BioTWINE hop waste transformation into novel product assortments for packaging and horticulture sector

Marjan Plavčak, Spring awakening of hop fields, Slovenia

Press release

LAYMAN'S REPORT

LIFE18 ENV/SI/000056
With the contribution of the LIFE Programme of the European Union

INŠTITUT ZA HMELJARSTVO IN PIVOVARSTVO SLOVENIJE
Slovenian Institute of Hop Research and Brewing

Lankhorst Yarns

TRIDAS
ENVIROMENT FRIENDLY PACKAGING

Razvojna agencija Savinja
Gospodarsko interesno združenje

Tecn packaging

TECO
Slovenian Tool and Die Development Centre

Zelfo TECHNOLOGY

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR

BRASLOVČE · POLZELA · PREBOLD · TABOR · VRANSKO · ŽALEC

ZDRUŽENJE HMELJARJEV SLOVENIJE

Outline

At the European level, there were in 2017 about 50,000 tonnes of hops produced on a surface of 26,500 ha. Slovenia produces nearly 2,800 tonnes on 1,590 ha annually and is currently ranked as the 3rd EU's largest hop producer, and the 5th in the world. The hop agricultural sector is the largest exporter in the agricultural segment in Slovenia, therefore it also has a great meaning for Slovenia's international visibility. Hop training systems in Europe are still based on wire or polypropylene (PP) twine trellises, usually guided for about 6-7 meters above the ground on a regular arrangement of wooden or concrete poles. The hop biomass after harvest yields up to 15 tons/ha (fresh matter) per season. Nevertheless, the PP twine mixed with hop's plants cannot be properly composted or recycled, only landfilled. IHPS has already been trying to find technical solutions and alternatives for PP twines. LIFE BioTHOP project will assure besides a better solution to the PP twine, adding tangible value to the industry by hop waste upcycling.

The goal of this project was to replace polypropylene (PP) twines used on the hop fields with a biodegradable, made of polylactic acid (PLA) which is produced from renewable materials, and that can be degraded by composting into water, CO2 and biomass. The use of PP twine leads to a non-trivial disposal process at the end of the growing season as hop plants and twine need to be separated in order for these waste streams to be handled according to established environmental regulations. By using a PLA twine for the support of the crops, the hop plant biomass after harvest can be used as main ingredient of composting together with the twine and as a natural fertiliser or material to produce biodegradable products (bio-composites, planting pots, and packaging trays). Therefore, the agro-waste can be drastically reduced and bring significant added value to this agro-waste stream via bioplastic compounders and processors. The demo region, which is the Lower Savinja valley in Slovenia, will be an example of good practice for all the hop-growing regions not only in the EU but also across the world. The project will also benefit in socio-economic value as it can improve the green or so called eco-tourism. The goal is to completely recycle the hop waste and to improve energetic efficiency by 25% by using the biopolymeric composites. Considering greenhouse gas emissions, there should be a significant reduction compared to conventional plastic production and disposal.

Objectives

- ✓ To introduce new PLA twine as fully competitive product to PP twine
- ✓ To use hop biomass as material for composting
- ✓ To use hop biomass as material to produce biodegradable products (bio-composites, planting pots, and packaging trays and else)
- ✓ To introduce circular economy with biomass waste
- ✓ To reduce plastic waste in hop growing sector
- ✓ To raise awareness among farmers about the impact of plastic and about composting
- ✓ To share good practices in hop growing and other agricultural sectors

BASIC PROJECT INFORMATION

Project name: LIFE BioTHOP, LIFE18 ENV/SI/000056

BioTWINE hop waste transformation into novel product assortments for packaging and horticulture sector

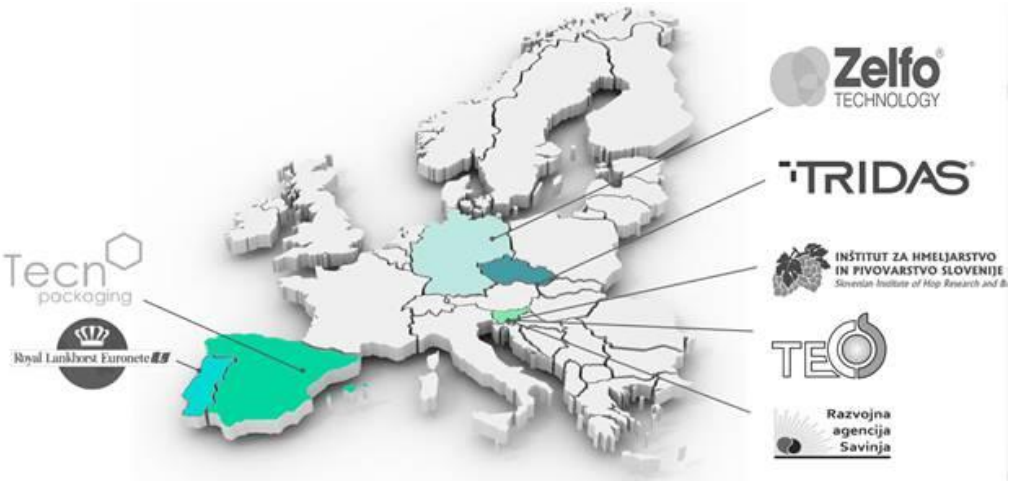
COORDINATOR BENEFICIARY

INŠTITUT ZA HMELJARSTVO IN PIVOVARSTVO SLOVENIJE
Slovenian Institute of Hop Research and Brewing

IHPS: Inštitut za hmeljarstvo in pivovarstvo Slovenije
Cesta Žalskega tabora 2, 3310 Žalec, Slovenia

ASSOCIATED BENEFICIARIES

Lankhorst Euronete (Portugal) - LEP
Zelfo Technology (Germany) - ZT
TRIDAS (Czech Republic) - TRIDAS
Tecnopackaging (Spain) - TECNO
Slovenian Tool and Die Development Centre (Slovenia) - TECOS
Development Agency Savinja (Slovenia) - DAS



START DATE: 01/07/2019 **END DATE:** 31/06/2022

TOTAL BUDGET: 1,919,901 €

EU CONTRIBUTION: 1,055,945 € (= 55% of the total budget)

WEBSITE: life-biothop.eu **EMAIL:** barbara.ceh@ihps.si

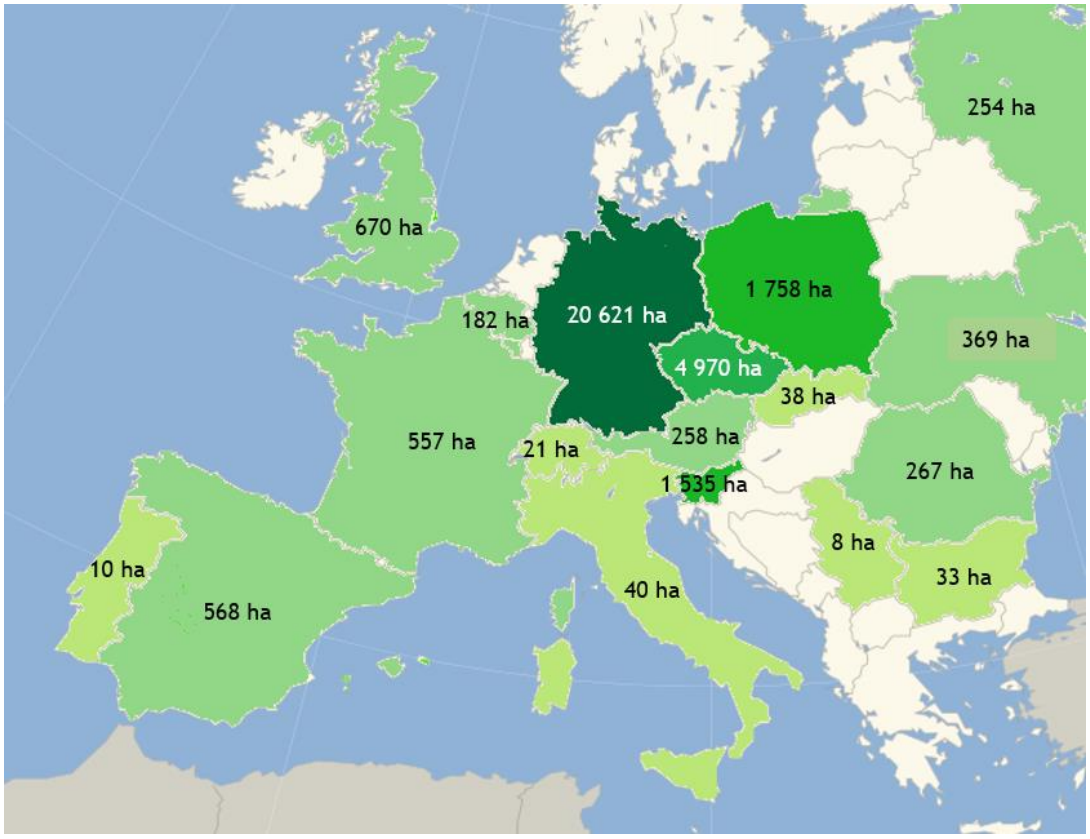
The BioTHOP project was financially supported by the LIFE program, the **Ministry of the Environment and Spatial Planning of Republic Slovenia** and 6 municipalities of Lower Savinja Valley, the biggest hop-producing region in Slovenia, and by the **Association of Slovenian Hop Growers**.

The LIFE programme is the EU's funding instrument for the environment and climate action created in 1992. The current funding period 2014-2020 has a budget of €3.4 billion. The EU LIFE provides funding opportunities for the support of Environment, Nature Conservation and Climate Action projects throughout the EU. The maximum EU co-financing rates for projects are 55%, 60% or 75%, depending on the project topic.

Regional importance

BioTHOP project was closely affiliated with all 6 municipalities of Lower Savinja Valley, which also co-financed the project (Municipality of Braslovče, Municipality of Polzela, Municipality of Prebold, Municipality of Tabor, Municipality of Vransko and Municipality of Žalec). Lower Savinja Valley is the biggest hop producing region in Slovenia, which in total owns close to 1,100 ha of hop plantations. Cofinancing of the project also included Slovenian Hop Growers Association, which are the users of the biodegradable twine for hop twining, they perform composting and returning the compost to the agricultural land and on the other hand own biomass after harvest, which can be also use as a raw material for various biodegradable products.

With close than 1100 ha of hop fields, Lower Savinja Valley with its 6 municipalities accounts more than 3% of European hop production



Hop acreage in Europe in 2021 related to country

Actions

Action A1	Field tests with current PLA Twine & Hop waste preparation	Before starting with LIFE BioTHOP, IHPS was carrying out preliminary tests of the commercially available PLA Elite Bio Twine, produced and supplied by LEP in hop gardens. Different types of that twine were tested and with some material modifications it was found that PLA twine would be a suitable replacement for the polypropylene twine. IHPS also tested other naturally derived twines for hop growing (made of coconut, hemp, jute, cellulose fibres). However, the PLA was selected as the most promising one. So, in summer of 2019, field tests on 30 ha of hop gardens in Lower Savinja Valley (the demo region of the LIFE BioTHOP project) was performed. This was followed by collection of hop waste after harvest for Action B1 and used PLA twine for tests in Action B2 in September 2019.
Action B1	Hop waste transformation into new valuable feedstock	Action B1 was implemented by IHPS in partnership with LEP involving work/collaboration by/with the hop growers. In 3 years, right after harvest 225 tons of hop biomass was set in composting experiments in order to prepare technological guidelines for proper composting. Many observations, measurements and analyses were made and results were analyzed. ZT was working on technology for improving hop fibres extraction from waste hop biomass in two ways – one for plastics based processes and one for ligno-cellulosic pulp forming. Tecnopackaging was focusing on the biocomposite material production and optimization.
Action B2	Adjustability of PLA twine for hop-growing sector	Action B2 demonstrated the feasibility of using the modified PLA twine in the hop growing industry. LEP coordinated action, in special related to PLA twine production and optimization. IHPS validated the modified PLA twine in relation to the hop growing experience requirements and capabilities for on-site composting, making further recommendations for its optimization and performing adaptability.
Action B3	Demonstration Pilot in Packaging Sector	Action B3 demonstrated the feasibility of using the transformed hop waste fibre sheets in the packaging sector. It was coordinated by TRIDAS, who is special related to packaging demonstrator applications. ZT optimized the process for fibre crumbs, formed from the recovered hop waste material, making recommendation for their further processability.
Action B4	Demonstration Pilot in Horticulture Accessories Sector	Action B4 demonstrate the feasibility of using the recovered fibres from hop waste residues in reinforced PLA composite materials, intended for injection moulding application in horticulture production sector. TECOS coordinated the action, in special related to the horticulture demonstrator production. Tecnopackaging optimize the biocomposite material formulations, which were based on hop fibres supplied by Zelfo Technology.

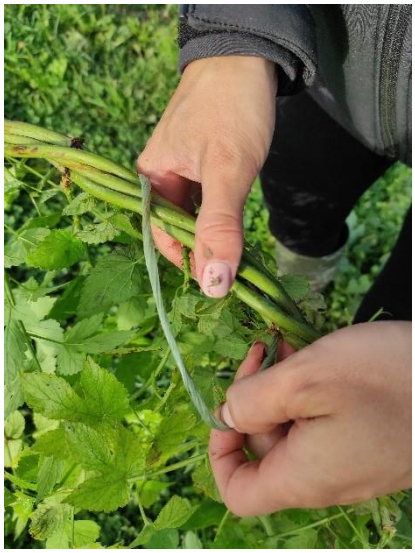
Action B5	Replicability and Transferability	In Action B5, we transferred our solutions to other areas of the EU and to other industrial sectors. According to the instructions of the project staff, the BioTHOP twine was installed, tested and composted in 7 EU regions outside the Lower Savinja Valley, which was a demo region, namely Koroška, Ptuj, Ormož, Saaz in the Czech Republic, Belgium, Serbia and Austria. The twine was also tested and introduced in the production of vegetables, namely in the production of high beans in hop trellis and in the production of tomatoes and eggplant in greenhouses. A range of different products were made from the biocomposite, namely playing bricks, pots for the cosmetics industry, shoehorns, phone holders, harvesting machine fingers, thermoformed trays for the automotive industry, paper, beer coasters and coffee capsules.
Action C1	Monitoring the project impact	Action C1 included key indications for a successful project execution and completion, project monitoring and impact evaluation. Both are in the role of the effective measure for the correctly assigned project progress and for timely perception of any potential delays, technical and/or economical conflicts, which could occur during the implementation of the project.
Action C2	Conclusions and recommendations	Conclusions and Recommendations of the project are based on the monitoring. The evaluation compared expected objectives with the progress results of the preparatory action (A1) and implementation actions (B1-B5) to evaluate the project's outputs and the benefits of its products.
Action D1	Communication strategy	The main objectives of the communication strategy were to ensure a proper and correct delivery of information, and sufficient impact of the project's development & results. We also released the influential results to the targeted audiences, with the use of adequate media and interactive communication channels.
Action D2	Dissemination of the project results and stakeholders involvement	In Action D2 all partners disseminated the project results at local, regional and international level and boost the involvement of stakeholders during and after the project execution. Actions contributed to raised awareness among the citizens, SMEs, large companies, associations, municipalities, clusters, agro cooperatives, research institutes and government institutions about the harvested hop waste management and valorisation, and bioplastic product benefits for the environment.
Action E1	Project management	Project management includes the overall management of the project, following the latest LIFE Regulation Amendments and the procedures and governance structure as agreed in the Partnership Agreement, including the project's own Steering Committee Board. It set up the practical direction for the project by orchestrating its technical activities in an orderly and seamless manner. The fulfilment of the project's key goals were done through periodical and detailed control of all actions/sub-actions, and always following the schedule and financial commitments proposed in the work plan.

Twine optimisation

The successful development of the hop Bio Twine has led to a new era in the waste biomass management for hop growers. So far, hops had been mainly grown using Polypropylene (PP) twines in Slovenia which limits the value of the waste biomass. The use of PP removes the possibility to compost the waste in order to recycle it onto useful soil amendment.

Hop field with BioTHOP twine

In other regions, steel wire is used as a plant support. Steel wire can be recycled onto more steel products and is ill suited for a compost pile. Other solutions include natural fibres such as jute or sisal. Nevertheless, these solutions are more expensive and only some growers can afford them.



Sampling BioTHOP twine for analyses at the end of hop growth season

The twine optimisation involved the Slovenian Institute of Hop Research and Brewing, Lankhorst Euronete Portugal and the hop grower community in the Savinja valley. The starting point was an existing product, the Elite BIO twine, which was developed for tomatoes and peppers and used mainly in greenhouses in northern Europe.

The new twine evolved iteratively during three seasons from 2019 to 2021, and each year it was improved in order to satisfy the exacting requirements of the BioTHOP project.

The resulting product is a strong twine which is easy to handle and that can offer a robust guide and support for the hop plants, even during inclement weather events.

The twine has been tested for compostability both by the growers in the Savinja valley and also by an independent certified laboratory in accordance to the ISO 13432 standard. This means that it will quickly degrade in a compost pile, getting transformed onto lactic acid that can be digested by bacteria.

BioTHOP twine on the hop field

BioTHOP twine (green) after 2 months in a compost pile

The twine was launched commercially and available for hop growers worldwide in the year 2022.

Hop waste transformation into new valuable feedstock

With implementation of the BioTHOP twine, the hop biomass after harvest became a valuable material **for composting and for fibres extraction**.

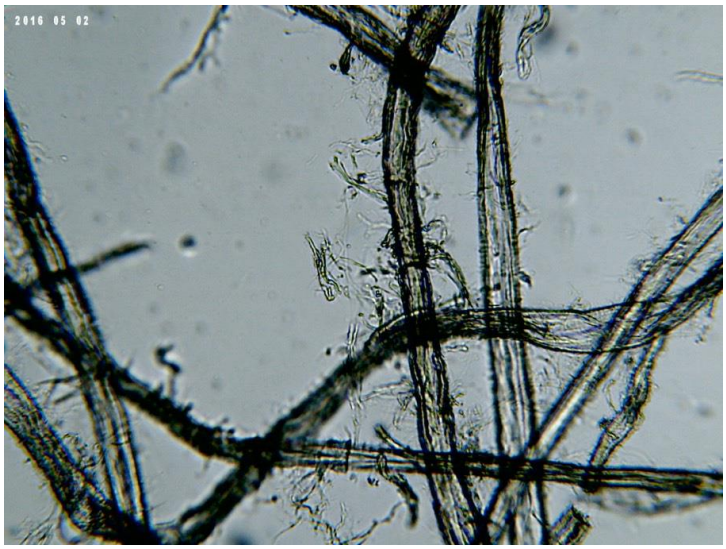
In close collaboration with hop growers from Lower Savinja Valley, which was the project's demo region, macro experiments with 675 tons of hop biomass after harvest were performed by the **Slovenian Institute of Hop Research and Brewing** during the three years in order to find the proper way of this biomass composting. The first steps comprised of the study of the post-harvest hop biomass, the nutritional content, the size of various particles and different ways of collection. Then, many different methods and their combinations were tested. The degradation of biomass was followed by the daily measurement of the temperature and by visual observation, chemical analyses were reviewed. Selected compost piles were subject to an aerated regime and these were aerated by mixing and turning of the material. The BioTHOP twine in the compost piles lost its strength and almost whole degraded in first few months already.

At the end of the process, composts were rich in nutrients, sufficient enough for further use. The percentage of organic mass was over 35%. Biological tests showed that they were stable and ready to use. Twine degradation was better when hop stems were cut on small pieces and the pile was aerated according to guidelines. The twine degradation was slower at the edge of the pile, therefore the compost has to be turned few times. The biomass itself is good composting source, especially when reduced to small particle sizes of 3–5 cm.

Composting the whole biomass after harvest (leaves and stems) is more efficient as composting stems alone, as it provides more nutrients and less empty spaces, thereby generating a longer thermophilic phase, which is crucial for PLA twine degradation and hygienisation as well. The combination of small particles of biomass and frequent turning of the pile are two most promising factors for efficient composting. Technological guidelines for proper on site composting were implemented at the end of the project.

The hop biomass after harvest was also used as a source for fibre extraction. A procedure for a valuable raw material production for its operative demonstration was developed by partner **Zelfo Technology**.

This fibre material is used later in the BioTHOP process for production of biocomposite, that can be used for various products, and wine bottle transport trays production.



Zelfo process defibrillated/engineered ligno-cellulose fibre

Two different fibre type combinations are required to fulfil the production requirements of two separate product forming systems (1. Plastics based processes; 2. Ligno-cellulosic 'pulp forming'). Hop stalks are the key component of both systems, the plastics forming system contained PLA twine whilst the pulp formed product fibre mix contained cellulose fibre twine.

ZT produced a fine 'filler type' material for the plastics products which fulfilled both the processing and the end-product requirements. The Pulp formed products required a 3-dimensional fibrillation of the fibre to create a fluffier mix which structurally merges with the standard pulps used in the product forming.

The hop biomass was also used as a source for the development of 'agro-residual' fibre containing materials.
To achieve this goal Zelfo Technology employed their fibre engineering processing system to demonstrate the production of valuable raw materials from the hops residuals. Specifically, the fibre materials were used for production of bio-composites utilising plastics production technologies and in addition using a separate forming technology, wine bottle transport trays.

Modified fibres from hop waste biomass

Clean defibrillated hop fibre

Test product production quantities of the materials were delivered in 2021 and have been successfully employed in the manufacture of both types of end products.

In regard to the Wine Bottle packaging, based on current understanding of the market the use of fibre containing agro-industry cellulose twine, the BioTHOP product is in terms of an innovation, a world first.

Biocomposite

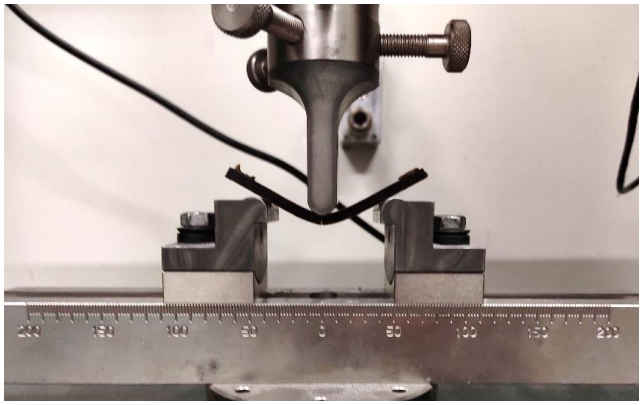
The pulverized fibre is then sent from Zelfo to TECNO, Spain, where the manufacturing process of BIOTHOP biocomposites starts. The first step is to make the fibre pass through a thermal treatment to remove all humidity content on it. The removal of internal moisture is crucial to obtain a material of high quality.

Compound extrusion machine (COPERION

Then the compounding process begins. The dried fibres are mixed with a biobased polymeric matrix derived from starch, a biodegradable material which will give the final biocomposite a high level of elasticity, since the horticulture pots need to have a high flexibility and to be highly deformable.

The materials are fed into an extruder machine, which is an equipment that can mix several materials by heating them and propelling them forward until the mixture comes through a die in a cylinder cross-section shape (a thread).

When getting out of the die, the new BIOTHOP material is hot and cannot be manipulated, so it must be cooled down. A long water bath is positioned in front of the machine die, using it to decrease the temperature of the obtained thread. Finally, at the end of the water bath, a machine called “pelletizer” chops the thread into small granules.



Mechanical characterization of the BIOTHOP composites

The resulting biocomposite pellets must be post treated, to remove any trace of humidity gathered during the cooling step of the compounding process. After the secondary drying, the material is packed and sent to TECOS, in Slovenia. There it is mixed with PLA and used for production of injection moulded planting pots as horticulture accessories.

Every formulation developed for the BIOTHOP project was submitted to mechanical characterization, by performing standardized ISO tensile and flexural tests. In an iterative process in which ZELFO, TECOS and TECNO collaborated closely, the BIOTHOP formulations that were according to the benchmark mechanical properties were upscaled and used for the injection of planting pots. TECOS would give feedback about the material performance, and modifications were made (if needed).

Biocomposite pellets

Demonstration Pilot in Packaging Sector

TRIDAS produced the packaging demonstrator – the box inserts for wine bottles packaging, based on pulp moulding technology, with the material supplied by Zelfo Technology (ZT). ZT rendered the hop waste suitable for pulp moulding applications, i.e., in a "pulp-like" form and as a ready-to-use input material for TRIDAS. We used mix of hop stems and cellulose twine material, as it was the most suitable for the producing process. The objective of this action was to be able to use hop biomass after harvest as replacement of part of TRIDAS usual input material. In the end, only 50% hop waste and 50% cardboard offcuts were used in the production process.

Forming of trays and transfering to the belt

The moulded fibre packaging is ecologic packaging material with tradition and future. TRIDAS is using renewable resources like recycled materials, old newspapers, cardboard waste or virgin pulp, eucalyptus paper, sugar cellulose, bagasse or recycled input raw material like agricultural waste. All of products are 100% recycled and recyclable, compostable and are CO_2 and NO_x neutral. The moulded fibre is produced without toxic substances and with a very low impact on environmental load. The production is 100% natural friendly. Moulded fibre packaging is offered as sustainable products, fully biodegradable, and in compliance with the ISO, OHSAS, and FSC certificates and with EU standards for eco-points.

Wet trays going to the oven for drying

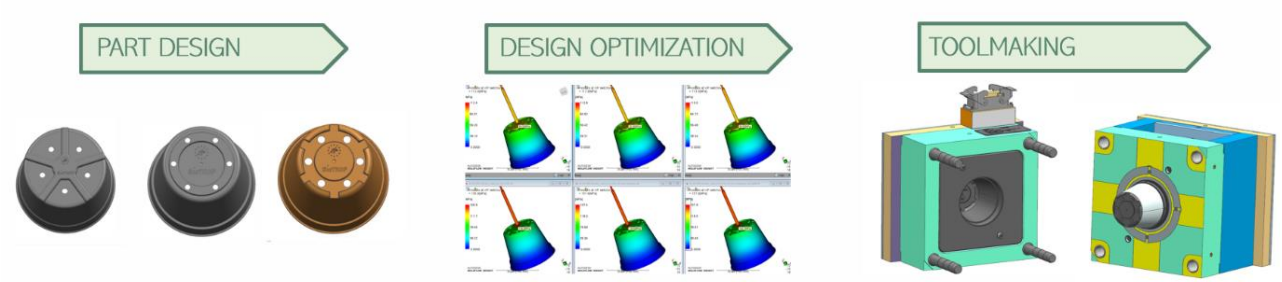
hop waste fibre sheets as one of the input materials brought the idea to develop the product, which will cover the market demand and offer even more eco-friendly variant for moulded fibre products. At the same time, it will contribute to a circular modular approach and zero agro-waste management. TRIDAS use 50% recovered and modified hop waste fibre crumbs as one of the input materials and 50% carton offcuts for new packaging demonstrators: TRAYS BOX INSERTS for wine bottle packaging.

TRIDAS has own design, research, development and modern production technologies, high level of quality and large production capacities. Moulded fibre products from TRIDAS have unlimited applications in a variety of industries. The opportunity to use

Final product - wine bottle tray

Demonstration Pilot in Horticulture Accessories Sector

TECOS developed biodegradable planting pots for different kinds of plants in horticulture production sector. These containers are based on biobased & biodegradable thermoplastic matrices, which are reinforced with natural re-engineered hop fibres. Fibres were recovered and modified by partner ZELFO Technology, while the bio-composite was developed with the plastic compounding technology by partner Tecnopackaging.



Final material formulations, which contains approximately 20% of hop fibres is at the end injection moulded into the mould. The objective of this action was to demonstrate feasibility of using the hop waste fibres in reinforced bio-composite materials and replace existing fossil fuel-based conventional planting pots. The implementation action's sequence includes the part design, tooling production, part production, validation and end-of-life testing.

The resulting demonstrators were validated for the cultivation of hop seedlings by IHPS in the first trimester of 2022. The Action also involved the production of demonstrative plating pots (2,000 demos) for IHPS's hop plant seedling, made of newly developed 100% biodegradable composite material produced by TECNO, on a small-series pilot production line located at TECOS' facilities. They were made in different material proportions, and IHPS evaluated which one is most suitable for planting pots. IHPS's yearly consumption of planting pots for hop seedling purposes exceeds the 150,000 pcs, thus the importance of introducing green alternative materials for such purposes is exceptionally high.

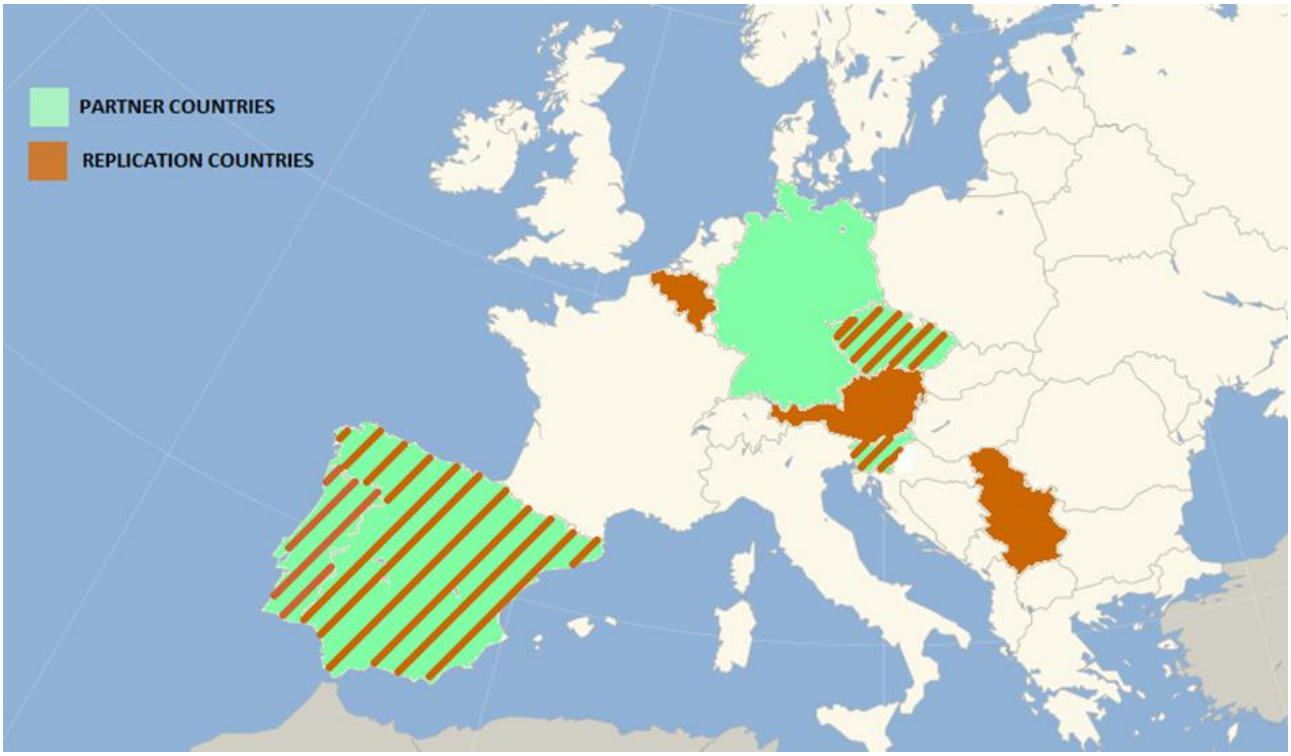
Trial planting of hop seedlings

BioTHOP planting pot with compost

Replicability and Transferability

It was planned to replicate and transfer the BioTHOP results to other EU regions and industrial sectors. The replicability and transferability of project results were on three-fold level: other transformation processes (extrusion blow moulding), new applications (bio-films), and trans-regional (demonstrative replication implemented in at least 5 other EU States).

The replicative regions for BioTHOP twine in hop production were **Steiermark Region in Austria, Saaz Region in Czech Republic**, and three Slovenian regions: **Koroška, Dornava and Ormož**. The BioTHOP twine was tested there in 2021 on 1 ha in each region. The twine in Czech Republic was tested alone, as replication of BioTHOP results, and also in a combination with iron string which is their common practice; in this technology they replaced 25 cm of plastic twine, that is commonly knotted to the iron string in order to be fit on the construction. Beside this, the twine was replicated in 2021 also to other EU hop regions on smaller scale: **Belgium, Serbia, Portugal** and **Severna Primorska region** (SI).



In all Slovenian replicative regions, Belgium and Serbia, there were no major problems with BioTHOP twine, they found it as a good replacement for polypropylene twine. The problems appear in regions, where their common technology is with iron string instead of twine; it these regions (Czech Republic and Austria) hop growers have very different cutting systems in the harvest machines. While the iron string is because of its structure easy to cut, with softer twine there were problems with twining on the harvest knives and other rotating parts. Because buying new harvest machines is a big expense, for the start the BioTHOP twine in these regions will replace the 25 cm part commonly used as polypropylene twine in a combination with iron strings.

Various products from BioTHOP biocomposite were developed: thermoformed covering trays for automotive industry, buttons, playing bricks BioTHOP. The materials & products were transferred to other sectors & applications (example: FMCG sectors in Spain & Germany).

The guidelines for transferring the BioTHOP materials to other potential sectors and applications were elaborated for fast up-take of the project results of our products/services.

BIOTHOP PRODUCTS, MADE FROM HOP WASTE

- COMPOSTING
  - COMPOST
    - 
- HOP FIBRES + PLA EXTRUSION
  - INJECTION MOULDING
    - PLANTING POTS
      - 
    - PLAYING BRICKS, BUTTONS, COSMETIC POTS, SHOE HORNS AND PHONE HOLDERS
      - 
      - 
      - 
    - THERMOFORMED TRAYS FOR AUTOMOTIVE INDUSTRY
      - 
    - HARVESTING MACHINE FINGERS
      - 
    - PACKAGING TRAYS FOR WINE BOTTLES
      - 
- RENDERING HOP FIBRES + CELLULOSE
  - PULP MOULDING
- DRY HOP STEMS
  - BEER COASTERS
  - PAPER
    - 

Communication actions

17 scientific / professional papers

Photo Competition “HOP & ENVIRONMENT”

Networking with 38 projects, 4 SI regions and 7 countries

1 project brochure
3 press releases
5 flyers
9 newsletters

674 FB page followers, 261,789 views within social media

Project presented to 337,300 visitors on the fairs

FB (261,789 views, 674 followers)
Instagram (282 followers)
LinkedIn (221 followers)
Youtube (37 videos)

1,698,970 newspaper and radio recipients / TV viewers

2 nominations:
ZT and TRIDAS announced **as key innovators by the EC Innovation Radar** as one of the Market Creating Innovation “Hop waste fibre sheets reused for wine bottle packaging” in 2021 and
BioTHOP project **one of the finalists in the idea category** within the “NEW TECHNOLOGIES IN AGRICULTURE” by Agrobiznis (SI) in 2021

www.life-biothop.eu (5,283 users, 27,493 page views)

24 articles in magazines and newspapers

Long term environmental impact of the project

The BioTHOP Project aimed to reduce the quantity of plastic twine waste from the hop growing sector. By introducing the biodegradable BioTHOP twine the replacement of part of the plastic twine was achieved. Moreover, farmers were able to make their own compost from hop waste intertwined with this twine without sifting compost and separation of plastic twines. More ways of use of hop wastes have been introduced, as they can be used in packaging and horticulture accessories sector.

The revalorization of hop biomass and its inclusion into biobased polymeric matrixes target the further reduction of fossil based plastics usage. The two main BIOTHOP outcomes (horti-garden pots and molded packaging commodities) have demonstrated to be high quality products able to compete with their fossil-based counterparts. The outcomes not only comply with their mechanical functionality, and once their lifespan as packaging or pots is finished, they can be used once again for compost.

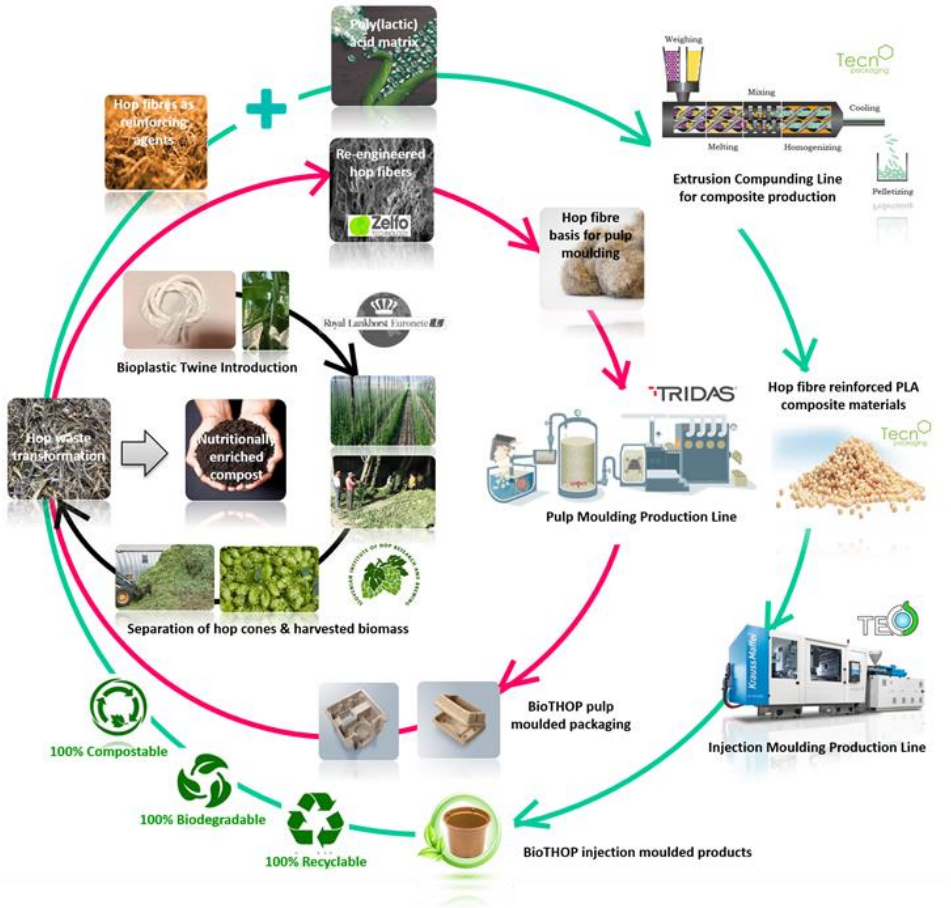
Find us on: www.life-biothop.eu

LIFE BioTHOP introduced a 100% recyclable and compostable twine into hop fields, as an environmentally friendly alternative to polypropylene twines, which are in use nowadays and which degradation in the nature can take up to 450 years.

To fulfil the requirements of the circular economy, the project partners were aiming to use the hop biomass after harvest and, together with this new twine, produce new bioplastic products in horticulture, agricultural and plastic packaging sectors.

Layman’s report was made with the contribution of the LIFE financial instrument of the European Union.

The project was coordinated by the **Slovenian Institute of Hop Research and Brewing** and consisted of 6 more partners from 5 EU states: Portuguese **Lankhorst Euronete Group**, German **Zelfo Technology**, **TRIDAS** from Czech Republic, Spanish **Tecnopackaging**, **Slovenian Technological centre TECOS** and **Development Agency Savinja**.



Circular Economy Model of the LIFE BioTHOP Project

Biodegradable BioTHOP PLA twine for hop plants

Modified fibres from hop waste residues

Hop biomass compost

Bio-composite formulation from hop waste residues

Biodegradable planting pots

Biodegradable wine bottle transport tray