CERESiS Project

NEWSLETTER

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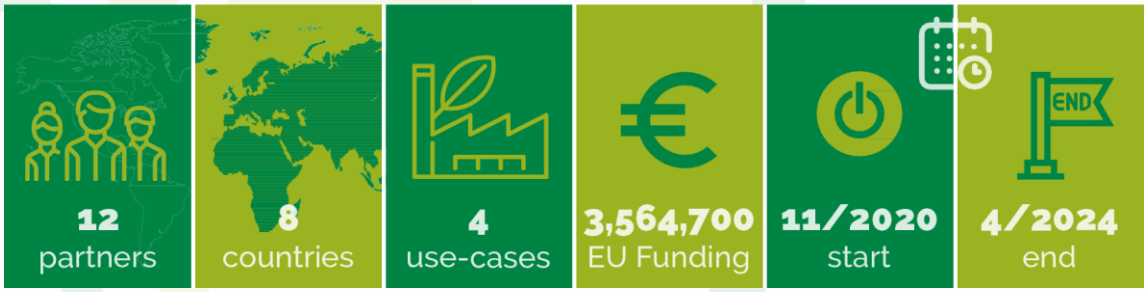
1 INTRODUCTION TO PROJECT'S PILLARS



CERESiS project aim is to provide **a win-win sustainable solution** by utilizing unused contaminated land to produce clean biofuel, using the process of phytoremediation. Therefore, also providing additional, improved land for biofuels production without using agricultural lands. To ensure success and accomplishment of its aim, the project is divided into **three different pillars** namely 1) the phytoremediation pillar, 2) the technological pillar, and 3) the decision support pillar. Collectively the CERESiS solution brings together the fields of agronomy, engineering & chemistry, management/decision support and IT with social sciences.

More specifically, the **phytoremediation pillar** concerns the utilization of a number of contaminated sites in various countries and climate zones for energy crop field trials, from which samples are being collected for research. The field trials assess the practicalities of using these contaminated lands and quantify the effect of contamination on biomass yields and quality. The **technological pillar** refers to the various biomass technologies and

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processes that currently are being investigated, for the production of biofuel with contaminated biomass. These technologies are categorized as pathway 1, SuperCritical Water Gasification and pathway 2, Fast Pyrolysis. Finally, the **decision support pillar** has to do with the development of a Decision Support System that will consider the whole value chain (energy crops selection, cultivation, pre-processing, conversion to liquid biofuel precursors, contaminant separation and upgrading to liquid biofuels), and eventually will constitute an decision support tool allowing potential users to make more informed decisions.

Remediation of large, contaminated areas can lead to the production of sustainable, non-iLUC, high quality and high value biomass for biofuels

2 PILLAR 1: ENERGY CROPS AND PHYTOREMEDIATION

Significant progress has been made so far as 15 field and greenhouse trials from 8 contaminated and brownfield sites in UK, Italy, Ukraine, and Brazil have been conducted. Additionally, 20 biomass samples from 8 field trials and 11 species have been collected in all the aforementioned countries. Furthermore, 3 new UK sites for experimentation have been planted, where in most cases great growth has been shown considering how challenging these sites are.

3 PILLAR 2: BIOMASS CONVERSION TECHNOLOGIES (CLEAN BIOFUEL PRODUCTION AND SEPARATION OF CONTAMINANTS)

In respect of the progress made in biomass technologies, 18 SuperCritical Water Gasification (SCWG) experiments have been performed successfully with 4 biomass types and with maximum operation of 9hrs without any identified problems, displaying a maximum carbon efficiency of 79.3%. Also, the optimized LENA plant (laboratory unit) has been remodeled and it is currently being tested.

The Fast Pyrolysis (FP) reactor has been tested and optimized, and a production of 5 kg of oil for microfiltration (MF) experiments was achieved. Also, FP tests have been conducted to assess the need for biomass pre-treatment. Lastly, bio-oil yield proved to have been increased, however, FP operating conditions will be further optimized to maximize it.

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4 PILLAR 3: DECISION SUPPORT

The Decision Support System (DSS) is in its development phase. Associated partners are working on detailing the architecture, on input from other partners and on evaluating the quality of data that will be fed into the DSS. A MILP (Mixed Integer Linear Programming) model was developed to optimize the total profit of the supply chain and the required input was identified to be, among others, geospatial data, technical specifications, costs, biomass yields, price of products etc.

5 NEWSLETTER FOCUS: FIELD TRIALS (UK, IT, UKR, BR)

UK Field trials (University of Strathclyde)

For the new phytoremediation trial in the UK, the University of Strathclyde has chosen to focus on more highly metal-contaminated industrial and mining sites using reed canary grass (*Phalaris Arundinacea*). This is to attempt to extend the successful results achieved for this native species energy grass on brownfield sites during the BioReGen Life project to higher levels of contamination and greater phytostabilisation challenges.

At the first UK trial site, a former Pb-Zn-F mine site in NE England, the CERESiS partners first trialed the use of surface applications of compost as a seed bed, so as to avoid any disturbance of the potentially contaminated soils. The two areas were previously used to hand-planted trials to compare different organic waste amendments

Baseline soil sampling at the third UK trial site in SW Scotland

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The second UK trial site is a derelict former dry dock and ship dismantling area on the Clyde close to the venue for COP26. In that site, partners broadcasted seed directly into the distributed soil and demolition rumble.

The third UK trial site after spreading green waste compost and biochar

Finally, at the third UK trial site in SW Scotland, partners successfully established growth on a previously unvegetated area of historic lead-zinc mine tailing using a surface application of green waste compost, together with biochar in one half. The site is prone to erosion into the local stream which impacts on the whole of the river catchment.

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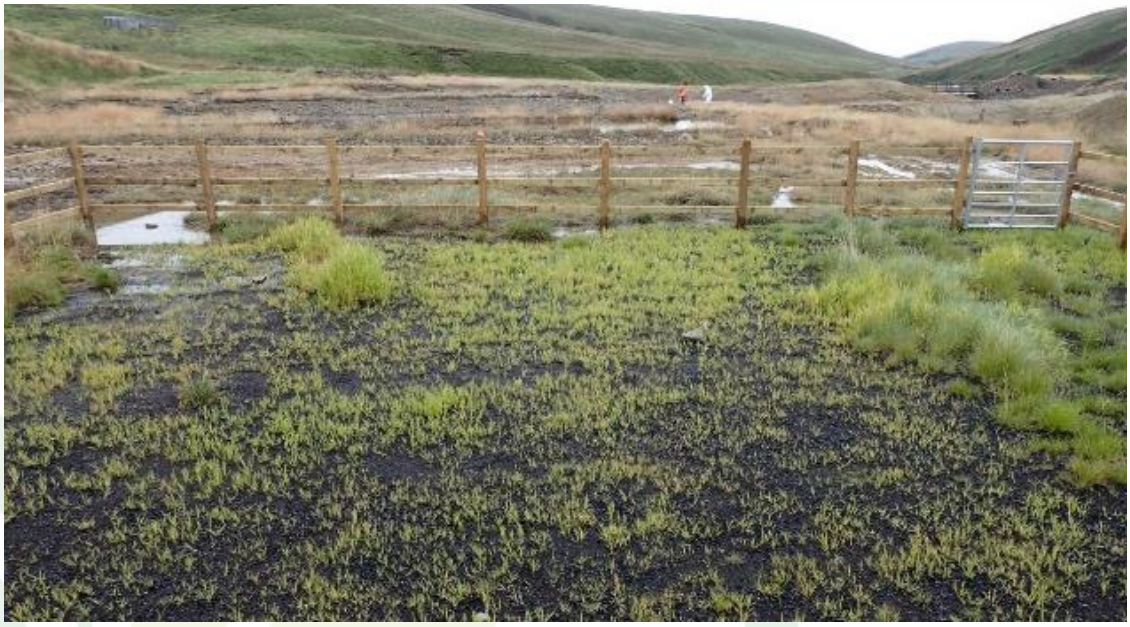
Initial growth of Reed Canarygrass (Phararis aundinacea) at the third UK trial site



Italy field trials (University of Tuscia)

There are three areas under experimentation in UNITUS farm: two dedicated to biomass production and harvest tests and one for the evaluation of agronomic aspects. In 2021, sowing was carried out with *Phalaris Arundinacea* (reed canary grass). One of the biomass areas provided a yield of 3996.77 kg ha-1 during the first year of trials. The other area was subdivided into plots with 6 treatments replicated 4 times with a total of 24 plots arranged in randomized blocks. The treatments involve different doses of nitrogen and seed treatment with *Trichoderma*.

In addition, permanent sampling areas have been established, on which harvesting is carried out at different times in order to understand when the most appropriate time for mowing is and to conclude on how many times per year, mowing can take place in a Mediterranean environment.

Results obtained during the first year revealed that texture affects biomass production, and clay soil gave higher yields than the treatment with the highest dose of nitrogen. It was also observed that the plant was less competitive during the first year and needed to be stabilized. Therefore, it remains to be seen whether or not first year's data will be confirmed by second year's data. The second year's sampling and measurements will be completed shortly and information on all aspects of harvesting will be provided.

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Site visit in UNITUS farm after the meeting in Viterbo

Ukraine field trials 1 & 2 (REA)

The second year of growing Reed Canary grass and *Miscanthus* at the two contaminated sites in Ukraine, faced an unprecedented danger due to the Russian invasion when Russian attacks came very close to the area of the trial sites. Fortunately, this area remained safe, and the crops continued to grow. However, first-year biomass characterization was delayed until summer.

Summer measurement showed promising results for the second year of growth and biomass collection for characterization in October 2022 revealed the following results:

***Phalaris Arundinacea* (Reed Canary Grass)**

- At organic pesticide contaminated trial site: 14.8 t/ha (fresh)
- At fuel & mineral oil contamination trial site: 13.2 t/ha (fresh)

Miscanthus x giganteus

- At organic pesticide contaminated trial site: 41.7 t/ha (fresh)
- At fuel & mineral oil contamination trial site: 38.9 t/ha (fresh)

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Miscanthus Giganteus field

Reed Canary Grass (*Phalaris Arundinacea*) field

Brazil field trials (Federal University of Goiás)

The site locations at which experiments are taking place in Brazil are Anicuns, Hidrolândia and Cromínia (with sandy and clayey soils). The soil in these sites has been contaminated by tanning activities, production of explosives and mining, respectively. Five experiments were set up being: BR1 on site in Anicuns, BR2 in greenhouse pot trials at UFG using Anicuns soil, BR3 in greenhouse pot trials at UFG using soil from Hidrolândia, BR4 in greenhouse pot trials at UFG using the sandy soil of Cromínia and lastly BR5 in greenhouse pot trials at UFG using the clay soil of Cromínia.

Experimentation site at UFG

Greenhouse at UFG

In each of these experiments 4 species were cultivated namely:) Capiaçu Grass (*Pennisetum purpureum cv. BRS Capiaçu*); b) Napier Grass (*Pennisetum purpureum Schum*); c) Sugar Cane (*Saccaharum officinarum*); and d) Energy Cane (*Saccaharum robustum*).

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It is noteworthy that the biomass production in all experiments is being impressive, with an interesting reduction in the concentration of Cr and Ni. Productivity analyses and analyses on the phytoremediation capacity of these crops are in progress and their results will be available soon.

Experimentation site at UFG

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6 CONCLUSION: DISSEMINATION ACTIVITIES

Dissemination activities are an integral part of the CERESiS project as they ensure the visibility of the project results. It is among the project's main concerns to ensure that the generated information will reach industrial, political, and social stakeholders in an effective manner. The CERESiS dissemination strategy ensures that the key messages are sufficiently highlighted and effectively communicated towards appropriately targeted stakeholders.

Within the first 24 months, CERESiS partners have been actively involved in dissemination and communication activities: the project frame and its preliminary results have already been presented in the context of 12 conferences, 3 exhibitions and 2 webinars, 1 workshop and 1 specialized event. Moreover, on the basis of CERESiS work, 7 courses and other educational activities have been prepared by our university partners while four journal papers have been produced!

Energy crops can be a suitable and effective solution for contaminated land remediation, exhibit high mass productivity and lead to sustainable biofuel production when coupled with appropriate conversion processes

For further information

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