BeonNAT

Innovative value chains from tree & shrub species grown in marginal lands as a source of biomass for bio-based industries

Luis S. Esteban Pascual (Project coordinator)

Nature- based solutions: case studies. Rimini, 7TH November 2024

The BeonNAT Project

Innovative value chains from tree & shrub species grown in marginal lands as a source of biomass for bio-based industries.
GA Nº: 887917

- BeonNAT explores the viability of the use of EU marginal lands to source forest biomass for the production of high added value bio-products following a cascade approach.
- BeonNAT plantations aim to improve soil fertility, organic carbon stocks and biodiversity.
- BeonNAT contributes to develop EU bio-economy creating new jobs in rural areas with risk of depopulation

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BeonNAT Project Info

Project leader: Centre for the Development of Renewable Energy Sources (CEDER-CIEMAT) SPAIN

BBI JU contribution: € 4,980,429
Duration: July 2021 – June 2025

8 RTOs

5 SMEs

2 Large Companies

1 Association

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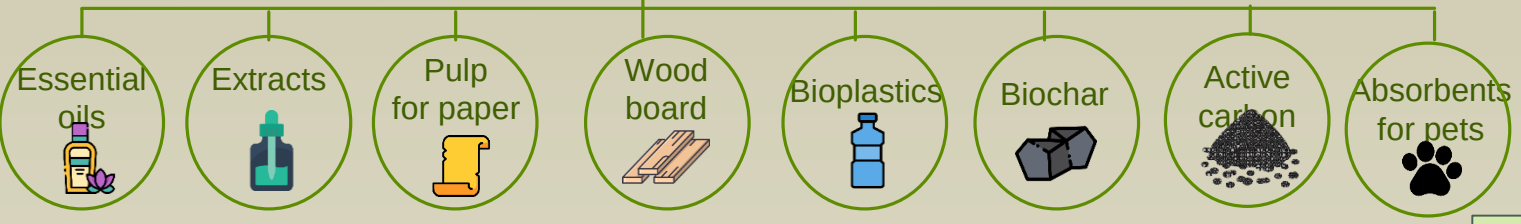
Bioproducts

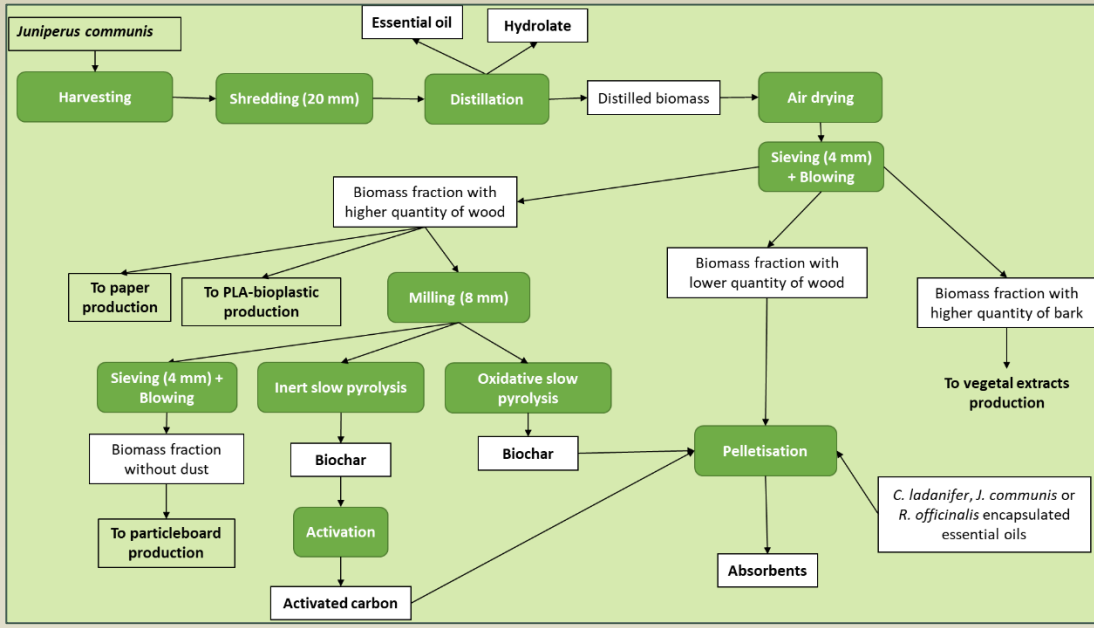
8 new bio-based value chains validated



Extracts **(IDS)**
Essential Oils **(CIEMAT, IPB-CIMO)**
Pulp **(CESEFOR)**

Lactic Acid and PLA **(CIEMAT, AIM, ATB, MAVERICK)**
Biochar and Active Carbon **(REC, ENV)**
Absorbents **(CIEMAT, TOLSA)**

Biomass conditioning and cascade approach: **CIEMAT**



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The soil health: a big deal for the future

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The soil health and the bioresources need

Over 60% of European soils are unhealthy and scientific evidence shows that soils are further degrading due to unsustainable management of the land, sealing, contamination and overexploitation[1].

But at the same time, Europe needs to reduce the use of fossil fuels by increasing bio-based substitutive products

Garzón-García, R., & Vega-Pozuelo, R. (2022). Ordenación de usos agrarios en áreas protegidas de media montaña mediterránea. Estudio de la Sierra Morena andaluza. Investigaciones Geográficas, (77), 279-301. https://doi.org/10.14198/INGEO.18057

1 EU proposal of a Soil Monitoring Law to protect and restore soils and ensure that they are used sustainably. https://environment.ec.europa.eu/topics/soil-and-land/soil-health_en

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Organic carbon in soil (SOC)

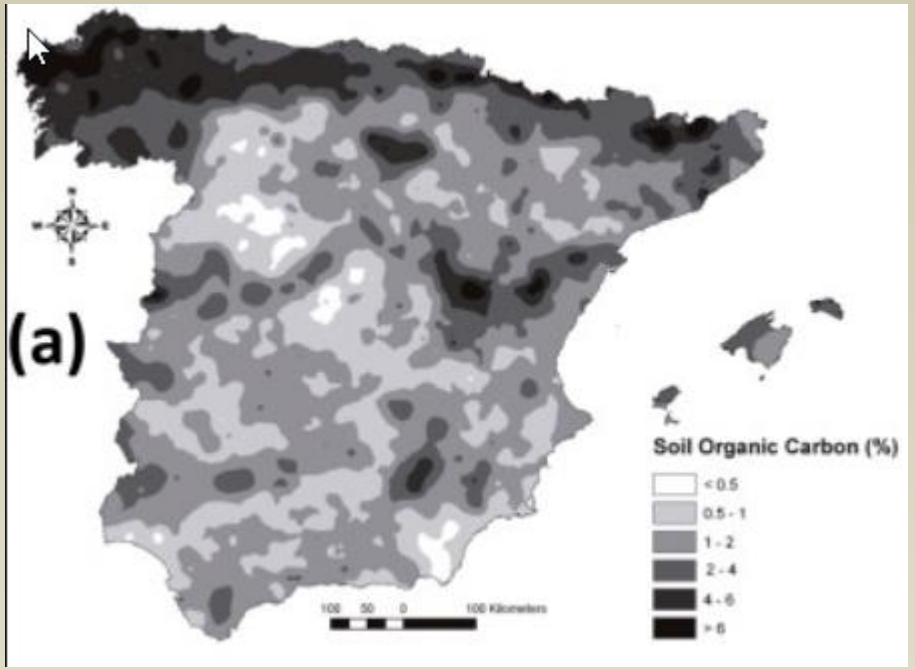
SOC, a crucial actor

Soil organic carbon boosts fertility, improves structure, and retains water. It also captures atmospheric carbon, aiding climate regulation.

Intensive farming, deforestation, and overgrazing together with a dry climate and intense rainfall cause erosion, and SOC depletion

We need less intensive cropping systems

	SOC (%C)		
	Mean	SD	H.Gp
Cropland	1.05	0.82	a
Grassland	3.27	2.81	b
Forestland	3.70	2.75	b

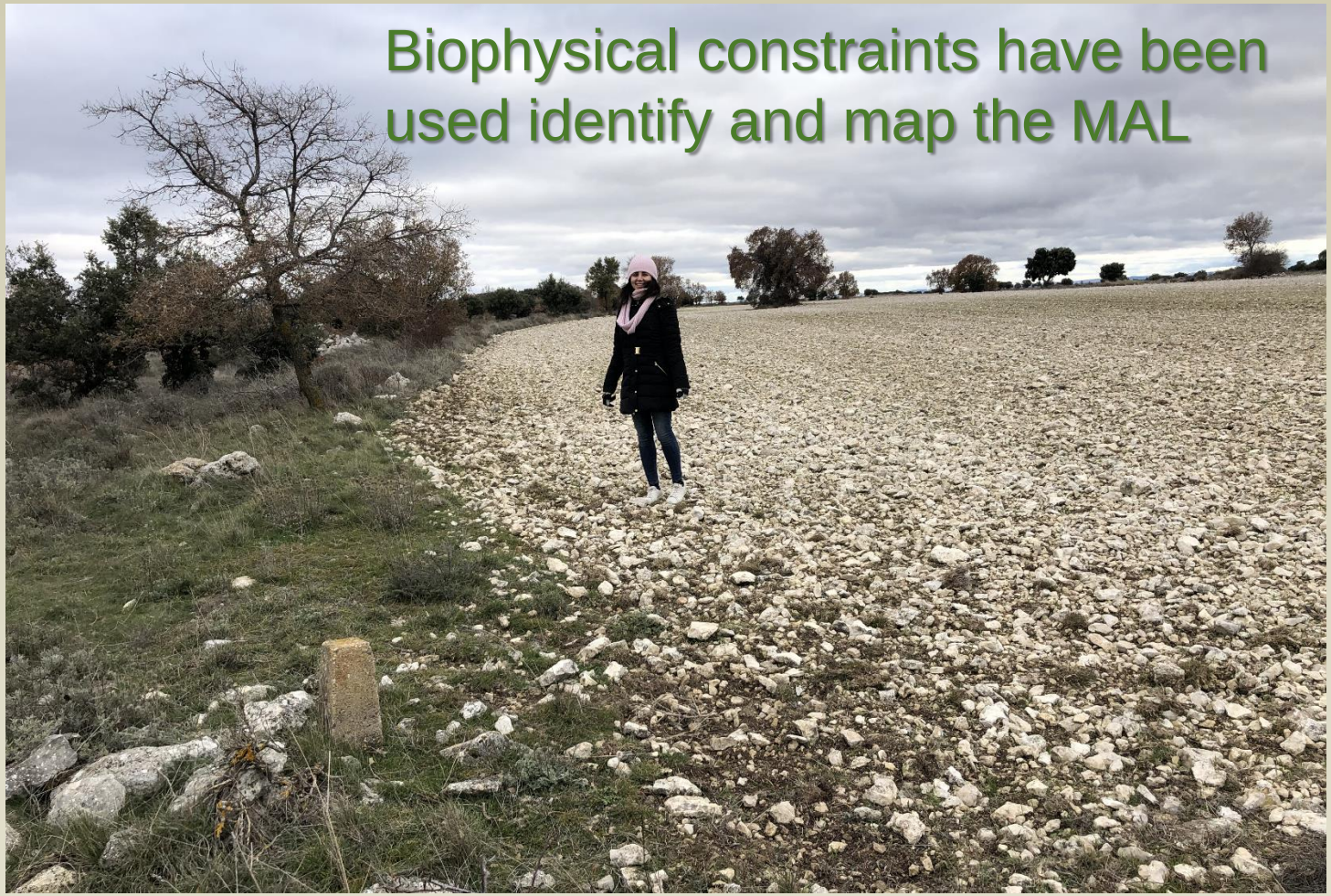


J.A. Rodríguez Martín, J. Álvaro-Fuentes, J. Gonzalo, C. Gil, J.J. Ramos-Miras, J.M. Grau Corbí, R. Boluda, Assessment of the soil organic carbon stock in Spain, Geoderma, Volume 264, Part A, 2016, Pages 117-125, https://doi.org/10.1016/j.geoderma.2015.10.010.

Marginal Agricultural Lands (MAL)

BeonNAT

Soil and climate characteristics that limit agricultural productivity



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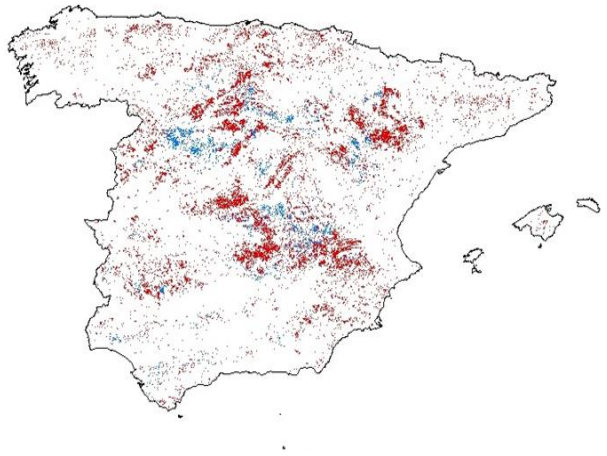
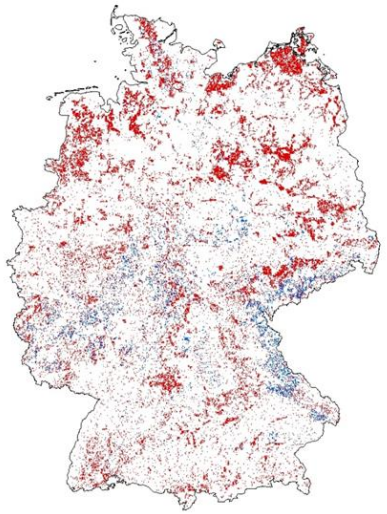
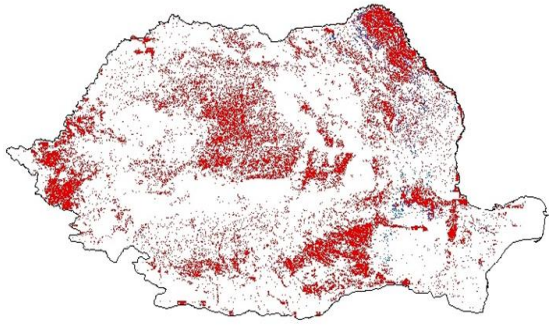
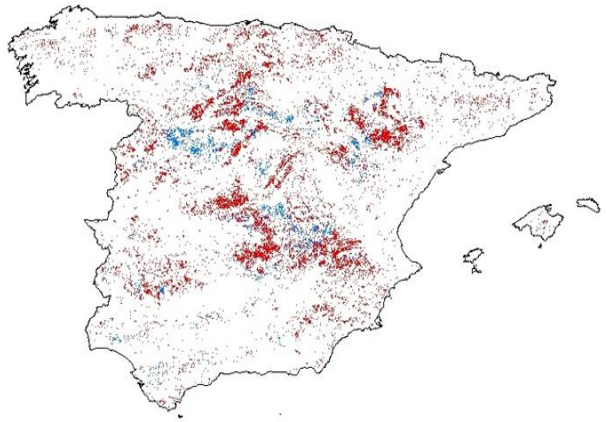
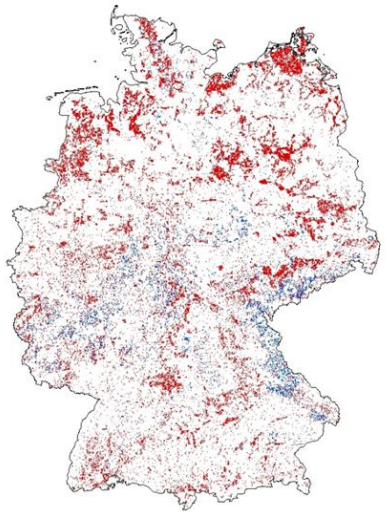
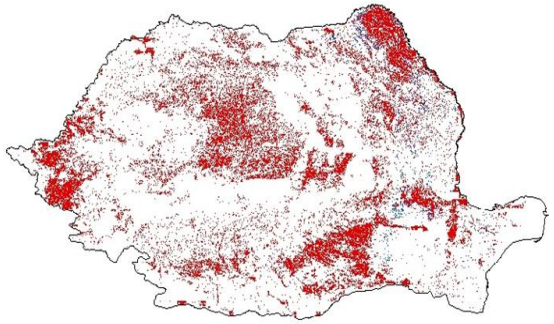
MAL mapping for Spain, Germany and Romania

	Spain	Germany	Romania
Agricultural land (Mha)	11.3	15.2	13.1
Marginal land (Mha)	6.3	6.9	5.1
Marginality caused by Individual biophysical factors Marginality caused by A combination of biophysical factors			

MAL mapping for Spain, Germany and Romania

	Spain	Germany	Romania
Agricultural land (Mha)	11.3	15.2	13.1
Marginal land (%)	(50%)	(45%)	(38%)
Marginality caused by Individual biophysical factors Marginality caused by A combination of biophysical factors			

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BeonNAT objectives

- 1.- Identify marginal lands in Spain, Germany and Romania
- 2.- Select the most suitable underutilised tree and shrub species with potential to grow in marginal lands in the three countries.
- 3.-Cultivate the species under marginal conditions by row intercropping
- 4.- Prove the aptitude of these selected species to produce up to 8 high added-value bio-based products following a cascade approach.
- 5.- Evaluate the sustainability of the 8 new value chains tested with a special focus on the improvement of biodiversity and soil quality.

Innovative elements of the project

- *Marginal Land Use for Tree and Shrub Cultivation (Underutilized Species)*
  - *Onsite Assessment of Marginality of Sites (Soil Quality Ratio) → Really Marginal Sites*
  - *Domestication of wild species for a successful cultivation*
- *Intercropping Cultivation of wild collected Species in real conditions*
  - *Surface of 1.5 ha/Site → Commercial machinery (Harvest Tests with different type of machinery)*
  - *Biodiversity , Soil Organic Carbon and plant survival assessment*

Innovative elements of the project

- *Four Stages for screening and selection of Species*
  - *From 16 species to 6 species*
  - *From lab scale to pilot and real scale tests*
  - *From wild biomass to cultivated biomass*
- *Cascade exploitation approach*
  - *From higher added value to middle value products*
  - *Continually improved in every Stage of the project to increase product yield and energy efficiency*

Research Work: Screening & Selection

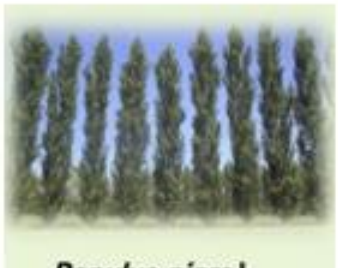
TREE AND SHRUB SCREENING: 8 trees, 8 shrubs candidate species

Betula pendula Roth
(Birch tree)

Carpinus betulus L.
(Common hornbeam)

Cupressus sempervirens L.
(Mediterranean cypress)

Euonymus europaeus L.
(Spindle tree)



Populus nigra L.
(Black poplar)

Robinia pseudoacacia L.
(Black locust)

Ulmus minor Mill.
(Field elm)

Ulmus pumila L.
(Siberian elm)

Calluna vulgaris (L.) Hull
(Common Heather)

Cistus ladanifer L.
(Mediterranean rockrose)

Cytisus scoparius (L.) Link
(Common Broom)

Hippophae rhamnoides L.
(Sea buckthorn)

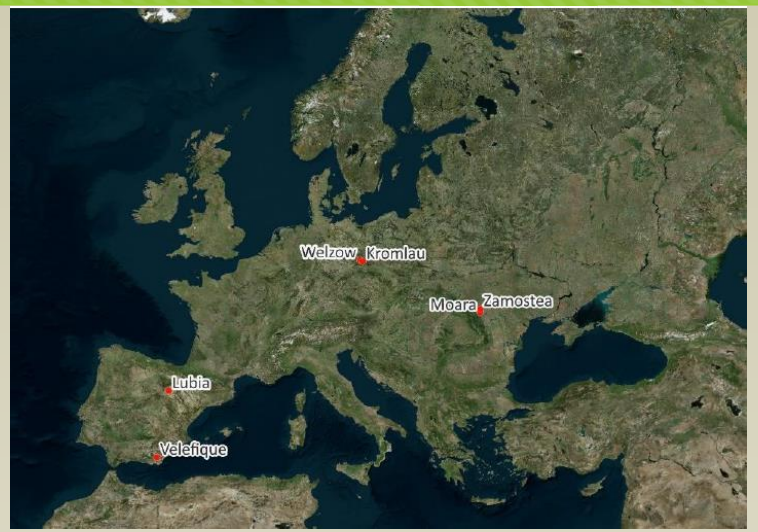
Juniperus communis L.
(Common juniper)

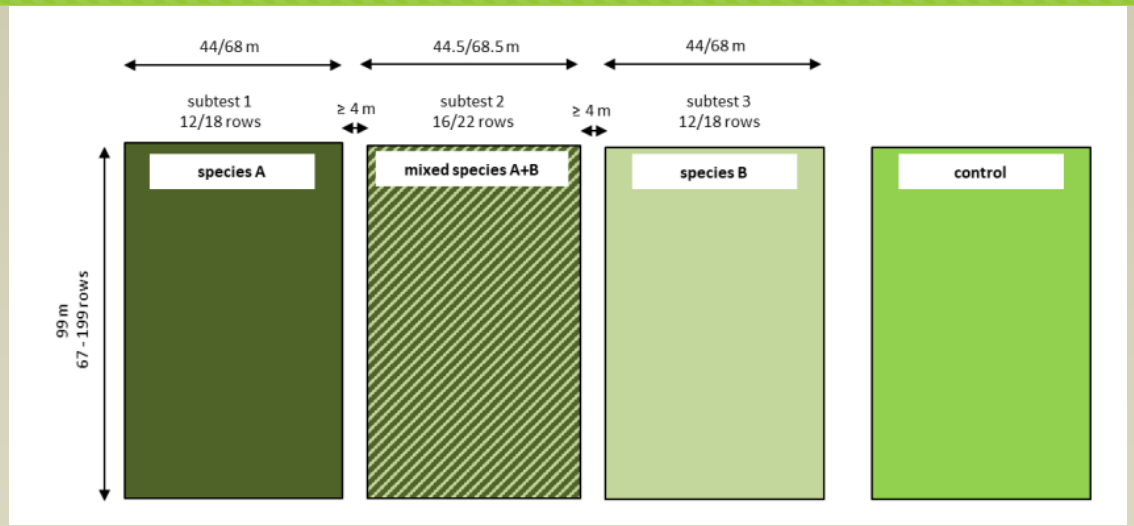
Rosmarinus officinalis L.
(Rosemary)

Rubus fruticosus L. Agg.
(Blackberry)

Spartium junceum L.
(Spanish broom)

Research Work: Intercropping design





Betula sp.
(Birch tree)

Cystitus Scoparius
(Common Broom)

Carpinus betulus L.
(Common hornbeam)

Cistus ladanifer
(Mediterranean rockrose)

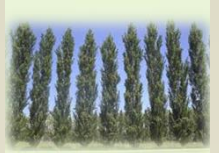
Rosmarinus Officinalis
(Rosemary)

Ulmus pumila
(Siberian elm)

Juniperus communis
(Common juniper)

Robinia pseudoacacia L.
(Black locust)

Rubus fruticosus L. Agg.
(Blackberry)



Populus nigra L.
(Black poplar)

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Sites Assessment:
Soil Marginality assessment by Soil Quality Ratio (SQR).
Brandenburg University of Technology (BTU)

BeonNAT

Soil Quality Ratio (SQR)

Basic soil indicators (BI)
(weighting factors for arable land, wf)
1. Substrate *(3)*
2. A horizon depth *(1)*
3. Topsoil structure *(1)*
4. Subsoil compaction *(1)*
5. Rooting depth *(3)*
6. Profile available water *(3)*
7. Wetness and ponding *(3)*
8. Slope and relief *(2)*

Soil hazard indicators (HI)
1. Contamination
2. Salinization
3. Sodification
4. Acidification
5. Low total nutrient status
6. Soil depth above hard rock
7. Drought
8. Flooding and extreme waterlogging
9. Steep slope
10. Rock at the surface
11. High percentage of coarse soil texture fragments
12. Unsuitable soil thermal regime
13. Miscellaneous hazards

Basic soil score (BSC)

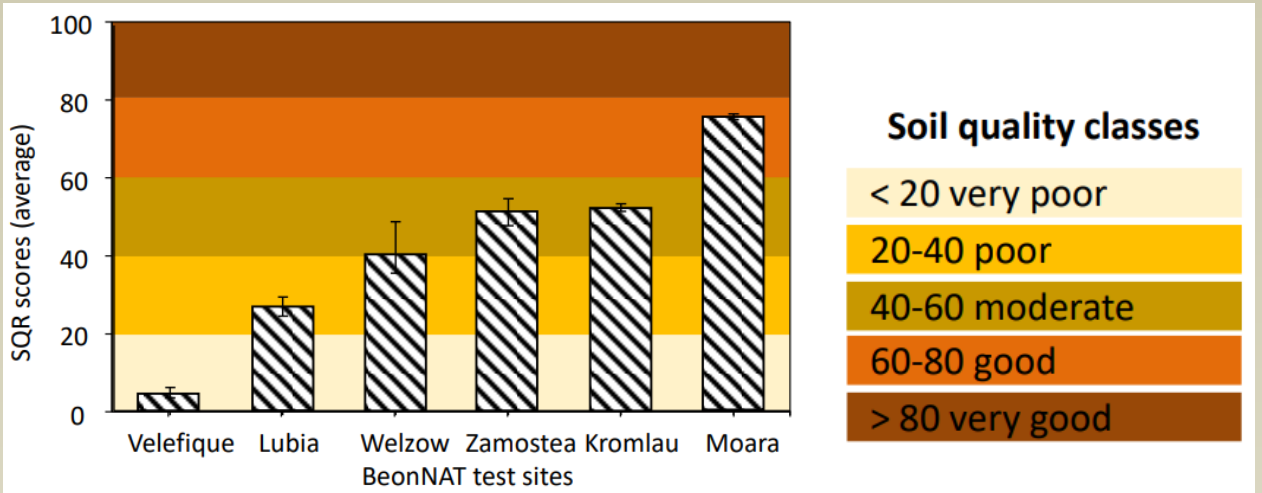
►BSC = ∑BI1 · wf1… BI8 · wf8
(between 0 and 34)

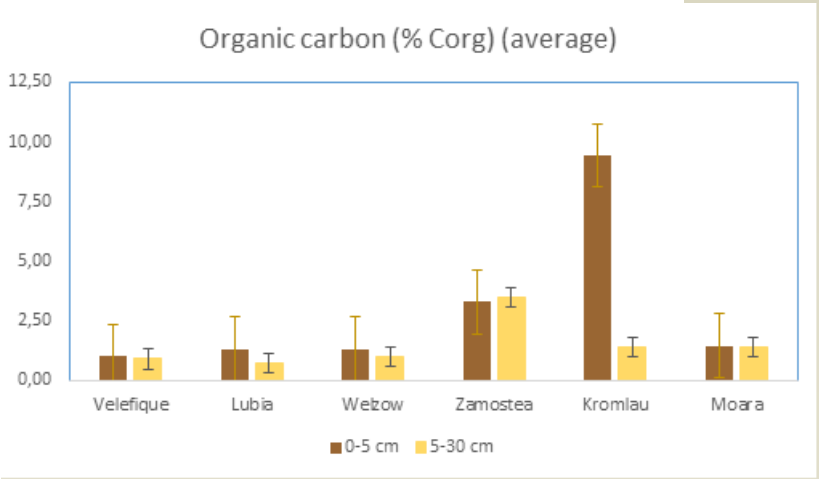
Hazard multiplier (HM)

►HM = minimum multiplier for HI1 … HI13
(between 0.1 and 2.94)

Final soil score (SQR Score)

►SQR Score = BSC · HM
(between 0 and 100)





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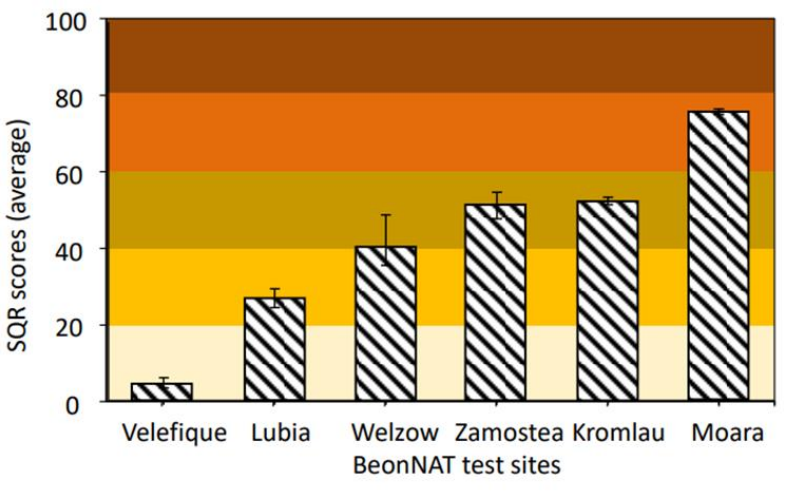
Initial Survival Rates

- Low to very low survival rates due to poor soil quality and extreme weather conditions, especially in Spain
- Those marginal sites may not always be suitable, even for plants that naturally thrive in similar environments



Survival in 2022

Site	Species	Months after planting	Survival (%)
Velefique	Cistus ladanifer	12	5.0
	Rosmarinus officinalis	12	27.3
Lubia	Juniperus communis	12	10.1
	Ulmus pumila	12	36.5
Welzow	Robinia pseudoacacia	7	75.8
	Rubus fruticosus	7	68.7
Zamostea	Populus nigra	site destroyed	
	Robinia pseudoacacia		
Kromlau	Betula pendula	18	60.8
	Cytisus scoparius	18	83.1
Moara	Betula pendula	11	78.7
	Carpinus betulus	11	76.6

Soils, biomass and biodiversity monitoring

BeonNAT

- Soil: physicochemical parameters once a year. Metagenimics: two times (2021 and 2024)
- Biomass: Plant survival, growth (SBD, height) and yield once a year
- *Biodiversity: Carabidae* at least twice a year (May and September). *Cormophyta* once a year (May)

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Conclusions

- Marginality of many agricultural lands in Europe can be reduced by adopting mixed plantations of tree and shrub species that improve soil quality
- There are possibilities of using underutilized tree and shrub species able to thrive in adverse soil and climate
- The Alley (row intercropping) system permits increasing biodiversity imitating nature, and being a reliable low input system
- Some species have been identified as promising to obtain biochemicals and bioproducts: *Betula pendula, Ulmus pumila, Cytisus scoparius, Cistus ladanifer, Rosmarinus officinalis* and *Juniperus communis*

Next steps until June 2025 and Beyond

- Until the end of BeonNAT Project (June 2025)
  - Results and conclusions on the impacts of the intercropping system on soil and biodiversity upgrading
  - Finish the last evaluation of bioproducts value chains at pilot-real scale
  - Perform and holistic evaluation considering techno-economic, social and environmental indicators
  - Select most promising value chains for the 3 bio-refinery case studies
- Beyond
  - Try to increase the TRL and prepare arrival to market
  - Promote promising case studies for industrial implementation

Thanks for your attention!

Nature- based solutions: case studies. Rimini, 7TH November 2024

Contact us at: luis.esteban@ciemat.es

https://beonnat.eu/

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