



BioTHOP LIFE18 ENV/SI/000056

BIOTWINE HOP
WASTE
TRANSFORMATION
INTO NOVEL
PRODUCT
ASSORTMENTS FOR
PACKAGING AND
HORTICULTURE
SECTOR



“The LIFE BioTHOP project has received funding from the LIFE Programme of the European Union.”

The BioTHOP project is supported by the **Ministry of the Environment and Spatial Planning of Republic Slovenia** and affiliated with **6 municipalities of Lower Savinja Valley** (co-financed by the municipalities of Braslovče, Polzela, Prebold, Tabor, Vransko and Žalec), the biggest hop-producing region in Slovenia and co-financed by the **Association of Slovenian Hop Growers**.



REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR

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.

Beneficiaries:



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

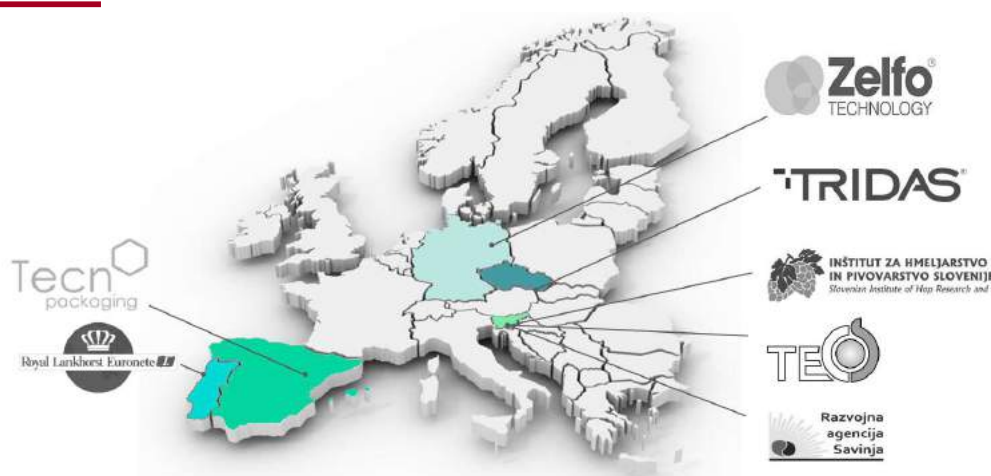


The goal of this project is to **replace polypropylene (PP) twines used on the hop fields with a biotwine made of polylactic acid (PLA)** which is produced from renewable materials, and that can be degraded by composting into water, CO₂ and biomass. The use of PP twine leads to a non-trivial disposal 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.

LIFE BioTHOP will **introduce 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 are 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**.

The project is coordinated by the **Slovenian Institute of Hop Research and Brewing** and consists 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**.



Start date: 01/07/2019
End date: 30/06/2022

Find us on: www.life-biothop.eu



Project's KoM on 17th July 2019 in Žalec, Slovenia

BACKGROUND

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.

Hop biomass
after harvest
with
intertwined
PP twine



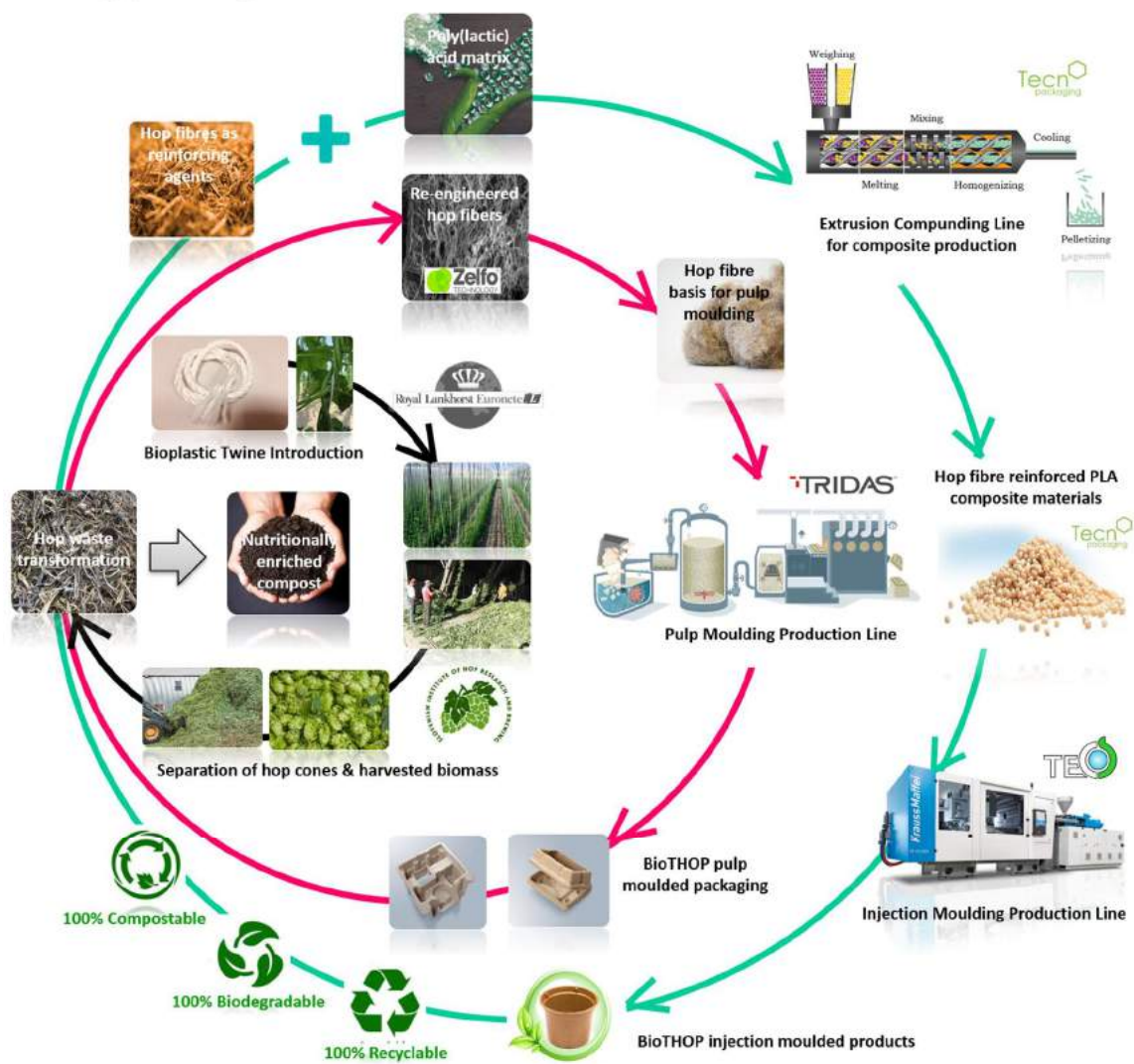
BioTwine and hop in A1 Action

COORDINATING BENEFICIARY AND THEIR ROLE IN THE PROJECT



The Slovenian Institute of Hop Research and Brewing (IHPS) is a research, development, advisory and educational public organization, established in 1952. Its principal functions are research and advisory services in growing field crop plants with emphasis on hops, brewing and a production of medicinal and aromatic plants. The R&D fields are complemented by applied projects relating to agriculture, environmental impact, as well as the preservation of the environment. Specific research areas in agribusiness are focused on field crops production technology, plant breeding, especially hop breeding, management and marketing.

IHPS is the Coordinating Beneficiary of the LIFE project BioTHOP and takes over the management of the project and monitors the project's impact, as well as working on dissemination. Its technical role is to replace polypropylene twines with biodegradable and compostable PLA twines in hop-growing industry and therefore 100% enlarge usability of hop biomass after harvest. The quality valorisation of the compost, consisting of hop biomass after harvest and PLA twine, will be investigated as a potential organic fertilizer. IHPS role is also to test the new planting pots, produced by partner TECOS within the project, in hop plantlets production.



Circular Economy Model of the LIFE BioTHOP Project

ASSOCIATED BENEFICIARIES AND THEIR ROLE IN THE PROJECT



Lankhorst Yarns, the industrial textiles division of Lankhorst Euronete Portugal S.A., is specialised in producing and delivering high-quality yarns and tapes. They are a worldwide supplier within selected Product Market Combinations (PMC). Their company's greatest assets are: the high quality of our products, flexibility, excellent service (including after sales) and high reliability. Customers see them as a quality supplier with a high level of innovation and a sustainable approach to the market and the environment. With newly developed sustainable products, they are making an important contribution to the reduction of waste. They define and develop new markets in response to new developments in sustainability. For example, Lankhorst Yarns is a key innovator when it comes to the use of compostable yarns.

Project role: Development of on-site compostable PLA twine for hop-growing sector.

Find more: www.wirecworldgroup.com



Zelfo Technology was formally established in 2011. Using patented technology and extensive knowhow, Zelfo Technology engineers ligno-cellulose fibre from a wide variety of sources to create self binding fibre for use as bio-binders, reinforcing agents, pulp formed products and composites. Beyond fibre engineering, their technology is designed to deliver additional material and chemical properties resident in various forms of bio-mass. With a wide spectrum of partners and clients Zelfo Technology has extensive relationships with international businesses and corporations.

Project role: Re-engineering of hop waste fibers to be usable in fiber pulp moulding applications and extrusion compounding transforming processes.

Find more: www.zelfo-technology.com



Tecnopackaging is a technology-based company specialised in the production of advanced nanocomposites & blends, including the development of plastic parts & packaging, particularly for industry application, and moulding of polymer parts with a high-quality surface & high requirements. Tecnopackaging main purpose is conducting R&D on advanced polymeric materials and their transformation processes industrial plastic applications, targeting companies which operate directly or indirectly in the agri-food & other industrial sectors such as automotive, construction, biomedical & aeronautical. Currently Tecnopackaging develops all its activities keeping in mind circular economy and bioeconomy perspective, analysing in each case the different alternatives that would reduce the environmental impact of both their products and processes.

Project role: Production of hop fiber PLA compounds for injection piloting & replication on extrusion blow moulding for producing films from BioTHOP materials.

Find more: www.technopackaging.com



TRIDAS ranks among prime European moulded fibre producers. At present it manages three production facilities covering the total area 22,000 m². Since 2018 TRIDAS has 9 fully automatic production lines providing a high variety of manufacturing and of products. The whole process is supervised by the quality control department, in compliance with the ISO, OHSAS, and FSC certificates. Its advantage is our own design and technology department, which is involved in the development of end products and manufacture of production moulds. Its own development and modern production technologies, as well as vast warehouses provide to their customers high-quality and flexible services.

Project role: lead of the piloting action on hop-waste fiber transformation into pulp moulded packaging products.

Find more: www.tridas-pulp.cz



Slovenian tool and Die Development Centre, TECOS, was established in 1994 to represent the collective interests of the Tool, Die & Mould-making (TDM) Industries. TECOS today operates on three dimensional assets, as Research and Development Centre, International Business Cluster and VET Institution, providing applicative engineering and plastic transformation processing services not only for TDM industry but also for other metal-plastic production companies in Slovenia and EU.

Project role: TECOS will lead the piloting action on injection moulding of plating pots for horticulture, in particular for hop seedlings cultivated by IHPS. Additionally, TECOS will have a strong impact on the external stakeholders' involvement, as it will link all the important actors of the bioplastic industrial chain (see LOIs) to strengthen the inter-sectoral cooperation on the B.5 Action, and to prove that BioTHOP materials can be effectively used in multi mass production sectors.

Find more: www.tecos.si



Development Agency Savinja was founded in 1998. It is located in the Lower Savinja Valley (unites municipalities Braslovče, Polzela, Prebold, Tabor, Vransko and Žalec), which is part of the Savinja region. Its founding and associated members are all 6 municipalities and the Chamber of Private Enterprises Žalec. Municipalities represent the largest hop growing region of Slovenia and strongly support the BioTHOP LIFE project proven by their co-financing contribution. The Agency cooperates with the supporting environment - institutions, organizations, farmers, hop-growers, companies, NGO's in different fields. Besides many projects where DAS cooperated there are two most important references: Establishment of The Eco-Museum of Hop Growing and Brewing Industry in Slovenia and the project From the chest of grandmothers and grandfathers for the wealth of grandchildren – harvesting of hops.

Project role: DAS will stimulate the active hop-growers involvement, disseminate, exploit and transfer the project results regionally & transnationally.

Find more: www.ra-savinja.si

TARGETED EU LEGISLATION

BioTHOP will support EU policies that are linked to emphasizing the importance of transforming the EU into a resource-efficient and low carbon economy zone, with particular focus on turning waste into a resource, with more prevention, reuse & recycling leading to a circular bioeconomy model.

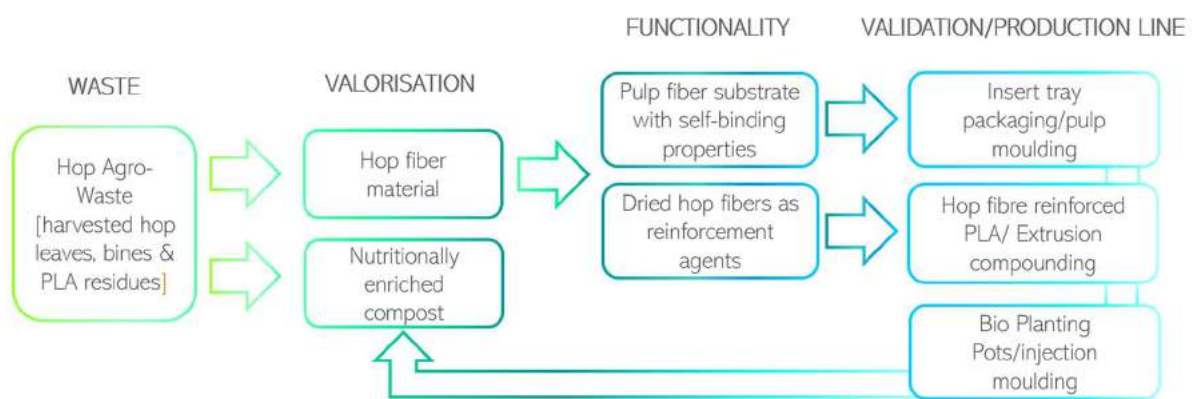
- ✓ Roadmap to a Resource Efficient Europe (COM (2011) 571)
- ✓ Resource-efficient Economy "Doing more with less"
- ✓ Safeguard the Union's citizens from environment-related pressures and risks to health & wellbeing
- ✓ Information up-dating "Best decisions on latest data"
- ✓ Towards Circular Economy
- ✓ Eco-design Directive (2009/125/EC; COM123, 2013)
- ✓ European Strategy for Plastics in Circular Economy (COM (2018) 28)
- ✓ Zero Waste Programme for Europe (COM 2014, 398)
- ✓ Waste Framework Directive (EU directive 2008/98/CE)
- ✓ Directive on the landfill of waste (COM 2014, 397)
- ✓ Using plastic more sustainably (COM 2013, 123)
- ✓ Thematic Strategy on the Prevention and Recycling of Waste (COM 211, 2013)
- ✓ EU Rural Development Policy
- ✓ "Innovation for Sustainable Growth: a Bioeconomy for Europe (COM 60, 2012)"
- ✓ Europe 2020 "Sustainable growth for a resource efficient, greener & more competitive economy"



Circular Economy in a Hop Production Agro Sector

EXPECTED RESULTS

- Optimised polylactic acid (PLA) twine specifically adapted for hop-growing sector: with improved resistance, training & harvesting manipulation, on-site compostability & potentially biodegradable in soil.
- Hop biomass after harvest as potential biofertilizer: properly composted hop biomass after harvest compost with PLA fractions will be valorised for the essential plant nutrients (N, P, K, Ca, Mg & S) - as organic fertilizer.
- Three new 100% biodegradable materials recovered from hop agro-waste: (1) hop fibers as filler additives, (2) hop fiber reinforced PLA biocomposites for injection moulding, and (3) hop fiber crumbs for pulp moulding applications.
- Demonstration of new products for horticulture sector: 2,000 injection moulded planting pots.
- Demonstration of new packaging items: 2,000 hop moulded packaging insert trays.
- Reaching an audience of at least 2,000 local consumers in the BioTHOP community and 10,000 website visitors: Awareness-raising on sustainable agricultural practices & hop agro-waste revalorization.
- Analysis of replicability & transferability: New materials will be validated in at least 5 other final products, and transferability of BioTHOP practice will be implemented in at least 5 other EU States (Austria, Czech Republic, Croatia, Spain & Germany).



Demonstrative Character of BioTHOP – Three new PLA product families are to be developed

The implementation actions for the optimisation of hop fibre extraction and posterior treatment of hop biomass with PLA residues and for the valorisation strategies of using hop fibres in industrial applications, namely packaging and horticulture product accessories will take place through the three demonstration stages.

END-OF-LIFE TREATMENT OPTIONS

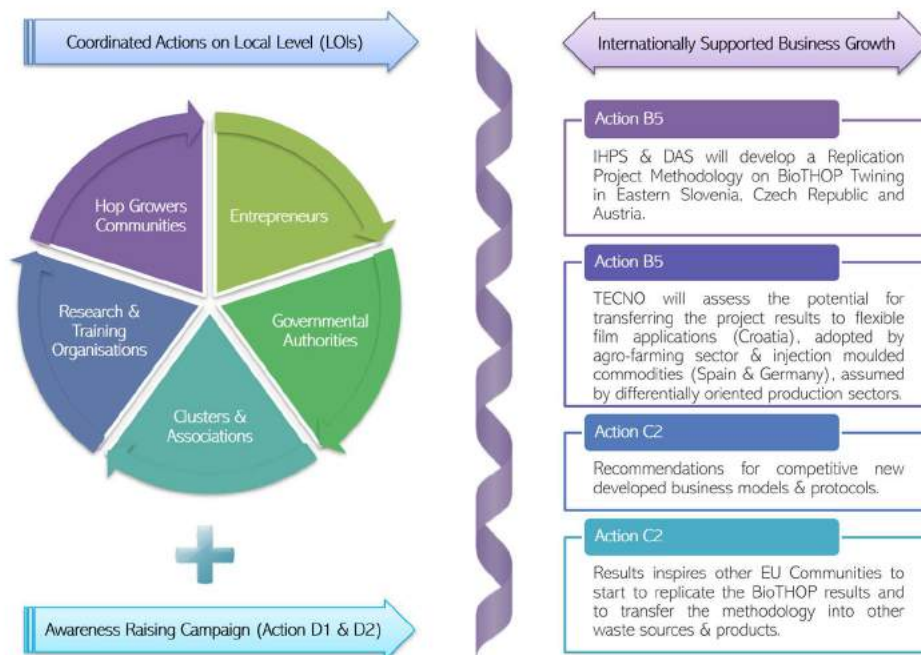
- the hop growers will be given the opportunity to decide how to redirect their side products after the harvesting process in a hop industry



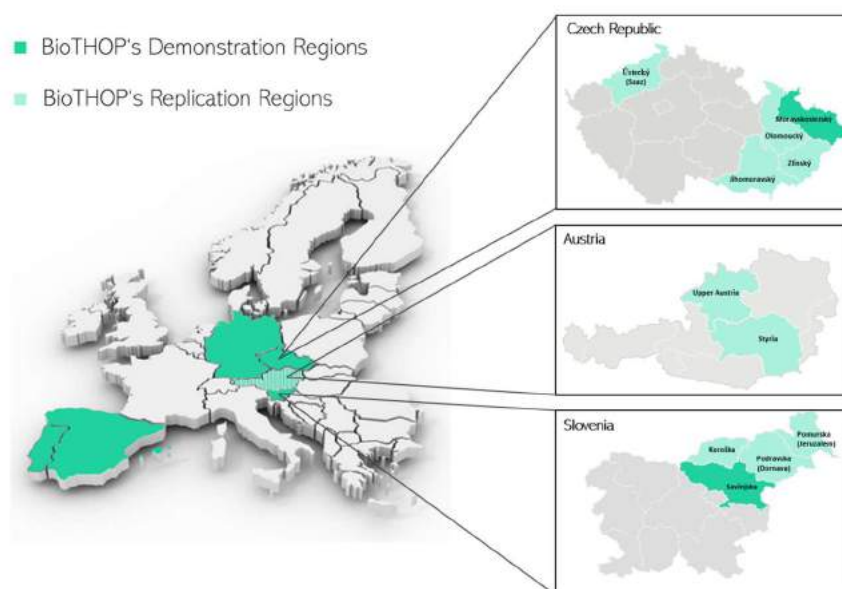
THE REPLICABILITY AND TRANSFERABILITY OF PROJECT RESULTS

The replicability and transferability of project results will be on three-fold level:

- ▶ other transformation processes (extrusion blow moulding)
- ▶ new applications (bio-films)
- ▶ trans-regional: information updates to 34 stakeholder organizations from the 20 Member States of the International Hop Growers' Convention (www.ihgc.org) and on spot project results application in 5 EU States: Austria and Czech Republic - , Croatia, Spain & Germany



Replication and Transfer Strategy



Replication methodology of BioTHOP hop growing practice

Results from July 2019 to August 2020

BioTHOP twine

The field tests on 25 ha at the Slovenian Institute of Hop Research and Brewing (**IHPS**) and hop growers of the project's demo region Lower Savinja Valley (Slovenia) were completed in the Summer of 2019. **Lankorst Yarns** carried out an extensive analysis of the available data and reports from the farmers in order to optimize the design of the hop twine. The focus for the modifications on the twine for the 2020 season was on 3 key drivers: strength, on site compostability and efficiency. This led to development of twines with different raw materials, processing conditions, additives and put-up. In spring 2020, the new modified twines were delivered to **IHPS** to be installed on 15 ha of hop fields in order to perform the field tests for the new season. Twelve hop-growing farms collaborate in testing this year and the response on the field has been very positive so far.



The optimisation of the twine and composting protocol will continue in season 2020/2021.

Guidelines for proper composting of hop biomass after harvest, intertwined with BioTHOP twine

After testing the twine on the fields in 2019, 100 tons of hop biomass after harvest was prepared in 9 heaps by **IHPS** in order to test different ways of onsite composting to get the best possible compost and degradation of BioTHOP PLA twine. Treatments were combinations of material type (leaves and stems, only stems, different cutting lengths) and by added accelerators (biocharcoal, effective microorganisms, Glenor, manure ...), heaps were aerated or not. Different parameters were followed during the process. The composts tested in spring 2020 had stimulatory effect on seed germination and plant growth. The twine degraded better when whole biomass is shredded into very small pieces therefore the nutrients are easily available to organisms for degradation. This way, the twine inside of the best composts is almost invisible.



Future modifications of the formulations will be focus on increasing the flexibility of the pots.

BioTHOP biodegradable composite based on polylactic acid and modified waste hop fibres

Tecnopackaging has developed the first generation of biodegradable composite materials based on PLA and modified waste hop fibres, produced by **Zelfo Technology**. The aim during this year was to set preliminary formulations to reach the end-users final requirements incorporating the maximum amount of hop fibres in them. For that purpose, several percentages of fibres were mixed with PLA to validate their potential mechanical properties (flexural and tensile conditions) and their automatized machine processability. Further iteration on the formulations were performed by integrating plasticizers and aid processing additives to enhance the obtained characteristics. The most promising blends were then produced at a higher scale and sent to **TECOS** to perform injection trials. Feedback from **TECOS** was sent back to **Tecnopackaging** to twist the PLA-hop fibre composites blends.

BioTHOP planting pots

In the first year of project duration project partner **TECOS** presented the first prototypes of plantings pots. Around 100 planting pots were sent to the project partner Slovenian Institute of Hop Research and Brewing (**IHPS**), where hop seedlings were planted in the pots to validate their durability and functionality. Planters are produced from the first batch of biocomposite material, which contains hop waste fibres and additives to enhance material properties.

Based on analysis and tests of first planting pot prototypes and discussion with hop growers and **IHPS**, some modifications will be made to the second iteration of material with the focus on increasing flexibility of the material and decreasing the length of the hop fibres, while maintaining the biodegradability function and the content of waste fibres.

Production of a new generation of prototypes is planned after the hop harvesting season in



2020 when a new batch of hop fibres will be prepared by **Zelfo Technology** and compounded with biodegradable matrices at partner **Tecnopackaging**.

BioTHOP planting pots – first testings

In summer 2020 the first batch of BioTHOP planting pots was planted with hop seedlings in the greenhouses of **IHPS**. They already grow and enjoy the new environment. We will observe their response all the time until their transplantation to the fields.



BioTHOP biodegradable bottle trays

Team of **TRIDAS** engineers with designers decided how the packaging should look like to suit general wine bottle and designed 3D design sample of wine bottle packaging with top and bottom part of closable packaging which should ensure safer packaging. The technical design was made with all measurements of general wine bottle packaging. The material, from which the wine bottle packaging is made, including hop material with added fibre which is normally used for packaging.



Replicability in other EU regions and agro sectors

The BioTHOP twine is in 2020 already in replicative hop region **Koroška** on 1 ha, where it responds fine by now. In **Germany** there is cca 1 ha of hop fields with industrial compostable PLA twine in combination with iron string, split over 5-10 growers. In **Notranjska region (Slovenia)** there is Zajec craft brewery with small demo hop field with BioTHOP twine next to the brewery. Two hop farms in **Portugal** use BioTHOP twine in 2020 season, as well.

We test / demonstrate BioTHOP twine in **high bean production** in hop trellis on 0.5 ha and at two eco farms for garden high bean production.

By now users are satisfied.





Monitoring

On 25 ha hop fields polypropylene (PP) twine was replaced with PLA twine in 2019. After harvest, 375 tons of hop biomass intertwined with biodegradable PLA twine was environmentally friendly eliminated: composted or converted into secondary raw materials (in further processes); by this 1,125 cubic meters of landfill space were saved. 1,550 kg less PP twine was used and consequently 221 kg of plastic twine did not accumulate in soil. We saved 1,987 kg CO₂ eq. emissions with replacing PP twine with PLA twine of application bioplastic material (PLA twine) - 6.3-times less releases of CO₂ are emitted with bioplastic materials in comparison to their fossil-based alternatives, namely.

Dissemination

We established corporate visual identity of the project, brochure and dissemination materials and spread the word about our LIFE BioTHOP project among **stakeholders, the general public and the mass media** regularly.

The project is very well accepted by **stakeholders, policy decision makers, co-financers, other LIFE or EU projects and the local community**; they actively interacts at events with many questions regarding the issue and they support the biodegradable and on-site compostable BioTHOP twine, technology solutions and products that this project will provide. All results is disseminated also on-line regularly.

You are kindly invited to follow us on:
www-life-biothop.eu, FB, LinkedIn, Instagram



Acknowledgements:

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The contents of this brochure do not reflect the opinion of the EU Institutions.



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



Lankhorst | Yarns

TRIDAS®

ENVIRONMENT FRIENDLY PACKAGING



Razvojna agencija Savinja
Gospodarsko interesno združenje

Tecn^o
packaging



Slovenian Tool and Die Development Centre

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