

REPLICATION MAGAZINE

FROM UNUSED LAND TO A BIOECONOMY RESOURCE



HUNGARY

Cultivating Land with Low
Organic Matter



SPAIN

Cultivating in Dry Conditions
and High Temperatures



GREECE

Rehabilitating Degraded
Soils



SWEDEN

Agriculture in Cold
Climates



GERMANY

Paludiculture in Peat Soils

PEOPLE

NATURE

REGIONS

SOLUTIONS



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SEEING POSSIBILITY WHERE OTHERS SEE LIMITS

Dr Philipp Grundmann, MarginUp! Project Coordinator



I have always been fascinated by landscapes that seem to have been left behind. Land shaped by difficult soils, drought, waterlogging or an industrial past. Spend time in these places, however, and talk to the people who live and work there, and you begin to see something very different: **possibility**.

That feeling has stayed with me throughout MarginUp!. Marginal land is not land without value. It can become a place where nature recovers, where farmers and businesses explore new opportunities and where rural regions build a more resilient future.

Our five European Use Cases have shown me just how diverse that potential can be. In Germany, biomass from rewetted peatlands is being turned into peat-free horticultural substrates, while rewetting can avoid around **20–30 tonnes of CO₂-equivalent emissions per hectare each year**. In Sweden, turnip rape has already demonstrated yields of **450–600 litres of biodiesel per hectare**. In Spain, hemp and kenaf are opening new pathways towards bio-based construction materials, with the Use Case targeting **8–10 tonnes of biomass per hectare**.

But some of the results I find most encouraging cannot be measured simply in tonnes or litres.

Biodiversity has been part of our thinking from the beginning. Across the Use Cases, we have examined what new forms of land use mean for birds, pollinators, vegetation, soils and carbon storage. The German Use Case, for example, shows how rewetting can combine productive biomass use with better habitats and increased soil carbon. For me, this is crucial: we should not measure the success of marginal-land use by what we harvest alone, but also by what we give back to the landscape.

And we have learnt to be humble. Not every crop works everywhere, and not every new value chain is automatically sustainable. Our Policy Brief therefore calls for better local evidence, reduced financial risks, stronger cooperation and policies that consider environmental, economic and social benefits together.

This is why I see this magazine not simply as a record of what MarginUp! has achieved, but as an invitation to look differently at these landscapes.

What if we stopped defining marginal lands by their limitations and started asking what they could become, for nature, local communities and a more sustainable bioeconomy, and how we can turn this potential into viable business opportunities? What innovative business models and exploitation opportunities exist, and how can we build sustainability-driven businesses that address real societal needs, create value across the entire value chain, and turn new knowledge and innovation into viable economic opportunities?

After everything we have experienced in MarginUp!, I believe that question is worth pursuing.

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FROM EVIDENCE TO OPPORTUNITY



HUNGARY: CIRCULAR MUSHROOM PRODUCTION

The Hungarian Use Case uses alternative biomass to make **mushroom production more circular and resource-efficient**. It can replace **25–35% of conventional straw**, while spent mushroom substrate offers further opportunities for valorisation. The approach connects local biomass resources with circular food production.



SPAIN: BIO-BASED MATERIALS FROM MARGINAL LAND

Hemp and kenaf are grown on low-productivity Mediterranean land to supply **renewable fibres for construction materials**. Biomass yields target **8–10 tonnes per hectare**, with residues also used for biogas and biofertiliser. The Use Case combines new products with benefits for soil, carbon storage and biodiversity.



GREECE: A NEW FUTURE FOR POST- MINING LAND

In Western Macedonia, former lignite-mining areas are being transformed through **land restoration and new bio-based value chains**. Robinia biomass is used as a renewable fibre source for MDF, while lavender creates additional opportunities. The approach links economic renewal with ecological recovery.

A close-up photograph of turnip rape plants growing in a field. The plants have green, lobed leaves with serrated edges. The soil is dark and moist. The background is blurred, showing more plants and a hint of a fence or structure.

SWEDEN: RENEWABLE FUEL FROM THE FARM

Turnip rape is being used to produce **biodiesel directly on the farm**, achieving approximately **450–600 litres per hectare**. Press cake can be reused as animal feed, strengthening the circular approach. The model connects renewable energy with farm resilience and rural value creation.



GERMANY: FROM REWETTED PEATLANDS TO NEW PRODUCTS

Rewetted fenlands provide biomass for certified **peat-free horticultural substrates**. Yields reach **3–12.7 tonnes of dry matter per hectare**, while rewetting can reduce emissions by **20–30 tonnes CO₂-eq/ha annually**. The approach combines productive land use with biodiversity, soil carbon and regional value creation.



SOUTH AFRICA: TURNING INVASIVE TREES INTO A RESOURCE

The South African Use Case turns an environmental challenge into an opportunity by using **invasive alien trees as biomass** for biochar, pellets and wood chips. Removing these species can help restore native biodiversity, improve water availability and reduce wildfire risks. At the same time, the biomass creates **new circular value chains and economic opportunities** from land restoration.



Stellenbosch
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ARGENTINA: NEW OPPORTUNITIES FOR SALINE SOILS

In Argentina's Pampas, MarginUp! explores how **saline, waterlogged and flood-prone land** can support new sustainable value chains. Winter oilseeds, biofertilisers and edible mushrooms from native biomass are being investigated as productive alternatives. The approach combines **soil recovery, biodiversity and circular biomass use** with new opportunities for local agriculture.



**Universidad
Nacional
de San Martín**

HOW MARGINUP! IS GIVING OVERLOOKED LAND A NEW ROLE IN EUROPE'S SUSTAINABLE FUTURE

Across Europe, large areas of land are difficult to farm. Poor soils, drought, flooding or the legacy of industrial activity have left many landscapes outside conventional agriculture. **MarginUp! asks a simple but important question: What if we looked at this land differently?**

Rather than trying to force marginal land into intensive farming, the project explores how carefully selected crops and sustainable cultivation can create **new opportunities for farmers, rural communities and the bioeconomy**, while protecting soil, biodiversity and natural resources.

Across **five European Use Cases**, this idea takes very different forms. Germany combines rewetted peatlands with biomass for peat-free horticultural products. Greece explores new opportunities on former lignite-mining land. Spain grows hemp and kenaf for bio-based construction materials. Sweden turns turnip rape into biodiesel, while Hungary investigates alternative biomass for more circular mushroom production.

International experiences from **Argentina and South Africa** add another perspective, showing how difficult soils can support resilient agriculture and how invasive biomass can become a resource rather than a problem.

MARGINUP! AT A GLANCE

What connects all these activities is a broader idea of value. **Success is not measured by biomass alone.** MarginUp! also looks at healthier soils, biodiversity, viable businesses and opportunities for the people who live and work in these regions.

Marginal lands will not replace Europe's most productive farmland, and not every marginal landscape should be cultivated. But where conditions are right, they can become part of the solution: **restoring landscapes, creating renewable resources and opening new opportunities for sustainable farming and rural communities.**



29
organisations



5 + **2**
European + International
Use Cases



2022-2026



€7.83M



Horizon Europe

OVERSEAS EXPERIENCE WITH EUROPEAN IMPACT

TWO USE CASES IN SOUTH AFRICA AND ARGENTINA

MarginUp! extends its perspective beyond Europe to understand how marginal lands can become productive while strengthening **biodiversity, soil health and local livelihoods**. The international Use Cases in Argentina and South Africa address very different landscapes and challenges, but both offer valuable experience for developing sustainable and replicable bio-based value chains in Europe.

ARGENTINA | MAKING DIFFICULT SOILS PRODUCTIVE AGAIN

In the Flooding Pampas around Chascomús, **Lotus tenuis** is being tested as a resilient pasture crop on saline, alkaline and periodically flooded soils. The results show strong potential: biomass yields reached **6.8 t/ha**, protein content increased to **14%**, and monthly cattle weight gain reached **15 kg**. At the same time, the approach investigates improvements in soil quality, biodiversity and pasture resilience, demonstrating how degraded agricultural land can regain productive value.

FACTS:

6.8 t/ha of biomass | **14%** protein | **15 kg/month** cattle weight gain | **>80%** pasture cover

SOUTH AFRICA | TURNING AN ECOLOGICAL THREAT INTO A RESOURCE

South Africa takes a different approach by exploring how **invasive alien trees can become a resource for biochar production**. Their removal supports ecological restoration, while the harvested biomass provides feedstock for a potential circular value chain. The reference scenario models **873 tonnes of biomass** and around **240 tonnes of biochar per year**, potentially supporting **300 jobs** and generating additional value through carbon credits and avoided restoration costs. These figures are scenario values used for analysis rather than outcomes achieved by MarginUp!.

FACTS:

873 t/year biomass | **240 t/year** biochar | **300 jobs** | **€74,035/year** potential carbon-credit value

LESSONS TRAVELLING BACK TO EUROPE

Despite their very different contexts, both Use Cases deliver a common message: **the value of marginal land goes far beyond the biomass it can produce**. Successful approaches need to connect productive land use with ecosystem restoration, biodiversity, viable business models and benefits for local communities. These experiences provide MarginUp! with practical insights for designing more resilient and sustainable marginal-land value chains in Europe.

CULTIVATING IN LANDS WITH LOW ORGANIC MATTER



LOCATION

Southern Great Plain, Hungary



AREA

1 hectare



CLIMATE

Semi-arid



BIO-BASED PRODUCTS

Oyster mushrooms and oyster mushroom substrate

PilzeNagy

A LASKAGOMBA-TERMESZTŐ

MAIN CHALLENGES

The area was an abandoned orchard on semi-arid, sandy soil with low and declining groundwater, poor nutrient content, and limited water-retention capacity, conditions that hinder agriculture.

SOLUTION WITHIN MARGINUP!

Cultivating herbaceous and woody biomass crops to be transformed into substrate for oyster mushroom farming. After use, the spent substrate is processed in a biogas plant to produce heat and electricity for mushroom cultivation, with by-products reused as fertiliser.

Biomass crops: Virginia mallow (*Sida hermaphrodita*) and Perennial rye (*Secale cereanum*)

BENEFITS



Biodiversity enhancement



Circular use of biomass



Improved soil quality and productivity



Water optimised production



Replication potential



New regional business models

STAKEHOLDERS ENGAGED

- Farmers
- Agricultural and agroforestry experts
- Bio-based businesses
- Research and innovation organisations
- Local and regional institutions
- Decision-makers
- Potential customers

INTEREST GROUPS

- Farmers in Mediterranean and drought-prone regions
- Livestock farmers
- Bioenergy and biogas producers
- Biodiversity monitoring and ecosystem services experts
- Policymakers supporting sustainable agriculture and land restoration

EXPECTED RESULTS

- Develop a circular value chain around biomass crops and oyster mushroom farming in conformity with legal and policy criteria.
- Develop a new raw material recipe for oyster mushroom substrate, envisaging the production of bio-products such as biogas and fertiliser.

REPLICATION POTENTIAL

High replication potential in water-scarce, desertification-prone areas, especially where farming is economically impacted - particularly relevant for Southern Europe.

PERENNIAL CROPS FOR MUSHROOM SUBSTRATE & SMS VALORISATION

A local circular bioeconomy in the Great Hungarian Plain

INTRODUCTION

In the Great Hungarian Plain, the MarginUp! project demonstrates how perennial crops grown on marginal sandy soils can replace part of wheat straw in oyster mushroom production, while spent mushroom substrate (SMS) is converted into biogas and digestate. This integrated local value chain creates renewable energy, recycles nutrients, supports rural jobs and shows the potential of marginal lands to deliver multiple benefits for a more sustainable and resilient Europe.

WHY THIS USE CASE MATTERS



MARGINAL LAND

Productive use for low-yield sandy soils



LOCAL IMPACT

Jobs, knowledge and rural development.



CIRCULAR VALUE CHAIN

From crops to mushrooms, energy and soil nutrients



SCALABLE SOLUTION

A model with potential for replication in other European regions

LOCATION AND LOCAL MODEL

LOCATION

Great Hungarian Plain (Kiskunsági Sand Plateau)

LOCAL ACTORS

Kujani Farm → Pilze

LOCAL LOGISTICS LOOP

~3.2 km



THE CIRCULAR VALUE CHAIN



.1. PERENNIAL CROPS ON MARGINAL LAND

Virginia mallow (Sida), willow and perennial rye are grown on sandy soils



.2. INNOVATIVE MUSHROOM SUBSTRATE

Perennial biomass replaces 25–35% of wheat straw in oyster mushroom production



.3. MUSHROOM PRODUCTION AND LOCAL SUPPLY

~900 t feedstock → ~2,700 t substrate → ~742 t mushrooms per year



.4. SMS TO BIOGAS

~1,500 t of spent mushroom substrate per year are converted into biomethane and electricity



.5. DIGESTATE REUSE

Nutrients return to the fields, closing the circular loop

KEY FIGURES (2023–2025)

~1.5 HA

Perennial crops established: 0.39 ha Sida + 0.42 ha willow + 0.61 ha rye

742 T/YEAR

Mushrooms produced from ~2,700 t substrate

1,500 T/YEAR

SMS valorised via anaerobic digestion

BIOMETHANE & ELECTRICITY

Renewable energy generated from organic side-streams

~3.2 KM

Local logistics loop; alternative biomass sourced within ≤10 km

~3–4 FTE

Jobs supported at demonstration scale

TRL PROGRESSION

OYSTER MUSHROOM BIOREFINERY | TRL 4 → 7

Pilot biorefinery demonstrated with partial straw substitution and full SMS valorisation. ~900 t feedstock → ~2,700 t substrate → ~742 t mushrooms; ~1,500 t SMS processed annually.

SHORT-DISTANCE LOGISTICS SYSTEM | TRL 2 → 5

Efficient local logistics loop demonstrated with reduced sourcing distances for alternative biomass. Local loop ~3.2 km; biomass sourced within ≤10 km.

OUR GOALS

- Demonstrate an oyster mushroom biorefinery using perennial biomass.
- Demonstrate a short-distance logistics chain.
- Valorise SMS through biogas production and digestate reuse.
- Foster local cooperation and knowledge transfer.

PROJECT PARTNERS



From Extremadura to Europe:

REPLICATING SPAIN'S HEMP SUCCESS



Kenaf crops at Extremadura's pilot site. Photo: CICYTEX

Hungarian representatives visit the MarginUp! Spanish Use Case to see how hemp and kenaf grown on marginal lands are feeding a new bio-based construction value chain

In northern Cáceres, one of Spain's most water-stressed agricultural regions, the [MarginUp! Spanish Use Case](#) is demonstrating that marginal and degraded lands can become the starting point of an entirely new value chain, one that links farmers to the construction industry through crops like hemp and kenaf.

In April 2026, that potential took a decisive step towards

replication. Representatives from the **Hungarian Ministry of Agriculture** and **Hungarian companies** travelled to Extremadura to see the pilot first-hand, a visit that turned the Spanish Use Case from a local experiment into a blueprint other countries can follow.

1. A PILOT BUILT ON CHALLENGING GROUND

Implemented across multiple municipalities in northern Cáceres, the Spanish Use Case integrates **drought-resistant**

industrial crops into existing rotations alongside tomatoes, maize, and peppers. The aim is to tackle the region's most persistent agricultural problems: **soil degradation, low organic matter, and water scarcity** driven by years of intensive farming.

The early results are encouraging. Rotation systems including **hemp and kenaf** are **showing higher biomass yields than monocultures**, and farmers are refining agricultural practices for hemp cultivation as the trials progress. The crops themselves are well suited to Extremadura's high temperatures and limited water availability, requiring up to 50% less water than traditional

regional crops and growing with minimal mineral fertiliser inputs.

The benefits go beyond the field. A considerable increase in pollinator presence has been observed during the crops' flowering period between July and September, a sign of improving biodiversity. According to the literature, industrial hemp can sequester 9–15 tonnes of CO₂ per hectare annually, comparable to a young forest, in just five months of growth. And with biomass yields of around 7 tonnes of dry stalks per hectare, the harvest is being turned into **prefabricated construction panels** that replace fossil-based materials such as polystyrene.

Nothing goes to waste. The system follows a **cascade-use model**: fibres go to construction, while the residual material from panel production is used for biogas and transformed into organic fertiliser in the form of digestate, which returns to the fields and closes the cycle.

2. SEEING IS BELIEVING: THE HUNGARIAN VISIT

For replication to happen, stakeholders need to see a working model, and that is exactly what the visit to Extremadura offered. At the **Extremadura Scientific and Technological Research Centre (CICYTEX)** and the **Spanish Leaf Tobacco Company (CETARSA)**, the Hungarian delegation toured the pilot sites where field trials are developed and fibre

separation processes are tested.

"Hemp and kenaf-based construction materials support the development of sustainable products in favour of a climate-neutral economy and a reduction in GHG emissions," explained Jerónimo González, Department Head at CICYTEX and pilot leader at MarginUp!. "MarginUp! is bringing this innovation to Spain by developing a business model that stakeholders across the country and Europe can replicate, as was demonstrated in the visit of the Hungarian stakeholders."

The interest from Hungary is telling. With its long tradition of hemp production, Hungary is looking at how the Spanish model, from marginal-land cultivation through to industrial processing, could be adapted at home. It is exactly the kind of knowledge exchange that MarginUp! is designed to foster across Europe and beyond.

The visit also took the delegation beyond the fields, to **Cânhamor**, a Portuguese company producing carbon-negative building blocks from hemp, lime, and clay. Considered a reference model for scalable low-carbon construction in the Iberian Peninsula, Cânhamor's ECOblocks show how natural resources can replace conventional fossil-based materials while reducing both costs and environmental impact across the construction lifecycle.

"The growing demand in the EU for truly sustainable, carbon-negative and high-performance construction materials has proven to us that our ECOblocks are not just a 'green trend', but

a genuine, impactful revolution in the construction sector," said Frederico Barreiro, Commercial Director at Cânhamor.

3. FROM PILOT TO EUROPEAN MODEL

At the heart of the **Spanish Use Case** is a new value chain connecting sustainable agriculture with bio-based industries, using hemp and kenaf biomass for construction panels, biogas and organic fertilisers. Collaboration across the entire chain has already enabled successful testing of fibre separation processes, prototype precast hemp panels, biogas production using hemp dust in the laboratory and pilot plant, and the characterisation of hemp fibres. **CICYTEX leads the pilot with the support of Ambienta, Modular Home, COPAL, and the CTAEX Technological Centre.**

With countries such as France and Portugal leading advances in hemp construction, **the Extremadura project is positioning Spain as an emerging leader in the field and offering a scalable model for Europe's transition to a greener, circular economy.** As interest grows across the continent, including from traditionally hemp-producing countries like Hungary, the Spanish Use Case underscores what MarginUp! set out to prove: that nature-based solutions grown on marginal lands can address climate challenges while strengthening rural economies.

CULTIVATING IN DRY CONDITIONS AND HIGH TEMPERATURES



LOCATION

Finca La Orden-Valdesequera, Coria,
Extremadura, Spain



AREA

15,000 hectares



CLIMATE

Mediterranean



BIO-BASED PRODUCTS

Precast panels (hemp fibre) and
biogas feedstock (hemp dust)



Extremadura, Spain

MAIN CHALLENGES

It spans 16 municipalities in northern Cáceres, where maize cultivation on irrigated land has degraded soils, adding to low pH and organic matter content. Combined with high temperatures and low rainfall, these conditions make the land marginal.

SOLUTION WITHIN MARGINUP!

Improving soil organic matter and irrigation efficiency by integrating kenaf and hemp—suited to high temperatures and low water availability—into existing crop rotations. Develop a value chain in which kenaf and hemp are used to produce bio-based products, such as precast panels and biogas feedstock, while promoting soil regeneration.

BENEFITS



Biodiversity enhancement



Replication potential



Improved soil quality and productivity



New regional business models



Circular use of biomass



GHG emissions reduction



Water optimised production

STAKEHOLDERS ENGAGED

- Regional farmers' groups
- Transformation factory (former tobacco facility)
- Modular System Global (precast panel partner)
- Local research and environmental organisations
- Public authorities
- Private companies (fibre processing and bioenergy)

INTEREST GROUPS

- Farmers in Mediterranean and drought-prone regions
- Construction sector
- Bioenergy and biogas producers
- Fibre transformation companies
- Biodiversity and ecosystem services experts
- Policymakers

EXPECTED RESULTS

- Development of good agricultural practices for kenaf and hemp.
- Increased soil organic matter and reduced water use in crop rotations.
- Development of prototypes of precast panels using hemp fibre, and hemp dust use in biomethanisation.
- Economic feasibility study of the full crop-to-product chain.
- Assessment of biodiversity impacts from crop rotation changes.

REPLICATION POTENTIAL

Replication potential in regions with similar climates and soils. Kenaf and hemp varieties can be adapted to local irrigation systems, while fibre processing and products can be tailored to regional markets—making it transferable across Southern Europe and beyond.

HEMP AND KENAF FOR CONSTRUCTION AND ENERGY

Innovative crops. Circular solutions. Resilient regions.

INTRODUCTION

The use case spans 16 municipalities in the **province of Cáceres**, within the **Autonomous Community of Extremadura**. This part of Spain is traditionally known for agriculture and livestock farming. The pilot trials are conducted at **Finca La Orden-Valdesequera**, where kenaf and hemp crops were first introduced in 2023. Soil constraints, mainly low organic matter, are the primary concern in this area. The initiative targets the improvement of crop rotations on irrigated lands to **promote sustainability and resilience**.

OBJECTIVE

Improve land use efficiency in Mediterranean low-yielding lands by integrating hemp and kenaf into sustainable construction materials, reducing water use and enhancing circular biomass utilisation.

TRL PROGRESSION

TRL 5 → TRL 7

From pilot to demonstration

THE VALUE CHAIN



.1. CULTIVATION ON MARGINAL LAND

Hemp & kenaf in crop rotation (with maize) in Coria, Extremadura



.2. HARVEST & PROCESSING

Fibre extraction and pre-treatment



.3. BIO-BASED CONSTRUCTION MATERIALS

Natural fibre panels (replacing 30–50% polystyrene)



.4. BY-PRODUCT UTILISATION

Residues for biogas and biofertilizer production



.5. SUSTAINABLE BUILDINGS & ENERGY

Use in prefabricated construction and renewable energy applications

LOCATION AND LOCAL MODEL

LOCATION

Coria, Cáceres, Extremadura, Spain

GEOGRAPHICAL SCOPE

Regional

LEAD BENEFICIARY

CICYTEX

KEY PARTNERS

MODULAR SYSTEM, AMBIENTA, CTAEX, COPAL Cooperative

KEY FIGURES (2025)

8–10 T/HA

Target biomass yield

–20%

Water use per hectare

200 M²

Prototype bio-based panels

≥ 70%

Biomass residues converted to biogas or biofertilisers

LOWER CARBON FOOTPRINT
(vs. conventional materials)

KEY GOALS AND ACTIVITIES

1. IMPROVE LAND PRODUCTIVITY & OPTIMIZE BIOMASS CULTIVATION

- Establish 500 m² pilot plots in Year 1, scaling up to 5,000 m² in Years 2–4.
- Implement crop rotation with maize to maintain soil fertility.
- Optimise irrigation through smart sensors.

2. DEVELOP BIO-BASED BUILDING MATERIALS

- Process 1 tonne/year of hemp & kenaf fibre for panel production.
- Develop 200 m² of bio-based panels (1 prototype dwelling).
- Optimize fibre treatment for higher durability and industrial processing.

3. ENHANCE CIRCULARITY & BIOECONOMY APPLICATIONS

- Use biomass residues for biogas and biofertiliser production.
- Conduct pilot trials with anaerobic digestion at CICYTEX.
- Develop local bioeconomy partnerships.

MAIN RESULTS AND STATUS

- Pilot plots and first cultivation – **Completed**
- Crop rotation and irrigation setup – **In progress**
- Fibre processing optimisation – **In progress**
- Prototype panels (200 m²) – **In progress**
- Anaerobic digestion trials – **In progress**
- Scaling and replication planning – **Planned**
- Final demonstration – **Pending** (M48)

BENEFITS

- Lower greenhouse gas emissions
- Circular use of biomass
- Rural jobs and income opportunities
- Resource-efficient construction

ENVIRONMENTAL IMPACT AND BIODIVERSITY

FEEDING HABITATS FOR BIRDS

Alauda arvensis, Apus apus, Ciconia ciconia, Emberiza calandra, Hirundo rustica, Saxicola rubicola

POLLINATION SERVICE

Supports wild pollinators and greater plant diversity

CARBON SEQUESTRATION

Increases soil organic carbon and root biomass, contributing to climate change mitigation

PROJECT PARTNERS



Feasible, sustainable, and profitable:

REHABILITATING FORMER LIGNITE MINE MARGINAL LANDS

22 August 2025

*In this interview, **Theodora Kalea**, coordinator of the Greek Use Case, shares key insights into the potential of the value chain being developed on site by **MarginUp!***

In Western Macedonia, Greece, MarginUp! is developing an initiative to rehabilitate land degraded by former lignite mining operations through phytoremediation while creating a bio-based value chain. Phytoremediation, essentially, involves the use of plants and associated soil microbes to reduce the concentrations or mitigate the toxic effects of contaminants in the environment. Specifically in this use case, experts chose to plant fast-growing and resilient species such as pseudoacacia trees (black locust) and lavender, accompanied by biodiversity-enhancing species like oak and chestnut trees.

The project aims to use pseudoacacia trees to produce MDF (a wood panel product used in construction and furniture) and lavender to produce essential oils. The circular value chain aims to promote sustainable regional business models that improve soil quality and productivity. To this end, the project has engaged with key stakeholders at local,

regional and national levels. In this short interview, **Theodora Kalea** — use case coordinator and Deputy Head of Bioeconomy & Social Innovation Department at CluBE — **shared key aspects of the use case with us, such as its main goals, replication potential, key challenges, and the progress to date.**

Since the project started in December 2022, what has been done so far?

Theodora Kalea: We have planted 1,500 pseudoacacia trees and 2,200 lavender plants to rehabilitate the abandoned former lignite mine, as well as 70 oak and 70 chestnut trees to enhance biodiversity.

In 2025, we started taking wood samples from pseudoacacia trees at the borders of the field. The objective was to measure the properties of the wood and to decide which percentage of it could be used in the MDF production tests.

What were the biggest challenges in your use case?

The biggest challenge so far was to get a logging permit for pseudoacacia trees from a neighbouring area. Weather conditions are also always a challenge.

Which interest groups have you been in dialogue with over the last two years and how have you and they benefited from this?

We have worked with representatives of the Regional Development Fund, policymakers from the region of Western Macedonia, municipalities, the Geotechnical Chamber, the power plant company, regional SMEs, associations, consulting companies, people working in the regional transition and companies that exploited former lignite mines.



Theodora Kalea from Clube – Greek use case leader and coordinator of all use cases.

We were able to analyse the value chain, examine potential problems, and find solutions together. We also discussed how replication could be achieved, what kind of support would be needed, the advantages, and the existing gaps.

In which areas of your development do you see the greatest replication potential and why?

There is significant replication potential in abandoned and transitioning European lignite mines, as well as in areas across Europe and internationally with comparable marginality attributes and climate conditions.

For example, in Europe only, there are 42 coal regions across 12 EU Member States. The greatest replication potential lies in three key areas: (1) plant selection,

as the chosen species can be adapted to similar degraded lands; (2) the bio-based products produced, which can be scaled up and diversified for different markets; and (3) the value chains created, as they offer economic opportunities that can be replicated in other regions.

What are the next steps in your use case?

To log the pseudoacacia trees and conduct the first tests on the MDF produced using a percentage of pseudoacacia wood biomass mixed with wood from other tree species.

What is the goal at the end of the project in 2026?

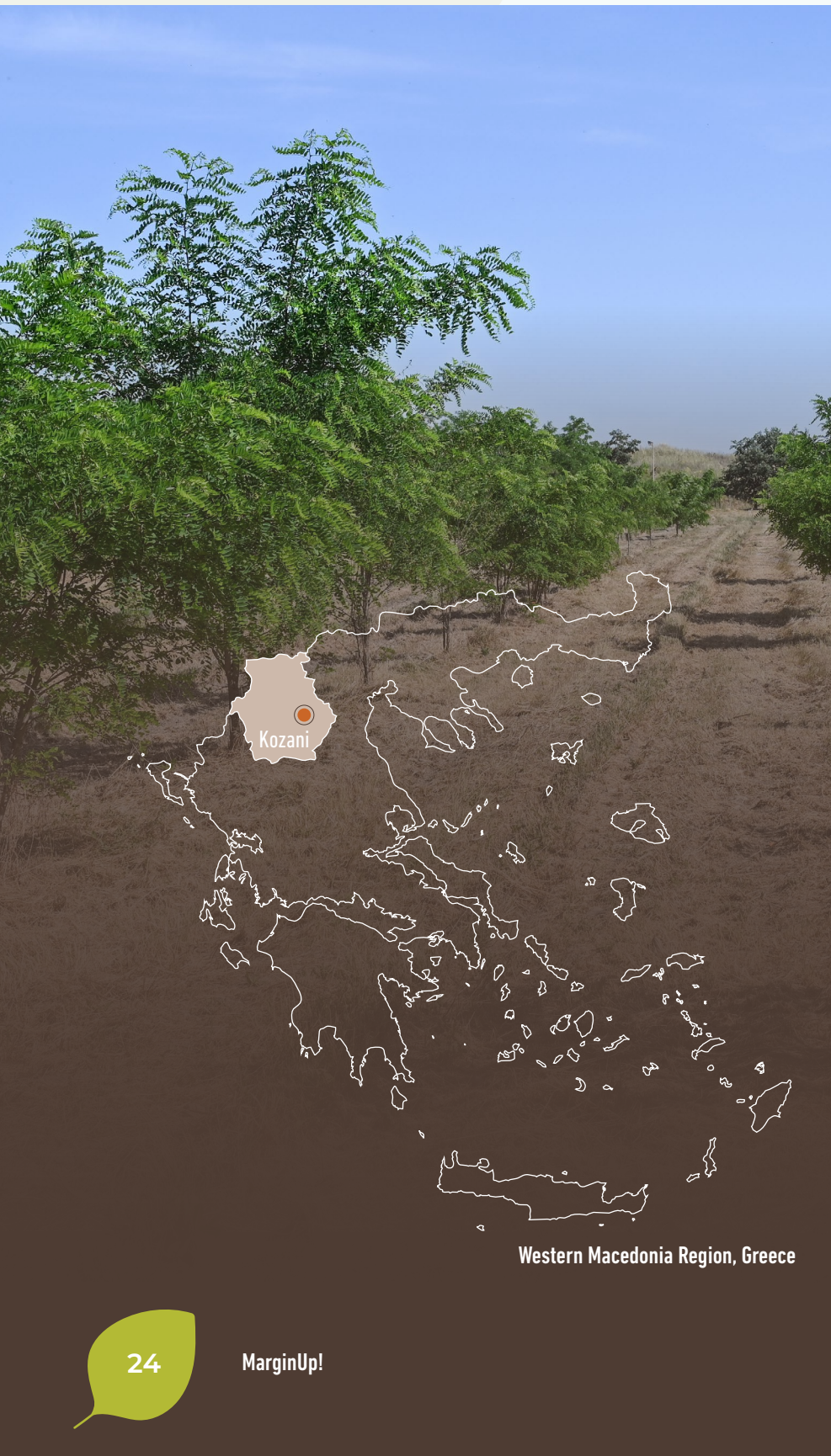
We need to have analysed all aspects of the value chain, such as the economic feasibility,

existing gaps, and all supporting mechanisms. This will allow us to demonstrate that our proposed method for rehabilitating former lignite mine marginal lands is feasible, sustainable, and profitable and can be replicated in many other regions.

What challenges do you see in the long term?

The Western Macedonia region is a region in transition. This means there will be many opportunities, but also potential obstacles. Our goal in the project is to help the region discover new ways of developing value chains and establishing new partnerships to navigate the transition, creating new jobs and a sustainable future. However, obstacles such as established practices and mindsets, as well as bureaucratic issues, still need to be overcome.

REHABILITATING DEGRADED SOILS



Western Macedonia Region, Greece



LOCATION

Western Macedonia, Greece



AREA

20 hectares



CLIMATE

Mediterranean/continental



BIO-BASED PRODUCTS

MDF (pseudoacacia), aromatic and medicinal plant extracts, essential oils

MAIN CHALLENGES

Focuses on rehabilitating land degraded by former lignite mining due to heavy metal contamination and altered soil properties. These changes have reduced soil fertility, undermined stability, and heightened erosion risks.

SOLUTION WITHIN MARGINUP!

Apply phytoremediation with resilient species like black locust and lavender, along with biodiversity-boosting trees such as oak and chestnut. It aims to regenerate degraded soils while developing a bio-based value chain involving the wood, essential oils, and beekeeping sectors.

STAKEHOLDERS ENGAGED

- Local authorities
- Research institutes and academia
- Cooperatives, agronomists, and agroengineers
- Local SMEs and bio-based businesses
- Companies managing former lignite sites
- Consulting firms
- Technology providers

BENEFITS



Biodiversity enhancement



Circular use of biomass



Replication potential



Improved soil quality and productivity



Water optimised production



New regional business models

INTEREST GROUPS

- Environmental NGOs and civil society
- Wood products and bioeconomy industries
- Policymakers
- Vocational training and skills providers
- Investors in sustainable land use
- Just Transition Fund and EU-level institutions
- Communities in marginal lands

EXPECTED RESULTS

- Demonstration of successful soil rehabilitation using phytoremediation.
- First trials of MDF production using pseudoacacia wood biomass.
- Increased biodiversity through intercropping and tree planting.
- Enhanced knowledge of wood quality and usability for bio-based products.
- Clear identification of the support mechanisms and feasibility requirements for replicating the model in other regions.

REPLICATION POTENTIAL

Potential for former lignite or coal mining areas, particularly in regions undergoing economic and environmental transition. The replication model features adaptable plant selection, bio-based product development, and local value chains.

MINE-LAND BIOMASS TO MDF PANELS AND AMP VALUE CHAINS

Restoring land. Creating bio-based materials.
Enabling new opportunities.

INTRODUCTION

In Western Macedonia, northern Greece, the use case focuses on 20 hectares of former lignite-mining land near Kozani. It explores opportunities to restore degraded soils and support the region's economic transition.

OBJECTIVE

Demonstrate a circular bioeconomy model in Western Macedonia Region by converting rehabilitated post-lignite mine-land biomass into industrial MDF panels, while assessing complementary aromatic and medicinal plant (AMP) valorization pathways, supporting Just-Transition outcomes.

TRL PROGRESSION

TRL 5 → TRL 7

MDF production with *Robinia* fibre integration

TRL 2 → TRL 5

Logistics & cooperation system (biomass recovery)

LOCATION AND LOCAL MODEL

LOCATION

Western Macedonia region, Greece

GEOGRAPHICAL SCOPE

Regional & national markets with niche international potential

LEAD BENEFICIARY

CluBE-Cluster of Bioeconomy & Environment of Western Macedonia

KEY PARTNERS

DIADYMA, Alfa Wood Group, University of Thessaly (UTH); AMP-related SMEs (exploratory)

THE VALUE CHAIN



.1. MINE-LAND REHABILITATION

Reclaimed post-lignite land in Western Macedonia planted with *Robinia pseudoacacia* and lavender



.2. BIOMASS RECOVERY & PRE-TREATMENT

Harvesting and conditioning of mine-land biomass (*Robinia pseudoacacia*)



.3. MDF PRODUCTION

Integration of *Robinia* fibers as alternative fiber source (5–10%) into industrial MDF production line



.4. AMP VALUE CHAINS (EXPLORATORY)

Cultivation of lavender and assessment of processing pathways



.5. CIRCULAR USE & REGIONAL VALUE

Sustainable materials, knowledge generation and new bio-based opportunities

KEY FIGURES (2023–2026)

~40 T

harvest Biomass recovered (Vevi area)

~1,000 M³/YEAR

so that we finally have “~5–10%”

~450 €/M³

MDF price (2026 indicative)

2 HA

Experimental *Robinia* & lavender cultivation

~90

Participants in three capacity-building events

MAIN RESULTS AND STATUS

- Biomass harvesting – Operational (~40 t/harvest),
- MDF production ~5–10% fibres”
- Economic assessment – Completed”
- “AMP cultivation – Implemented (processing not demonstrated)
- Capacity-building / dissemination events – Completed (3 events, ~90 participants)”

PROJECT PARTNERS



KEY GOALS AND ACTIVITIES

1. REHABILITATE POST-LIGNITE LANDS & RECOVER BIOMASS

- Identify suitable mine-land biomass sources
- Harvest and pre-treat *Robinia*/mine-land biomass

2. INTEGRATE MINE-LAND BIOMASS INTO MDF PRODUCTION

- Condition and blend fibres into MDF line
- Industrial production with partial fibre substitution

3. DEMONSTRATE TECHNICAL & ECONOMIC FEASIBILITY

- Optimise fibre/resin ratio and energy parameters
- Document industrial CAPEX/OPEX context

4. EXPLORE AMP VALUE CHAINS & SME COOPERATION

- Cultivate selected aromatic plants (lavender) – ERASE e.g. from this sentence
- Assess processing requirements
- Engage with AMP SMEs for exploratory data collection

5. BUILD CAPACITY & LOCAL COOPERATION

- Capacity-building, dissemination and cluster facilitation
- Strengthen regional multi-actor cooperation

ENVIRONMENTAL IMPACT AND BIODIVERSITY

FEEDING HABITAT FOR BIRDS

Chloris chloris, *Falco naumanni*, *Pica pica*, *Parus major*, *Erithacus rubecula*, *Turdus merula*. Higher habitat value on *Robinia* and lavender compared with abandoned and mined areas.

POLLINATION SERVICE

Supports pollinators such as the common carder bee (*Bombus pascuorum*). Higher activity on lavender and black locust compared with mining areas.

CARBON SEQUESTRATION

Increased soil organic carbon and root biomass on *Robinia* and lavender compared with abandonment and mining areas, contributing to climate change mitigation.

TRANSFORMING AGRICULTURE IN NORTHERN SWEDEN

How one resilient crop could help farms create fuel, feed and new opportunities in a challenging climate



Farming in northern Sweden has never been easy. Long winters, short growing seasons and vast distances leave farmers with few options. In Västerbotten, only **1.2% of the land is arable**; in Norrbotten, the figure falls below **0.3%**. Many areas are considered marginal because the cost of farming can outweigh the income they generate.

But what if those limitations could become the starting point for something new?

Through the EU-funded **MarginUp! project**, researchers, farmers and businesses are testing **turnip rape**, an oilseed crop well adapted to cold temperatures and short growing seasons. The idea is remarkably practical: grow a crop suited to local conditions and use as much of it as possible. The seeds provide oil for **biodiesel**, the protein-rich press cake becomes **animal feed**, and glycerol from biodiesel production is being investigated for **biogas production**.

Turnip rape is suited to cold temperatures and short growing seasons, making it adaptable to northern Sweden. Photo: Johan Granstrand / Cinedox.

LEARNING FROM THE LAND

Progress has not followed a straight line. After around four weeks without rain, the first cultivation attempt in 2023 produced no harvest. Instead of abandoning the idea, the team adapted its approach. Sowing methods were changed, additional harrowing introduced and less fertiliser used. In 2024, the fields delivered **1,150 litres of oil**, and the first batches of biodiesel were produced.

This willingness to learn is central to the project. At the Öjebyn Agro Park, two oil presses can produce around **12 litres of oil per hour**. The remaining press cake does not become waste: its high protein content makes it valuable as animal feed. The extracted oil is converted into biodiesel in a compact production unit designed to make decentralised processing possible.

The value of turnip rape also begins before harvest. Used in crop rotations, it can help improve soil productivity, break cereal disease cycles and provide flowering resources for pollinators.

MORE THAN A NEW CROP

For northern Sweden, this is about more than producing renewable fuel. Rural communities are ageing, smaller farms are disappearing and agriculture remains heavily



The biodiesel plant is a fully equipped container, provided by Ernsts Express. Photo: Johan Granstrand / Cinedox.

dependent on milk and meat. New crops could give farmers additional sources of income and strengthen cooperation between farms at a time when maintaining vibrant agricultural communities is becoming increasingly difficult.

The project brings together farming specialists, researchers, bioenergy experts and businesses across the value chain. That cooperation matters because not every farmer will want, or be able, to operate a biodiesel plant. Some may simply grow turnip rape, sell the seeds or use the press cake as feed. Others could share processing infrastructure through farmer associations.

That flexibility may ultimately be the most important result. MarginUp! is demonstrating how a locally adapted crop can connect **agriculture, renewable energy and circular resource use** without demanding one solution for every farm.

For communities facing difficult growing conditions and declining agricultural activity, that creates something valuable: **another choice**. And for other cold and sparsely populated regions, northern Sweden offers a practical example of how marginal land could become part of a more resilient rural future.

AGRICULTURE IN COLD CLIMATES



LOCATION

Öjebyn Agro Park near the town of Piteå and a farm near the town of Skellefteå, Norrbotten and Västerbotten counties, Sweden



AREA

15 hectares



CLIMATE

Cold



BIO-BASED PRODUCTS

Animal feed, biogas, biodiesel



MAIN CHALLENGES

Focuses on the northern regions of Västerbotten and Norrbotten, where cold conditions and short growing seasons challenge agriculture. Climate conditions limit crop options, while remote farms complicate logistics and cooperation. A declining, ageing population reduces labour and strains rural services.

BENEFITS



Biodiversity enhancement



Replication potential



Circular use of biomass



New regional business models

SOLUTION WITHIN MARGINUP!

Developing a value chain for spring turnip rape, a crop well-suited to cold climates. The harvested oil is processed into biodiesel, the press cake is used as animal feed, and the glycerol by-product is evaluated for biogas production. This circular model boosts land efficiency, soil health, and regional self-sufficiency.

STAKEHOLDERS ENGAGED

- Research institutes and universities
- Technology providers
- Bio-based businesses
- Farmers, beekeepers and rural entrepreneurs
- Industry partners
- Public sector organisations

INTEREST GROUPS

- Cold-climate farmers across Europe
- Renewable energy developers (biodiesel, biogas, etc.)
- Feed and fertiliser producers
- Local cooperatives
- Circular agriculture advocates
- Regional development agencies in remote areas

EXPECTED RESULTS

- Develop an upscaled value chain for turnip rape providing new alternatives for the agricultural sector in northern Sweden.
- Identify suitable practices to use turnip rape as an environmentally sustainable oil crop that can diversify crop rotation at northern latitudes.
- Demonstrate and optimise the production of biodiesel from turnip rape.

REPLICATION POTENTIAL

With its adaptable, decentralised model, this circular system can be replicated in cold or marginal regions where access to large processing facilities is limited. It boosts rural resilience and self-sufficiency in energy and agriculture.

TURNIP RAPE FOR ON-FARM BIODIESEL PRODUCTION

Local crops. Renewable energy. Stronger rural regions.

INTRODUCTION

The use case is located in the provinces of **Västerbotten and Norrbotten**, Sweden. It is active specifically in the areas of **Djupliden in Skellefteå** and **HS Agro Park in Piteå**. Agriculture in these areas is largely focused on milk and meat production, and a larger portion of arable land is utilised for ley cultivation compared to Sweden as a whole.

OBJECTIVE

Demonstrate how turnip rape can be integrated into local crop rotations on marginal lands in northern Sweden for producing on-farm biodiesel and valorising press cake as animal feed, contributing to rural energy self-sufficiency and fossil fuel reduction.

TRL PROGRESSION

TRL 6 → TRL 7

On-farm biodiesel production unit

Fully automate and optimise the production process to improve reliability, precision, product quality and yield.

Scale/capacity: approximately 40,000 L/year

LOCATION AND LOCAL MODEL

LOCATION

Piteå region (Öjebyn Agro Park), Norrbotten and Skellefteå

GEOGRAPHICAL SCOPE

Regional

LEAD BENEFICIARY

RISE

KEY PARTNERS

Hushållningssällskapet (HS), RISE Processum, Ernsts Express, local farmers

THE VALUE CHAIN



1. CULTIVATION ON MARGINAL LAND

Turnip rape (15 ha per year) in local crop rotations on marginal lands



2. PRESSING & REFINING

Small-scale on-farm pressing and refining unit



3. BIODIESEL

High-quality on-farm biodiesel for local use



4. BY-PRODUCT UTILISATION

Press cake as animal feed. Glycerol for biogas or other uses



5. USE IN TRANSPORT

Biodiesel tested in a tractor

KEY FIGURES (2025)

1.5–2 T/HA

Seed yield (turnip rape)

450–600 L/HA

Biodiesel yield

MAIN RESULTS AND STATUS

- Site preparation and sowing – **Completed** (M7)
- First seed harvest and yield assessment – **Completed** (M12)
- Installation of pressing unit – **Completed** (M18)
- Biodiesel production trials – **Completed** (M36)
- Press cake testing – **Completed** (M36)
- Tractor testg – **Completed** (M41, 2026)
- Final demonstration – **Completed** (M48)

KEY GOALS AND ACTIVITIES

1. INTEGRATE TURNIP RAPE INTO SUSTAINABLE CROP ROTATIONS

- Cultivate turnip rape (15 ha per year).
- Monitor yield and soil quality.
- Best farming practices are evaluated (M48).

2. DEVELOP ON-FARM BIODIESEL PRODUCTION

- Install and optimise small-scale unit.
- Conduct training.
- Verify fuel quality.
- Reliable biodiesel unit achieving TRL 7 (M48).

3. VALORISE BY-PRODUCTS FOR CIRCULARITY

- Test press cake as animal feed.
- Assess glycerol use for biogas or other uses.
- Value chain evaluated (M48).

4. DEMONSTRATE BIODIESEL USE & SUSTAINABILITY

- Test in tractor.
- Monitor engine, consumption, energy and cost.
- Verified performance (M48).

BENEFITS

- Lower greenhouse gas emissions
- Circular use of biomass
- Rural jobs and income opportunities
- Energy self-sufficiency

ENVIRONMENTAL IMPACT AND BIODIVERSITY

FEEDING HABITAT FOR BIRDS

Supports species such as the skylark (*Alauda arvensis*) and the white wagtail (*Motacilla alba*)

POLLINATION SERVICE

Provides habitat for pollinators such as the common carder bee (*Bombus pascuorum*)

CARBON SEQUESTRATION

Increased root biomass and soil organic carbon contribute to climate change mitigation

PROJECT PARTNERS



Hushållnings
sällskapet



ENABLING SUSTAINABLE USE OF MARGINAL LANDS: POLICY RECOMMENDATIONS FOR BIOMASS VALUE CHAINS

MOTIVATION

Marginal lands offer opportunities to supply raw materials for the bioeconomy while contributing to rural development and resilience. At the same time, sustainable cultivation of marginal lands can support biodiversity and provide important ecosystem services. Governing marginal lands for industrial feedstocks requires balancing conflicting agricultural, environmental, and social priorities. Key policy challenges stem from the lack of a universal legal definition for marginal lands, leading to data gaps and regulatory fragmentation. Policymakers must simultaneously manage ecological trade-offs, navigate the “food versus industry” debate (ILUC), de-risk investments for economic viability, and address underlying issues of social acceptance and land tenure.

Currently, programmes and policies are being established to develop and demonstrate value chains for industrial feedstock. Some of these value chains focus on climate-resilient and biodiversity-friendly non-food crops grown on marginal and low-productivity lands. Drawing on the knowledge and experiences gained through research and innovation activities, this policy brief presents policy recommendations for the sustainable development of value chains using biomass from marginal lands. The recommendations consider the environmental, economic, and social dimensions of sustainability.

DIVERGING EFFECTS (“TRADE-OFFS”) IN MARGINAL LAND USE AND THE ROLE OF POLICY

Despite the potential of marginal lands to provide multiple benefits, pilot projects demonstrate that achieving these different functions simultaneously can be challenging. For example, cultivating crops on marginal lands can generate economic benefits while negatively affecting biodiversity or ecosystem functions. Conversely, management approaches that prioritize biodiversity and ecosystem functions may not generate the same economic benefits. Trade-offs can also occur within environmental dimensions, as management practices may benefit some species or services while adversely affecting others. Developing biomass value chains on marginal lands therefore requires recognizing and navigating trade-offs between different land-use functions and sustainability objectives.

Policy and regulation must play a central role in resolving these trade-offs. They can help clarify competing interests and objectives, facilitate dialogue among stakeholders, provide incentives for pursuing multiple objectives, provide compensation for losses and establish requirements to ensure that these objectives are taken into account. However, many policies and regulations affecting marginal lands continue to focus on individual objectives, or policies addressing different objectives are often poorly

coordinated. **This limits the potential to develop integrated land-use solutions that generate multiple environmental, economic and social benefits simultaneously.**

POLICY GUIDELINES FOR THE SUSTAINABLE USE OF BIOMASS FROM MARGINAL LANDS IN THE BIOECONOMY

1. Clarify trade-offs associated with alternative crop cultivation on marginal lands



Key Findings from MarginUp!:

Alternative crops on marginal lands do not necessarily deliver positive environmental outcomes across all dimensions. Their impacts can also vary depending on cultivation practices and local conditions.



Relevant policies and regulations:

The EU Bioeconomy Strategy Progress Report emphasizes assessing trade-offs in the management and use of biological resources. The Commission's Technical Assessment on Sustainable Carbon Cycles in 2021 specifically highlights potential trade-offs associated with using marginal and degraded land.



Policy recommendations: Policy should facilitate localised research and its compilation into accessible databases linking crop characteristics, ecosystem services, environmental conditions, and economic potential. Farm-level assessment tools should be integrated into agricultural advisory systems.

2. Communicate the multiple benefits and trade-offs of alternative crops on marginal lands



Key Findings from MarginUp!: The cultivation of alternative crops on marginal lands is shaped by social,

economic, environmental, cultural, and perceptual factors.



Relevant policies and regulations:

The Common Agricultural Policy integrates the Agricultural Knowledge and Innovation System (AKIS) concept to facilitate knowledge exchange, co-learning, and improved advisory services.



Policy recommendations: Transparent, evidence-based outreach on the benefits and trade-offs of alternative crops can support their uptake. Educational activities can help farmers understand their environmental, economic, and social outcomes, while raising consumer awareness of marginal-land biomass products.

3. Reduce financial barriers and risks for farm businesses and value chains working with marginal-land biomass with multiple benefits



Key Findings from MarginUp!:

Alternative biomass crops on marginal lands may involve trade-offs between environmental and economic benefits. Financial uncertainty can discourage farmers and entrepreneurs from adopting practices that could deliver additional environmental and climate benefits.



Relevant policies and regulations:

Areas with natural or other area-specific constraints (ANC) payments under the CAP support farmers operating under such constraints. Transition support proposed under the post-2027 CAP aims to facilitate shifts from intensive to ecosystem- and climate-friendly farming.



Policy recommendations: Financial support for farming in areas facing natural or other constraints should reflect the diverse conditions of marginal lands. Greater support for



downstream activities, such as product development and marketing, can strengthen the long-term viability of marginal-land biomass value chains.

compensation for unavoidable costs or losses. Administrative and legal support through cooperatives, innovation clusters, or local authorities can help reduce these barriers.

4. Govern conflicts and regulatory barriers



Key Findings from MarginUp!:

Marginal-land cultivation may trigger competing interests beyond the common tension between biomass production and nature conservation. Fixed compliance costs may disproportionately burden small-scale businesses, undermining economic viability and exacerbating trade-offs.



Relevant policies and regulations:

Land-use planning framework, permitting requirements, product quality standards, and reporting obligations.

Policy recommendations:

Transparent, inclusive, and long-term deliberation should incorporate just transition principles and provide fair

5. Strengthen demand and market mechanisms for products from marginal lands



Key Findings from MarginUp!:

While farmers and entrepreneurs perceive strong potential in market mechanisms that reward the benefits of marginal land use, participation is perceived as demanding in terms of time, knowledge, and administrative resources.



Relevant policies and regulations:

The EU Carbon Removal Certification Framework provides a voluntary certification framework for measuring and verifying carbon benefits. The Commission's Roadmap towards Nature Credits sets out plans to develop a market mechanism for ecosystem services.



Policy recommendations: Capacity building should support farmers and SMEs in carbon-removal certification. Nature Credits should be further developed, while policy should support the development of sustainability labels for marginal land products that recognize social benefits.

6. Support collaboration across marginal land biomass value chains



Key Findings from MarginUp!: Lack of collaboration along value chains is a common challenge. Cooperation among producers, processors, and other actors can improve economic viability but remains difficult due to risks in emerging value chains, high upfront costs, and declining rural economic activity.



Relevant policies and regulations: LEADER, EIP-AGRI, farm advisory services under CAP, European Regional Development Fund



Policy recommendations: Policy should support regional innovation networks, cooperatives, and intermediaries such as biomass hubs to connect value chain actors, share knowledge, and build capacity. Support for infrastructure and model contracts can help reduce risks and clarify responsibilities in new partnerships.

7. Improve policy coherence for the multifunctional use of marginal lands



Key Findings from MarginUp!: While an increasing number of policies create incentives for the multifunctional use of marginal lands, perverse incentives persist that favour unsustainable land use or consumption and undermine the sustainable cultivation of alternative crops.



Relevant policies and regulations: Policies covering agriculture, forestry, biodiversity, environment, climate, land



use, and rural development, as well as regulations governing products and by-products.



Policy recommendations: Greater coherence across these policy areas is needed to avoid conflicting objectives. Regional policies are also crucial for addressing local marginal land conditions and integrating environmental, economic, and social objectives. Alignment with international sustainability standards can further facilitate market access for marginal-land biomass products.

**About this Draft: This document is a Consultation Draft prepared for discussion at the MarginUp! Final Event during the Global Bioeconomy Summit 2026. It presents preliminary findings and recommendations. It is not the final published version and should not be cited or distributed without permission. We welcome your feedback and input during the expert roundtable sessions to help shape the final publication.*

PALUDICULTURE IN PEAT SOILS



LOCATION

Havelländisches Luch and Rhinluch
regions, Brandenburg, Germany



AREA

165,000 hectares



CLIMATE

Wet-humid



BIO-BASED PRODUCTS

Pellets, substrates, fibre materials
(via twin-screw extrusion)



MAIN CHALLENGES

The project targets drained peatlands once used for cattle feed, which caused habitat loss and water system changes. Despite challenges, these soils offer potential for climate-smart, low-impact cultivation.

SOLUTION WITHIN MARGINUP!

Promotes the restoration and use of rewetted peatlands via paludiculture, harvesting wetland plants for bio-based materials. In partnership with research and industry, it tests processing methods like twin-screw extrusion to boost biomass usability and market readiness.

BENEFITS



Biodiversity enhancement



Circular use of biomass



Replication potential



GHG emissions reduction



Soil health



New regional business models

STAKEHOLDERS ENGAGED

- Local farmers and landowners
- Farming cooperatives
- Research institutes
- Local manufacturers and bioeconomy industries
- Drying and processing companies
- Policymakers and public authorities
- Water and environmental agencies

INTEREST GROUPS

- Peatland managers in other regions
- Bio-based product developers
- Climate and environmental NGOs
- Regional development agencies
- Ecotourism promoters
- Policy and funding bodies

EXPECTED RESULTS

- Demonstration of paludiculture biomass as a viable resource.
- Technical optimisation of extrusion for wetland biomass.
- Development of marketable substrates, pellets, and fibre-based products.
- A replicable circular model linking rewetted lands to bioeconomy applications.

REPLICATION POTENTIAL

Replication potential in other rewetted peatlands in Europe. The twin-screw extrusion technology and moisture control strategies can be more widely adopted by industries.

PALUDI PELLETS FOR SUSTAINABLE SUBSTRATES

Rewetting land. Creating bio-based value. Supporting climate and nature.

INTRODUCTION

In Brandenburg, Germany, the use case focuses on degraded peatlands. Rewetting these former agricultural areas offers opportunities to restore valuable wetland ecosystems while enabling sustainable land use.

OBJECTIVE

Valorise biomass from rewetted fenlands in Brandenburg into ProPlantis Paludi® pellets certified as a peat-free substrate additive for green-roof and horticultural applications, linking wetland restoration with sustainable circular bioeconomy markets.

TRL PROGRESSION

TRL 5 → TRL 7

Biomass production and pellet formulation

TRL 6 → TRL 7

Quality assurance and standardisation

LOCATION AND LOCAL MODEL

LOCATION

Brandenburg, Germany
(Havelländisches Luch and Rhinluch)

GEOGRAPHICAL SCOPE

Regional pilot with potential for national replication

LEAD BENEFICIARY

ATB – Leibniz-Institut für
Agrartechnik und Bioökonomie

KEY PARTNERS

- FMS GmbH
- FMS Futtermittel GmbH
Selbelang

THE VALUE CHAIN



.1. REWETTING & BIOMASS PRODUCTION

Sustainable harvesting of cattail, reed canary grass and sedges from rewetted fenlands



.2. COLLECTION & PRE-TREATMENT

Natural drying, baling and transport (20–50 km)



.3. PELLET PRODUCTION

Bale desintegration, extrusion, drying, sieving, mixing and pelletising



.4. PEAT-FREE SUBSTRATE PRODUCT

ProPlantis Paludi® pellets for green-roof and horticultural applications (NPK 2.2-0.5-1.2; 8% MC)



.5. CIRCULAR USE & MARKET UPTAKE

Regional value creation, reduced peat use and replicable business model

KEY FIGURES (2023–2025)

3–12.7 T DM/HA

Biomass yield from rewetted fenlands

2,000 T/YEAR

Processing potential (up to 3,000 t/year)

20–30 T CO₂-EQ/HA/YR

Emission reduction through rewetting

NPK 2.2–0.5–1.2

Certified pellets (8% moisture content)

REGIONAL MARKETS

Green-roof & horticulture sectors

MAIN RESULTS AND STATUS

- Harvesting – **Operational** (M10–M14)
- Pellet production – **Market entry achieved** (2024)
- Market Conformity (DüMV & FLL) – **Completed** (June 2024)
- Energy and process optimisation – **Ongoing** (M18–M48)
- Regional outreach & scaling – **Ongoing** (M18–M48)

PROJECT PARTNERS



PROPLANTIS



KEY GOALS AND ACTIVITIES

1. ESTABLISH FEEDSTOCK SUPPLY FROM REWETTED FENLANDS

- Harvest cattail, reed canary grass and sedges (3–12.7 t DM/ha)
- Natural drying, bale and transport (20–50 km)
- Ensure stable and traceable supply

2. DEVELOP AND CERTIFY PALUDI-BASED SUBSTRATE PELLETS

- Optimise production process (drying, extrusion, pelletising)
- Compliance with DüMV (2019) and FLL (2018)
- Launch ProPlantis Paludi®

3. OPTIMISE PRODUCTION EFFICIENCY AND QUALITY

- Improve energy performance
- Implement QA/QM
- Assess cost structure

4. STRENGTHEN MARKET UPTAKE AND REGIONAL VALUE CREATION

- Engage with green-roof, substrate and landscaping sectors
- Demonstrate environmental and economic co-benefits
- Explore regional procurement and investment opportunities

5. REPLICATION AND LONG-TERM IMPACT

- Document and disseminate results
- Develop transferable business and technical models
- Support national replication

ENVIRONMENTAL IMPACT AND BIODIVERSITY

FEEDING HABITAT FOR BIRDS

Grus grus; Vanellus vanellus; Acrocephalus schoenobaenus; Alauda arvensis; Gallinago gallinago; Lanius collurio. Rewetted fenlands provide greater habitat value than abandoned or mined areas.

POLLINATION SERVICE

Supports pollinators such as the common carder bee (*Bombus pascuorum*). Higher pollinator activity in rewetted areas than in mined areas.

CARBON SEQUESTRATION

Increased soil organic carbon and root biomass on rewetted fenlands compared with mining areas, contributing to significant climate change mitigation (20–30 t CO₂-eq/ha/yr).

FROM EVIDENCE TO OPPORTUNITY

Economic analysis, environmental assessment and exploitation planning reveal where marginal-land biomass can create value, what drives its environmental footprint and which innovations are ready for further development. The findings point to practical routes towards more resource-efficient production and market uptake, while highlighting the barriers still to overcome.

1. VALUE CHAINS

WHERE ECONOMICS WORK

7

value chains analysed

Existing farm and industrial systems, partial biomass substitution, short-distance logistics and cascade uses offer the strongest economic prospects.

Value-chain stages



MARGINAL LAND CROPS

Climate-resilient non-food crops



HARVESTING & LOGISTICS

Local supply and short distances



PROCESSING

Adapted technologies and partial substitution



BIO-BASED PRODUCTS

Multiple applications and markets

Example: mushroom substrates

25–35% wheat straw substitution in Hungarian mushroom substrates using perennial biomass (Virginia mallow, willow and perennial rye).

Main barriers

Processing scale, consistent biomass supply and buyer requirements remain key barriers for wider market uptake.

2. LIFE CYCLE ASSESSMENT (LCA)

WHERE IMPACTS ARISE

10

assessments across 5 European use cases

8 impact indicators covering climate, resources, soil, water, eutrophication and more.



0

pesticides applied across all five crop systems



3 OF 5

crop systems without mineral fertiliser



85–88%

of assessed German farm-stage impacts driven by diesel operations

Example: environmental hotspots (German value chain)

Contribution to key impact categories (farm stage):

Diesel use (field operations): **85–88%**

Seed and planting material: **6–9%**

Fertiliser production: **3–6%**

Machinery (production): **1–3%**

Transport (field to first processing): **<1%**

Different functional units and system boundaries are used across the assessments. Absolute results cannot be directly compared between use cases.

3. EXPLOITATION

FROM RESULTS TO UPTAKE

19

key exploitable results (products, technologies, tools, guidelines and business models).

3 pathways to market



Continued development by owners



Partner replication in new regions



Third-party uptake

Example: German paludiculture substrate pellets

Estimated market potential (by 2030):

€500 million: total market (e.g. horticulture and professional growing media in Europe)

€100 million: serviceable market (realistic share for paludiculture-based substrate pellets)

Approximately €3 million: obtainable market by 2030 (conservative estimate, not revenue)

Key conditions for success

- ✓ Certification and standards
- ✓ Validated product quality
- ✓ Investment and financing
- ✓ Processing capacity
- ✓ Ownership and business models



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Project Website

<https://margin-up.eu/>

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