



Midas

MARGINAL LANDS. INDUSTRIAL CROPS
AND INNOVATIVE BIO-BASED VALUE CHAINS

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Introduction

The European Green Deal aims at transforming the EU into a resource-efficient and competitive economy with zero net greenhouse gas emissions in 2050, decoupling economic growth from the use of fossil resources, while making our ecosystems more resilient to climate change and protecting our environment. To achieve this goal, Europe's agriculture must ensure the production of enough food for a growing population in a sustainable and inclusive manner, as well as the supply of renewable biomass both for energy and materials, complementing the circular use of residues and wastes in the transition from a fossil-based to a bio-based economy. This must be accomplished without reducing the land available for food production, and with sustainable farming systems that protect and possibly enhance the health of our soils and the biodiversity of ecosystems in rural areas. Matching all these goals is the ambition of MIDAS, a Horizon Europe Innovation Action, to **develop and demonstrate innovative solutions to grow industrial crops on marginal agricultural land and to build sustainable value chains for a wide range of bio-based products**. The project started in November 2022 and will continue through October 2026.

MIDAS is carried out by a consortium of 23 partners from 13 countries coordinated by the Greek Centre for Renewable Energy Sources (CRES), including research organizations, industries and SMEs. The approach of MIDAS builds on two pillars:

- 1) To optimize selected industrial crops and cropping systems, both through breeding and agronomic practices, to be able to tolerate water scarcity and to mitigate desertification, while improving biodiversity conservation, in Mediterranean and central European marginal land.
- 2) To improve the functional performance and the resource efficiency of specific bio-based value chains, in order to promote the sustainable use of non-edible industrial biomass in a biorefinery concept.

Through the implementation of a comprehensive range of activities across the entire value chain, MIDAS partners are poised to achieve multifaceted outcomes. These outcomes encompass advancements in scientific knowledge, such as insights into the future potential of marginal land under climate change scenarios and the biodiversity effects of industrial crops and farming practices. Moreover, the project is set to deliver improved breeding materials, marketable bio-products, robust business plans, and sustainable upscaling strategies for the value chains. In doing so, MIDAS aims at providing a tangible contribution to the deployment and the market uptake of innovative technologies and products.

Building on the project's original concept, its preliminary results, as well as on the partner's expertise and on the feedback received from regional advisory groups, this report aims at introducing MIDAS work and framing the main policy aspects that are relevant for the management of marginal land and the development of bio-based value chains. These aspects will be further analysed in the second part of the project, with the aim of informing the policy discussion at European and national level, for the creation of a solid enabling environment to deploy bio-based agricultural value chains, as solutions to manage marginal agricultural land, and to increase the resilience of both farmers and agroecosystems to the impacts of climate change.

Marginal land in Europe

Across Europe, vast areas of land fall under the classification of marginal agricultural land. This land is characterized by inherent bio-physical limitations that can include factors such as shallow soils, poor drainage, lack of water, low soil organic content, steep slopes and others. Due to these factors, marginal land is less suitable for conventional agricultural practices, making increased inputs for productivity or benefits barely feasible. This land offers limited options for diversification without external inputs, and an improper agricultural management poses a significant risk of irreversible degradation and abandonment.

Growing non-edible industrial crops to produce biomass for bio-based materials, energy and fuels, can be an option to utilize marginal land, preserving it from further degradation and reducing the risk of abandonment, while also minimizing the risk of incurring in indirect land use change (ILUC). This is the aim of MIDAS project: **to valorise European marginal land, by growing selected and climate-resilient industrial crops, to eventually build sustainable value chains for a range of innovative bio-based products.**

Defining and mapping the extension of marginal land

There are multiple definitions for marginal land, previous Horizon 2020 projects investigated this subject and developed methodologies to characterize marginal lands based on biophysical limitations to agricultural productivity (MAGIC, SEEMLA, FORBIO). These limitations encompass factors like **adverse climate, excessive wetness, adverse chemical conditions, low soil fertility, limitations in rooting, and adverse terrain conditions**. This approach aligns with the European Commission Joint Research Centre's framework for identifying 'Areas of Natural Constraints' (ANC) (Van Oorschoven, et al., 2014 and Terres et al, 2014). ANCs are primarily used to guide the allocation of financial support to farmers operating in these challenging areas, this classification was initially adopted in MAGIC project, to create an extensive mapping of marginal land in the European Union. MIDAS has updated this mapping with more recent and refined data, including also climate projections (CHELSA) and soil data (ISRIC SoilGrids).

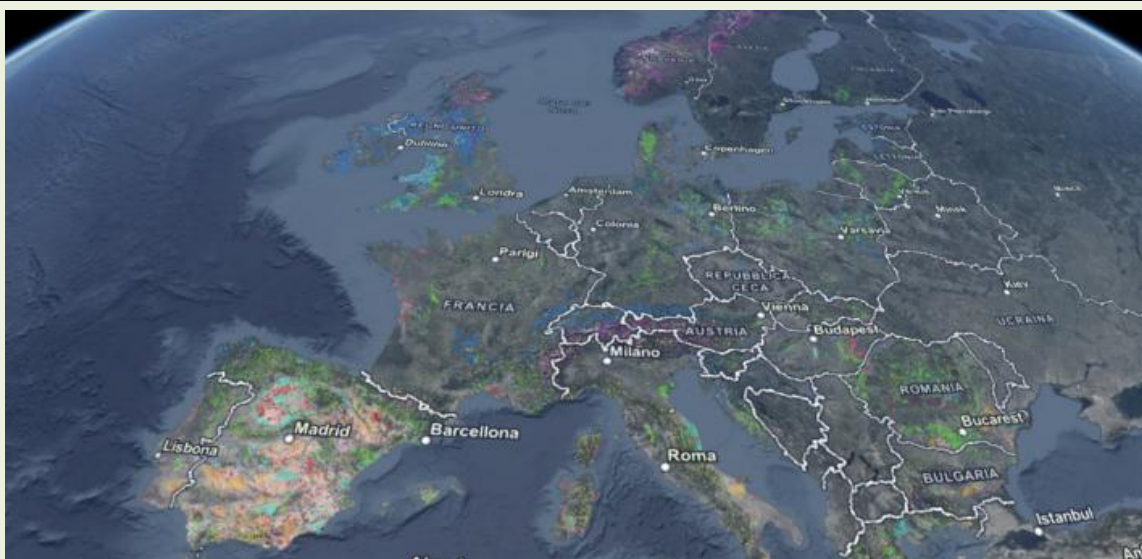
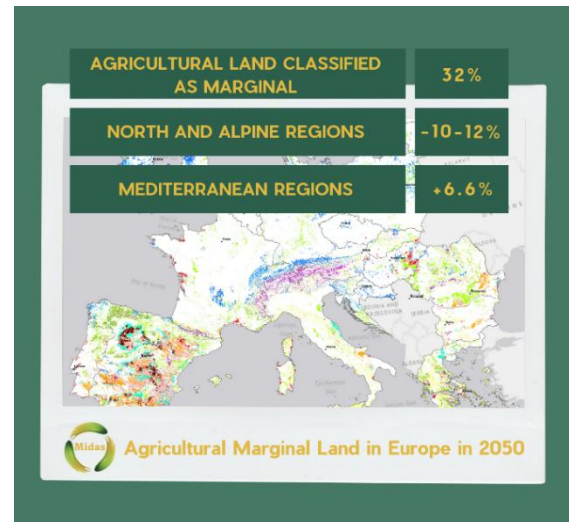


Fig. 1 - A storymap of marginal land in Europe. A complete and up-to-date interactive mapping of the extent of European marginal land, with detailed explanation provided by Wageningen University and Research is available [here](#). (Source: M. van Eupen, B. Elbersen, G. Hazeu, S. Verzandvoort, W. Meijninger & S.Mantel, 2023).

More than one third of agricultural land in Europe shows conditions of marginality

The more accurate data and the updated mapping methodology used in MIDAS, led to the finding that the **actual share of marginal land in the EU (plus UK and Serbia) can be as high as 32%**, that is 5.5% larger than the previous estimation conducted in MAGIC.

The study also estimated the possible extension of marginal land at regional level in 2050, considering the expected effects of climate change on those land. Although the net area of marginal land should not vary significantly in 2050 compared to 2020, relevant variations could take place in different geographic regions of Europe in the next decades. In particular, the Nordic and Alpine regions could see a decrease of marginal land (-12.4% and -10.4% respectively), mainly thanks to the increase of mean temperatures and a reduced soil wetness. This translates into a potential expansion of suitable agricultural lands for food production thanks to an extended crop growing season.



On the contrary, **the Mediterranean region might see an actual increase of marginal land up to 6.6%**, mainly due to **adverse climate** (high temperatures), combined with a **decrease in the stock of soil organic carbon** and an increased risk of **floodings** in certain areas. In practical terms, the recurring heatwaves, the increase in both frequency and magnitude of floodings, and the loss of organic matter in the soil, could pose an area of **more than 190,000 km²** of agricultural land in the Mediterranean region, at **significant risk of irreversible degradation and abandonment**.

Adaptation strategies needed to preserve soil health

Comparing the maps of marginal lands in 2020 and 2050 reveals an urgent need for Mediterranean farmers to shift towards more drought-tolerant agricultural systems. In the absence of likely changes in the climate trajectories, **adaptation strategies will be needed to cope with the effects of climate change on the quality and the fertility of agricultural land**. Strategies and practices to manage the risk of floods, as well as to maintain and increase the levels of soil organic carbon in those marginal land, should be extensively demonstrated and deployed in the most sensitive areas. Some of these include practices such as cover cropping, intercropping, agroforestry, using drought-resilient annual and perennial crops, and the use of biochar as a soil amendment. In these marginal areas there will be a need to **either compensate**



Fig. 2 - MIDAS Demo site in Emilia Romagna. Located in a hilly area of chalks and gulls in the province of Bologna, this site is characterized by a steep slope and sandy soil. Here the University of Bologna is testing and demonstrating the strip cropping of annual and perennial species (crambe, safflower, hemp, miscanthus).

farmers for higher cost and lower returns from their lands in order to prevent land abandonment **or to stimulate the development** and investments in alternative uses of the land that can be combined with the natural constraints in place. One of the alternatives may be the **production of non-food biomass to be used as feedstock for the production of bio-chemicals and biomaterials** for the European bioeconomy.

Harmonization of statistical data and local mapping of marginal land is necessary

The mapping work of MIDAS and the previous European projects is conducted at European scale, but all these solutions require a deeper identification and mapping of marginal land at national level. At present there is no universally accepted definition of "marginal land" that applies across all relevant policy sectors, such as agriculture, environment, and bioeconomy. This lack of a common definition makes it challenging to design policy interventions for the sustainable use of marginal land. In addition there is still a lack of statistical data on their extent and characteristics at national level, which further hinders and monitoring. Ultimately these gaps pose significant challenges to the sustainable utilisation of marginal land for bio-based industries. **Harmonising statistical data collection with mapping and modelling activities is crucial for effective target setting at national and local levels, and to make farmers and local rural communities aware of the extension and the characteristics of their marginal land.**



Fig. 3 - Two MIDAS demo sites in Spain.

Left: Located near Fuentidueña de Tajo (Madrid), this semi-arid area faces challenges like low rainfall, sandy soil with low organic matter and poor biodiversity. Here the Instituto Técnico Agronómico Provincial Albacete is demonstrating the cultivation of guayule as an industrial crop to produce rubber for car tires. Intercropping with safflower as an annual oilseed is also being tested. Right: The agroforestry demo site in Soria is characterized by very sandy soil, very low organic matter content and limited rainfall. Here CIEMAT is demonstrating the cultivation of annual crops (melilot, safflower and crambe) with perennials (lavender) and trees (Siberian elm).

Industrial crops and bio-based value chains for marginal land

The European Union's updated Bioeconomy Strategy (2018) seeks to foster a sustainable and circular economy, harnessing renewable biological resources for food, feed, bio-based products, energy, and services. The strategy's progress report (2022), observes the emergence of promising innovations in bio-based industries, an emerging sector that could generate one million new jobs by 2030, according to industry estimates.

In line with this vision, MIDAS suggests that **marginal lands present a valuable opportunity for the cultivation of non-edible industrial crops, which can serve as low-ILUC-risk feedstock for diverse bio-based applications.** The development of innovative bio-based value chains, transforming these industrial crops into bio-based products, can offer **alternatives and opportunities to farmers**, contributing to rural development, job creation and reducing the risk of abandonment of those areas.

Numerous industrial crops can serve this purpose, however, these crops must be resilient to the challenging environmental conditions of marginal lands, demonstrating the ability to thrive with minimal inputs while producing sufficient yields to ensure economic viability for farmers. In MIDAS, three types of industrial crops are extensively tested and demonstrated at 16 demo sites across Europe: lignocellulosic crops, oilseed crops and specialty crops. Oilseeds from annual crops (castor, crambe, safflower and carinata) are used to produce biodegradable mulch films, bio-lubricants, bio stimulants and phytosanitary products. All these bio-based products can be then used in agriculture, to replace fossil-based products, thus increasing the circularity and the sustainability of agricultural value chains. Lignocellulosic crops such as hemp, fibre sorghum, miscanthus, willow and Siberian elm are used to produce MDF (medium density fibre) panels, particle boards, biochar and nanocarbons. Specialty crops such as guayule and lavender are used to produce rubber for car tyres, latex for gloves, adhesives, coatings and essential oils.

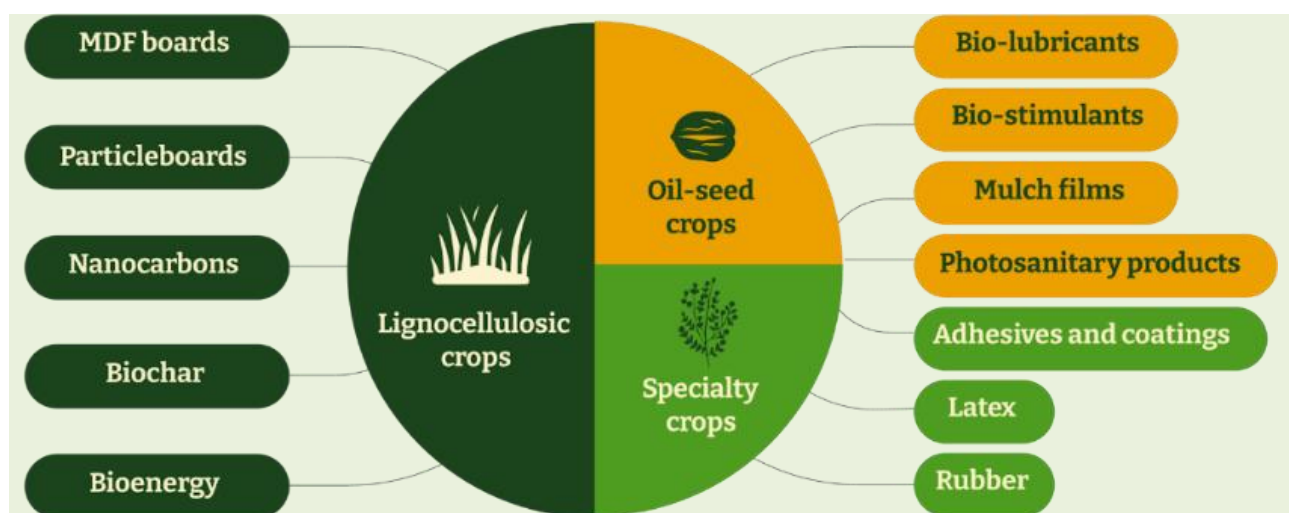


Fig. 4 – In MIDAS tree different types of industrial crops are grown with innovative farming systems such as intercropping and agroforestry, to produce feedstock for over 12 different types of bio-based products.

Although these crops are inherently suitable to growing in conditions of land marginality, adaptation and optimizations techniques are needed to strengthen their resilience and to ensure their economic viability. MIDAS employs two primary approaches to achieve this goal. Firstly, it focuses on breeding and developing crop varieties that exhibit resilience to water scarcity, nutrient deficiencies, and other stresses prevalent in marginal environments. This involves utilising advanced breeding techniques and modern biotechnology tools to develop elite varieties with enhanced biomass quality and resource use efficiency. Secondly, it applies and demonstrates sustainable farming practices such as intercropping and agroforestry, that can provide several benefits for the mitigation of soil erosion, water management and the increase of soil organic carbon. These practices can also help in enhancing biodiversity and providing ecosystem services, by creating habitats for a wider range of species compared to monocultures. This increased biodiversity leads to more robust and resilient agroecosystems, with benefits such as natural pest control, pollination services, and improved soil health.



Fig. 5 – One of the MIDAS demo fields in Grece is located in Lexaina/Illia in an area with sandy and alkalic soil and low organic matter content. Here intercropping of perennial crops (miscanthus) and annual crops (fibre sorghum, safflower, castor bean) is being demonstrated, also providing a way to diversify the agroecosystem, compared to the monocultures in the background.



Fig. 6 – At the MIDAS field site in Bologna, the strip cropping of miscanthus (foreground), safflower and crambe (middle) and hemp (background) help to keep the sandy soil covered during heavy rainfalls, while diversifying the landscape and offering food and shelter to different insect species.

Challenges of introducing new crops and crop schemes

Although industrial crops for bio-based products can represent an effective alternative to traditional crops for farmers in marginal area, growing crops on those land remains inherently difficult, and adopting new crop schemes and innovative cropping system is still a challenging task. Selecting appropriate crops and tailoring management practices to specific local conditions is vital, therefore **extensive and effective knowledge transfer, training, and demonstration activities are needed, to raise farmers' awareness and to build confidence on the viability of these solutions.** This is what MIDAS and other projects are doing across Europe, however this is not sufficient per se. Encouraging the adoption of relatively new crops among farmers is a key challenge, requiring improved **technical dissemination, training, and economic incentives.** Integrating new crops into existing farming systems and establishing reliable industrial supply chains is crucial for farmer confidence and decision-making.

The role of European and national policies, CAP in particular, together with the adoption of national plans and local bioeconomy strategies are vital instruments to build durable bio-based value chains.

The Common Agricultural Policy encompasses a green architecture that includes a series of measures to provide financial support to farmers, to incentivize sustainable land management practices, and to address barriers related to the uptake of new crops and cultivation systems. This can be achieved in the form of direct payments and adoption of eco-schemes, as well as through funding for agri-environmental commitments and rural development actions. However, a certain degree of **misalignment** between **CAP tools and national agricultural strategies**, with the **specific needs of bio-based value chains** on marginal land, is often seen by farmers and practitioners as a barrier to their deployment. **The eligibility of many industrial crops for specific cap measures is not always ensured**, therefore leaving the farmers at risk of losing access to basic direct payments, eco-schemes, or agri-environmental measures of the Rural Development Program. This can be due to operational aspects of the National Strategic Agricultural Plans and their effective implementation at local scale. National and regional administrations play a key role in defining and monitoring and implementing CAP measures at the local scale, therefore a **higher coherence between the local, national, and European levels of CAP implementation is needed, to facilitate wider adoption of industrial crops and innovative cropping systems by farmers, and to effectively support the deployment of local bio-based value chains.**



Fig. 7 – The demo site in Monterotondo (Rome) is located in a marginal area prone to water logging. At this site, CREA-IT is growing safflower as an annual oilseed crop between the rows of an established poplar plantation. The trees deep roots mitigate the effect of excess moisture also adding organic content to the soil together with their deciduous leaves, while the high stems provide shade to the oilseed crop during the flowering stage.

Market uptake

In addition to supportive policies and regulations, Successful market uptake will also depend on addressing key challenges related to processing infrastructures, market development of end products, and potentially integrating revenue streams from ecosystem services. It is vital to plan and to develop whole agro-industrial value chains gathering all the operators, including industrial partners. This requires the collaboration among research institutions, farmers, and industries to create demand and to secure stable supply chains. Local bioeconomy plans and strategies can play an important role in this, putting together the operators together with regulators, in order to create the enabling conditions for bio-based value chains. **A robust ecosystem for bio-based value chains requires to have processing capacity and established markets both for the end products and for the agricultural feedstock.**

In order to secure a stable biomass supply, it is essential that **agricultural actors in the value chain are adequately rewarded** and that they can count on sound **business cases**. While biomass provisioning is their primary focus, sustainable bio-based value chains should also include the possibility of **generating revenue from additional ecosystem services** provided by farmers growing industrial crops on marginal land with sustainable farming systems. As an example, many industrial crops are flowering species like lavender, safflower, crambe and melilot, that **attract and protect pollinators**. In addition, the diversification of crops can contribute effectively to **habitat functioning** and **biodiversity enhancement** of agroecosystems especially when adopting intercropping or agroforestry systems that include both annual and perennial species, These can also effectively **mitigate soil erosion** particularly in sloping areas and sandy soils, by keeping the soil covered for longer periods of time than traditional monocultures, and by creating a multilayer of roots at different depths inside the soil, that **reduces soil and nutrient leaching**, while also nurturing soil biodiversity. Last but not least, both the crops and the cropping systems hold potential to **increase soil carbon sequestration**, and this a particularly important aspect in marginal land that are quite often characterized by very low content of soil organic matter.



Fig. 8 and 9 – many industrial crops can help to diversify the rural landscape in marginal area, also providing ecosystem services, such as attracting pollinators, habitat functioning, increasing biodiversity and mitigating soil erosion.

The value of these services should be thoroughly **assessed and recognized**, in order for farmers to count on a solid business case and be willing to adopt and take up these innovations. This could be in the form of **simplified and increased access to CAP measures** such as eco-schemes, together with **access to carbon markets**, or private funding from organizations and companies subject to ESG (Environmental Social Governance) compliance. While an accurate quantification and valuing of ecosystem services remains a challenge, the facilitation, development and implementation of such mechanisms are crucial for realizing this revenue potential.



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The consortium

