vineyard. While composting was exclusively a cost burden, the introduction of new products brings a positive economic impact and strengthens the market position of the winery.
An important factor to take into consideration is the time for processing the residues. The whole process needs to be carried out in a relatively short period after harvest, especially for large volumes that have to be run fast enough to prevent damage caused by mould and other pathogens.

PA85 – Ecopanels I – The Business model — Czech Republic

In rice cultivation in India, local farmers usually have no use for straw waste. It is therefore burnt directly on the fields after harvesting. This practice contributes significantly to air pollution.
Another problem in the region is the limited resources of building material for growing populations, which results in a lack of cheap but good quality housing.
Currently, there is an interesting project for the construction of cheap houses using a technology developed in the Czech Republic. Waste straw is used to create high-quality building materials (panels) and to solve both of these problems simultaneously. The straw is collected from regional suppliers and transformed into panels.
The project is now focused on fine-tuning the technological process as to make the ecopanels from different types of straw and possibly other natural materials, while maintaining the high-quality properties that comply with the construction requirements.
In India, there is currently a short of approximately 44 million homes, according to a report by the GOI.

The challenge of the project is to build at least 5 percent of this number in the next five years. It could mean 2 million houses made from Ecopanels.
An important socio-economic factor is the creation of high-quality yet affordable social housing in India.
The wide availability of cheap biomass will allow low overall construction costs. However, in order to scale up the technology, the project requires stronger institutional and political support.

PA86 - Ecopanels II – The process — Czech Republic

In the ecopanels' practice, the innovation applies straw waste to create high-quality building materials. The main product is a building element that replaces classic building materials of plasterboard.
Ekopanel is produced by pressing straw under high pressure without the use of binders. Lignin, which acts as a natural binder, is released from straw sticks at high pressures and temperatures. Together with cardboard, it creates solid ecological and diffusion-open building boards.
Various types of straw may be used, including rice straw. The manufactured component is supplied in fixed dimensions.
Local farmers can valorise waste that is currently worthless (straw residues). When involved in a project, they may have a new by-product that will make a very significant economic contribution.
The implementation of the project will open up important markets to the technology supplier and significantly increase the company's turnover.
The current solution to the problem of housing and the use of unused waste has a significant synergy effect and will allow the stabilization of society in new markets.
The construction of a small social house in the countryside today takes about 2 months. The use of the Ekopanel system could reduce this time by up to half.
The implementation of the project will also create a new network of supplier-customer relations and opportunities.
The advantage is also excellent properties of building elements:

- attractive price
- easy mounting on wooden structures,
- the possibility of various finishes,
- strength and rigidity of the structure,
- excellent heat accumulation ability,
- highly fire-resistant,
- resistance to mechanical damage,
- very good thermal and acoustic insulation.

PA87 - Hydrolysis of chicken feathers I — Central Bohemian Region, Czech Republic
The business model

Feathers account for 5-7% of the total weight of the chickens. Currently, this waste, mixed with other slaughter waste, is usually converted to biogas by aerobic fermentation. However, feathers can be used to produce significantly more valuable products. One possibility is its processing in the form of hydrolysis.
This technology has great benefits, firstly in animal production, where waste (feathers) is used to produce high added value products. Another key application can be found in plant and animal production in the form of nutritional additives, protective spraying, etc.

For processors, the deployment of this technology is beneficial in expanding the product portfolio. An important factor is the ability to offer primary livestock producers a service that will help them to better locate and recover hard-to-treat waste materials.
The resulting product includes specific properties (amino acids, low molecular weight protein, free fatty acids) and it's useful as a stimulator or plant protection agent.
The technology is currently being tested in a pilot plant. Significant factors for widespread use include the form of waste materials (ratio of quill vs. plumage in the feathers used), optimisation of the conditions for isolating aspartic acid from hydrolysates, and the size of the hydrolysis equipment.
It may also be of interest to extend the treatment to other types of animal waste (eg animal hair) or to a possible mixture of animal and vegetable waste.

PA88 - Hydrolysis of chicken feathers II – The process — Central Bohemian Region, Czech Republic

Feathers account for 5-7% of the total weight of the chickens. Currently, this waste, mixed with other slaughter waste, is usually converted to biogas by aerobic fermentation. However, feathers can be used to produce significantly more valuable products. One possibility is its processing in the form of hydrolysis.
Feathers consist of 91% protein (keratin), 1% lipids and 8% water. Thanks to the new technology, feathers are treated by a patented process in an apparatus called autoclave, where hydrolysis is carried out at high pressure and temperature. The result is protein hydroisolates - solutions containing amino acids and partially soluble proteins.
A completely new procedure is used for the recovery of feather - bio-waste, which is difficult to process. This process is patented and includes, in particular, specific conditions for carrying out the hydrolysis and separation of the catalyst product.
The resulting hydrolysis products have significant effects on plant growth. When used as toppings, biomass growth, increased nutrient uptake, photosynthesis, increased stress resistance of plants and other positive factors have been demonstrated.
They can therefore be used in many applications:

- Humidification of composts, recycling of biogenic elements
- Protective spraying of plants (stress by drought, sunlight...)
- Nutritional additives for animal feed
- Nutrients for algae cultivation.

PA89 - 3PLW – Added value products from food and agricultural residues — Israel

3PLW is developing a comprehensive anaerobic digestion system for deriving fully biodegradable bioplastic from municipal and agricultural waste sources. The process converts the collected biomass into building blocks for bioplastic production, extracting maximum value for the conversion with minimal impact on the environment.
3PLW proprietary waste to biochemicals production process is based on the core principles of Anaerobic Digestion (AD). It entails hydrolysis of complex organic waste sources, and subsequent anaerobic fermenta-

tion. The novel bioprocess reduces AD residence times to less than 48 hours allowing greater productivity with a smaller process footprint.
3PLW transforms food and organic waste into high-value feedstock. The industrial process with near-zero carbon emissions footprint produces biodegradable plastic with reduced price, with the aim to attract new clients and markets.
The development of the business model was made possible thanks to intensive and successful research and the opportunity to develop a big scale operation and large employment of the end product.
The company's vision is a true circular economy scheme described as follows:

- 3PLW biorefinery: Co-generation of PLA, energy and compost
- Bioplastic production: products for major food companies, retailers and other consumers
- PLA food packaging: PLA is 100% recyclable and compostable
- Consumers: PLA food packaging can be discharged in the same bin as organic waste.

PA90 - APM – Hemp for the automotive industry — Bourgogne, France

APM is a French company established in 2013 through a joint-venture between Faurecia (a worldwide innovator in the automotive industry) and Interval, an agricultural cooperative.
The business model builds up on the opportunity to use the side steam of as raw material in the production of automotive elements, which allows weight savings in comparison with standard automotive plastics.
As a joint venture, APM masters the complete value chain from hemp's fields to production facilities.
There are no intermediary actors along the value chain. APM is a cooperative which has be co-founded by hemp producers with the objective of creating added value from hemp side streams, collaborating directly with hemp producers and the industry.
This facilitates the monitoring over the input material, which must comply with the high-quality standards set by the automotive industry for plastics components (in this case bioplastic).
The hemp and the compound are produced in France and sold in Europe and Asia.
First bioplastics compound was produced in 2014, while the latest grade NAFILean stiff has been awarded on new vehicles and will be largely applied by 2021.
All new grades use natural fibres as filler, which reduce density of the material, improve mechanical performances in thinner parts, and are fully recyclable in comparison with PP filled with glass fibres that are partly recyclable.
The business model revived the economy of hemp producers as it permits to have new co-products with high added value thanks to the diversification of hemp usage. It is also an important plant as almost all parts (seeds, fibres and granulates) can be used or sold. The plant also contributes to keep the soil clean from weeds while nourishing biodiversity.

PA91 - Biobased Insulation materials — Hesse, Germany

AgriCell, produced by the company Biowert GmbH, is an innovative grass fibre blow-in insulation material for wall, roof and floor cavities, made of 100% renewable natural cellulose from meadow grass. The goal is to substitute conventional insulation material based on crude oil and to use raw materials as efficiently as possible. A closed-loop manufacturing process was invented to avoid waste water or waste products that only utilises a minimum of resources. By this, AgriCell minimises the emission of greenhouse gases and maximises environmental resources compared to conventional insulation products based on crude oil.

The applied cradle to cradle approach (i.e. the product can be fully recycled without generating waste products or waste water) is environmentally friendly and resource efficient. The necessary energy in the form of electricity and heat is provided by the affiliated biogas plant, which runs with the by-products and residues of the biomass.
Biowert offers long-term contracts to farmers with increasing profits from the sale of meadow grass. With growing demand of AgriCell and other grass-based products, grass prices may rise and provide a secure income for farmers. Grass is easy to cultivate, only low input of labour, machines, and fertiliser are needed, also several harvests per year are possible. The cultivation of grass will not lead to a depletion of soils, as biomass residues that cannot be processed into 100% recyclable products are returned to the field as fertiliser.
Promotion of the end product at costumer-oriented events; cooperation with other building industries or architects that may use and promote AgriCell products as an alternative to conventional insulation products.

PA92 – Biobased Diapers — Brandenburg, Germany

Fairwindel is a small enterprise that produces sustainable diapers, which consist almost completely of renewable materials and are 100% compostable.
The first idea of Fairwindel was born because the inventors used ¾ of their trash bin for diapers. When they realized that diapers contain a large amount of mineral oil, especially in the component that stores the liquids (superabsorber - SAP), they started to search for ecological and biodegradable alternatives.
The main problem was the so called superabsorber which was hard to replace because of its good suction power. Yet, the method developed by the company is able to replace the superabsorber produced from mineral oil with a biodegradable version of it.
The whole concept of the company can be labelled as "environmentally friendly" and responds to the concept of circular economy.
The farmers direct benefit is not clarified yet. But most of the ingredients contained in the diaper are made from organic materials (like potato or corn starch) which could increase the involvement and sales of local farmers.
Fairwindel is still a small company which makes the impact of its biobased products quite small. The solution has a clear environmentally-friendly content, but costs twice the price of normal diapers. Yet, Fairwindel is growing and their demand for biobased products is expected to increase.
The concept also pushes a more sustainable thinking around products and sectors that until now had lack of involvement or interest in applying circular approaches. The idea is capturing the public interest and made its appearance on the media several times, while being nominated for the GreenTec-Awards 2017.

PA93 – Biobased Ethanol — Craiova, Romania

Sunliquid is a brand that produces ethanol from agricultural residues like corn or cereal straw. The idea behind *Sunliquid* is to use parts of the plants which are not in concurrence with food and feed production e.g. straw, excluding the eatable part of cereal or corn plants. The product is a cellulosic alcohol obtained through a method that saves almost 50 percent of the energy because able to ferments C6-sugars in addition to C5-sugars fermentation. The entire process originates from the lignin obtained as residue in the biomass.

Ethanol is versatile and can be used in many ways. The most known brand in Germany using the ethanol produced by *Sunliquid* is FROSCH, which adds it to its *bio spirit cleaner*.
This practice was developed thanks to an EU-funded project and mainly involves local farmers working with these plants.
Clariant (producer of Sunliquid plants and developer of the process) sees a huge potential in the global cellulosic alcohol production because of the cheap process.
In fact, this method is energy self-sufficient and can save up to 95 % of greenhouse gas emissions compared to fossil ethanol production.

PA94 - Grass Paper Labels I – The business models Hesse, Germany

The company K-D Hermann, that invented the grass paper label has a long history of responsible and sustainable productions. The company owns a distilling plant for their waste and a water treatment plant for their wastewater. 90% of the liquid production waste is used as a substitute fuel for the processing energy demand.
With the new grass paper labels, the company takes sustainability to a new level. The sustainable production chain is guaranteed due to the close vicinity and the water and energy saving characteristics of the fast-growing biomass. The sustainable process of grass paper (reduction of process chemicals in contrast to wood pulp paper) and its recyclable/compostable properties are a further step towards an eco-friendly business.
The medium sized company K-D Hermann offers labels containing 50% of the sustainable and fast re-growing biomass grass. The self-adhesive labels are especially environmentally-friendly in the production, saving significant amounts of water, energy and CO2 emissions. The biomass is locally grown, harvested and transported. The grass paper product itself is recyclable and compostable.
50% of the material is made of an established FSC Mix certified pulp; the other half however is made of sun-dried grass. The resource is not only renewable but can be harvested several times a year from nearby extensively unused meadows, thus keeping transport distances at a minimum.
The local farmers gain a further income with the supply of the virgin fibre material from their otherwise extensively unused meadows. The harvest and therefore supply of the fast-growing resource take place several times a year, adding to the value of the revenue.

PA95 - Grass Paper Labels II – The process Hesse, Germany

A German company has developed a high-quality grass paper labels that can be used both for industrial as well as commercial labelling. Retailers that want to establish an eco-friendlier design in general or want to re-brand single bio-products, can resort to the grass paper labels from K-D Hermann.
The fibre feedstock saves water utilisation during the processing since less than 1l per 1t grass fibre is needed instead of 6000l/1t in the conventional wood pulp production. Furthermore, the innovative process saves up to 80% energy (grass pulp 1t - 150 kW/h compared to 1t - 6000 kW/h). Both energy and water savings lead to a CO2 reduction of about 4.8 tonnes, guaranteeing a sustainable production chain.
The practice shows a wide range of benefits for the actors involved in the business model:
Economic benefits for the company:

- High level of added value
- High energy savings of up to 80% compared to wood pulp

- High water savings – practically no water necessary for the product processing (less than 1l per ton grass pulp)
- Promotion of regional associations: Long-term agreements for biomass supply and partnerships with other regional to global stakeholders
- Development of a new technology for biomass processing

Economic benefits for the farmers:

- Constant availability of the biomass due to several harvests each year
- Revenue is much higher compared to former utilisation which was none (unless they were ecological compensation areas as required by the federal government)

Niche product:

- The increasing requirements from customers of organic high-end products can be met, i.e. eco-friendly appearance and actual highly sustainable processing of the product

PA96 - Insulation materials from cereal straw — Bavaria, Germany

Each year, an estimated 30 million tons of crop straw occur as an agricultural side product in Germany. This makes up almost half of the entire mass from cereals harvest. Between 25–45 % of the raw by-product from food production can be removed from the field and reprocessed for other uses without harming the environment, recent studies suggest.

Landpack is the first company worldwide to make straw process fully automatic without use of adhesives and further additives.

The classical insulation material styrofoam is based on oil. Straw as an agricultural side product, will not only increase resource efficiency by substituting oil, but furthermore does not compete with food production.

The natural packaging products of Landpack are innovative, ecological and long term sustainable due to their reusability and compostable properties. The new Packaging Act [enacted January 1st 2019] urges all companies that circulate goods initially to private consumers, e.g. online retailers, to adopt more ecological packaging solutions.

The in-house developed and internationally protected Landbox® from Landpack, is the worldwide first completely biodegradable insulation packaging comparable to styrofoam (Internal temperature below 4°C for up to 65 hours). The product is made of pure straw without any additives. Due to renewable energies their production is climate-neutral and regional farmers as resource suppliers complete the sustainable picture.

The purchase of trade partners' crop side-products, e.g. straw from spring barley, offers farmers a second income apart from selling grains. Adaptations on the farmer's machines for the necessary type of bale pressing were partly realised with European and national funds.

2 Annexes

Annex 1: Template for the Enabling's practices

Format for best practice collection	
Defining the Background context: **Why have you developed this practice/process?** **What have been the reasons that prompted, led or encouraged the realisation of the business model, process or activity?**	
Short summary of the practice: **Description of the process, activity or business model.**	
Region(s) involved	
List the main actors involved and what activities they cover, or have covered, in the practice or business model.	
In what phase is the innovation? (What is the Technology Readiness Level? See Figure 2 in the handbook).	
What is innovative in the process? **How has it been developed?**	
What is the expected or final outcomes of the activity?	
What is the benefit for the famers involved in the value chain? How is this value created?	
What is the benefit/added value for the biobased product companies involved in the value chain? How is this value created?	
What is the benefit/added value for other practioners or end-users involved in the value chain (retail, logistics, service markets, consumers)? How is this value created?	
Identify and describe other factors that have made possible, or can make possible, a successful realisation of the practice/activity.	

Annex 2: Practice Abstract Template

Practice "abstract" 40:	*Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.*
Short title in English (0-150 characters)	
Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English* This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	
Short title in native language (0-150 characters)	
Short summary for practitioners in native language (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	

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