















LIFE SUBESED - LIFE17ENV/IT/000347
01/10/2018 – 30/09/2022

Project co-financed by
the European Union
through the LIFE Programme

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LAYMAN'S REPORT



Sustainable substrates for agriculture from dredged remediated marine sediments:

FROM PORTS TO POTS

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Duration of the Project: 1st October 2018 – 30th September 2022
Total Budget of the Project: 1,745,524 €
Project co-financed by the European Union: 59,97%

The experimental trials of the LIFE SUBSED Project have been carried out in Italy, in Pescia (Pistoia), Montecarlo (Lucca) and in Spain in San Javier (Murcia) and Orihuela (Alicante).

Project Consortium

Beneficiary Coordinator
Flora Toscana, a cooperative of growers based in Tuscany, Italy, coordinator of the project and responsible for the Italian demonstration trials;

Beneficiary Partners
CREA, Research Center for Horticulture and Horticulture, Pescia (Italy), scientific manager of the agronomic trials conducted in Italy;

CNR-IRET Research Institute on Terrestrial Ecosystems, Pisa (Italy) branch of the National Research Council, responsible for soil analyses as an expert in phytoremediation;

Carbon Sink Group s.r.l., a spin-off of the University of Florence (Italy), responsible for the LCA analysis on the Italian tests, also assisted CREA in the experimental trials;

UMH - Universitas Miguel Hernández, of Elche (Spain), scientific manager of agronomic trials in Spain as expert in characterization and analyses of plants;

Caliplant, a Spanish nursery based in the province of Murcia, responsible for the Spanish demonstration trials conducted in the nursery.

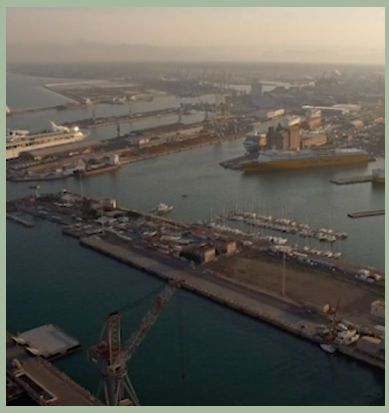
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THE LIFE SUBSED PROJECT

Life Subsed is a co-funded project within the LIFE program. The LIFE program is the European Union funding instrument for the environment and climate action, born in 1992.
In these 30 years, the EU has co-financed thousands of projects, contributing to the implementation, updating and development of the European Union's environmental and climate policy and legislation.
The project demonstrates the potential and suitability of the use of reclaimed dredged sediments as components of an agronomic substrate that can be used in the horticultural and fruit growing sectors, recovering waste to produce new resources in a circular economy perspective.





OBJECTIVES

The Life Subsed project has two main objectives:

• Convert a waste, in this case a dredged and reclaimed sediment, into a resource, or into a commercial substrate to be used in agriculture, through the application of sustainable techniques both from an environmental and an economic point of view, in a circular economy perspective . These sediments are the result of dredging the course of rivers and the seabed of ports, a fundamental operation to allow both navigation and the outflow of waterways.

• Reduce the use of peat in the horticultural sector and thus protect peatlands as natural environments that are not easily renewable. Peat bogs occupy about 3% of the earth's surface and are extremely important habitats for both biodiversity and climate regulation. They were formed in wet and swampy areas over thousands of years through a slow process of rotting and decomposition of plant material. Today they are severely threatened on a global scale by the expansion of commercial agriculture and other forms of economic development.

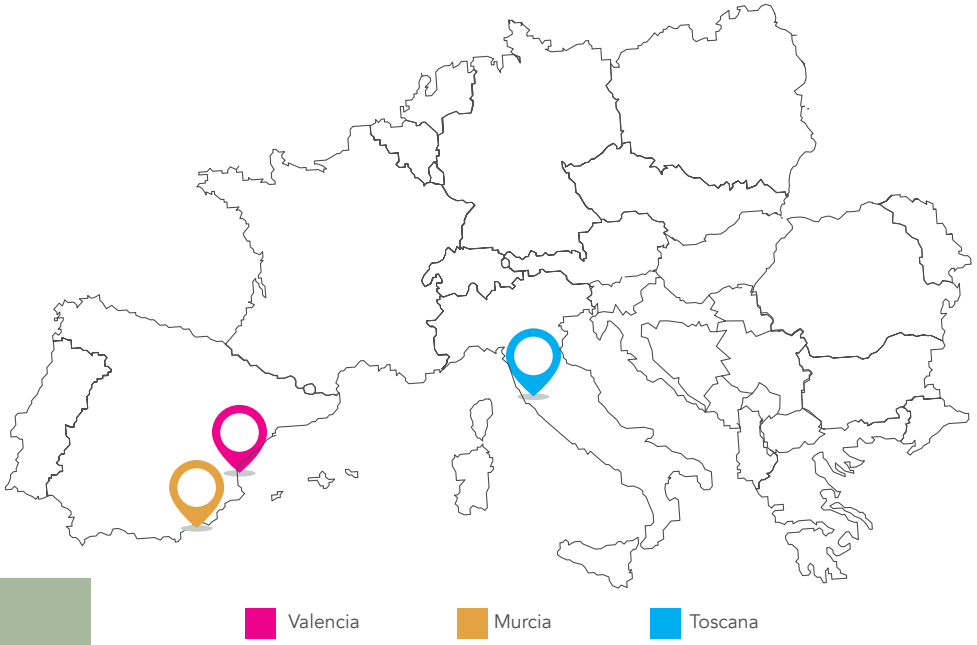
The dredging of ports, rivers and canals is an indispensable activity for navigation purposes which, according to current estimates, involves about 200 million cubic meters of sediment per year throughout Europe. In order to be used in agriculture, these sediments need to be free of contaminants or, if not, be reclaimed.

Among the methods used for reclamation purposes, phytoremediation represents a sustainable solution from both an environmental and an economic point of view. It is in fact a technology that is practiced on site and that uses green plants and their microorganisms for the decontamination and remediation of sites contaminated by heavy metals, organic pollutants, mainly hydrocarbons, and radioactive substances.

PROJECT ACTIONS

LANDFARMING AND PRODUCTION OF SEDIMENT-BASED SUB-STRATES

LIFE SUBSED has used sediments already reclaimed during the previous project named AGRIPORT, in the course of which a new phytoremediation methodology was validated and patented.
During the first phases of the LIFE SUBSED project, this sediment was subjected to three months of landfarming which consisted of repeated processing in order to homogenize and oxygenate the soil to improve its biological, physical and chemical characteristics.
Subsequently, the obtained material was mixed in various proportions with commercial preparations based on peat, coconut fiber and wood fiber to best meet the needs of the various crops. It was then used as a substrate for the soilless cultivation of various species for ornamental and food use. Demonstration tests were carried out in Pescia and Montecarlo (Tuscany, Italy) and in San Javier and Orihuela (Alicante) in the communities of Murcia and Valencia, Spain.



THE CULTIVATION TRIALS

In order to validate the use of these substrates in agriculture, some cultivation tests were conducted on the following species



Laurel

Prunus laurocerasus cv. Novìta

The effects on the propagation and growth of this evergreen ornamental species, one of the most important from a commercial point of view for the Italian nursery sector, were evaluated.



Calla Lily

Zantedeschia aethiopica

This species was chosen for the production of cut flowers, due to its economic importance worldwide.



Protea

Protea cynaroides cv. Little Prince

It is the national flower of South Africa. The trial involved variety Little Prince which, thanks to its relatively compact habit, is suitable for growing in pots.



Basil

Ocimum basilicum cv. Genovese e Valentino

Basil, is an aromatic and seasoning plant, it represents one of the most loved and widespread species in Italy and in the world.



Blueberry
Vaccinium corymbosum cv. Bluecrop e Duke
In recent years, the interest in this small fruit, considered a superfood, has grown considerably because of its many beneficial properties for human health.



Woodland strawberry
Fragaria vesca cv. Regina delle Valli
Perennial herb that produces many small fragrant fruits, very adaptable thanks to its rhizomatous nature.



Olive tree
Olea europaea cv. Frantoio
This evergreen tree adapts to the most unfavorable climate and soil conditions. The experimentation began during the hardening phase of the grafted seedlings and involved growth in the nursery phase.



Lemon
Citrus limon cv. Fino 49 (nursery phase) e cv.Verna 52 (productive phase)
Lemon, a citrus fruit known all over the world, has been propagated and cultivated on different types of rootstocks.

All demonstrative tests were carried out in greenhouses. At the beginning and at the end of the experimentation on the cultivation substrates, the parameters required by the legislation on fertilizers were determined. In addition, measurements were made related to the agronomic quality of a substrate and therefore to its fertility in terms of nutrients, ability to retain water and enzymatic activity. Destructive and non-destructive measurements were carried out on the plants under study in order to evaluate the production performance both from a yield and quality point of view through morphological, physiological and, as regards food plants, nutraceuticals.

ANALYSIS OF THE REGULATORY FRAMEWORK FOR THE USE OF SEDIMENTS IN AGRICULTURE

The LIFE Subsed project has also addressed the legislative and authorization aspects relating to the use of sediments in agriculture. This involved a comparison with both the environmental and fertilizer legislation. Specific meetings were also organized with authorities and policy makers, who were presented with the potential of SUBSED solutions and the need for an update of the regulatory framework that favors the transition towards circular economy measures. During the last phases of the LIFE SUBSED project, a small additional experiment was also launched which allowed to define the procedure to be followed to obtain the "End of Waste" of a non-dangerous dredged sediment, transforming this sediment from "waste" to top soil.

LIFE SUBSED: ENVIRONMENTAL AND ECONOMIC SUSTAINABILITY

A Life Cycle Assessment (LCA analysis) was performed to verify the environmental sustainability of the use of phytoremediation sediment. LCA is an analysis that aims to assess the environmental impacts generated by the processes required to create a product or service during its entire life cycle.
A business plan was also prepared to assess the economic sustainability and a questionnaire was distributed to assess the socio-economic impact of the project and the public's sensitivity towards these issues.

TRAINING, INFORMATION AND DISSEMINATION

In order to provide useful and effective tools for the replication of the solutions proposed by LIFE SUBSED, the consortium organized four workshops for different types of participants and three technical days for sector technicians, nurserymen, students and researchers. Guidelines were also produced and disseminated detailing all the phases of the processes validated during the LIFE SUBSED project: the guidelines can be freely downloaded from www.lifesubsed.com

In order to disseminate and transfer the results achieved and the experience gained, the consortium conducted an intensive communication and dissemination campaign, aimed at reaching different targets: from citizens to researchers, from sector associations to policy makers. In addition to online communication through the website www.lifesubsed.com and the Facebook and Twitter profiles, the consortium has collaborated in the production of information material such as brochures, videos, banners and LIFE SUBSED branded gadgets. Articles have also been published in scientific journals and trade journals.
The beneficiaries have also taken part in a large number of national and international events, conferences and fairs, during which it has been possible to get in touch with institutions, stakeholders, sector operators and researchers from all over Europe.

RESULTS AND BENEFITS

Landfarming has improved the agronomic and biological characteristics of the sediment making it more suitable for plant cultivation.

Landfarming has ensured homogenization of the substrate and a further reduction of organic contamination (reduction of about 100% of C> 12), making it possible to achieve the physico-chemical characteristics required by the Italian legislation for agronomic substrates (Legislative Decree 75/2010), with the sole exceptions of organic carbon and bulk density.

At the end of landfarming, despite a reduction of more than 20%, the bulk density was slightly above the maximum limit (1.19 g cm-3 instead of 0.95 g cm-3), while the organic carbon was significantly below the level required (1.4% vs. 4%). However, to achieve the organic carbon concentration and bulk density required by the legislation, it was sufficient to mix the sediments with low bulk density, carbon-rich agronomic substrates such as peat and coconut fiber.
All the substrates in which the sediment was used at the dose of 50% or less, have reached the characteristics required by the legislation.
The species subject to experimentation responded positively with extremely promising results both from the agronomic point of view, referring in particular to the reduction of water consumption, and from the point of view of the quality of the productions.

Studies carried out on food plants have shown that the use of remedied sediments does not present significant risks to human health. The data collected showed that this sediment can be a resource and be successfully used as a constituent of a cultivation substrate in the variable portion between 25% and 50%, depending on the species considered, on laurel, calla lily, olive tree, strawberry, basil and lemon. More difficulties were instead observed in particularly demanding species in terms of soil porosity and pH, such as Protea and Blueberry.

Laurel
Prunus laurocerasus cv. Novìta

Mixture	Vegetative development	Heavy metal content in the leaves	Suitability of the sediment
25% ST 75% SBT	very good	very low	**yes**
50% ST 50% SBT	good	very low	**yes**
25% ST 75% SBFC	good	very low	**yes**
50% ST 50% SBFC	acceptable	very low	**acceptable**
25% ST 75% SBFL	poor	very low	**no**
50% ST 50% SBFL	poor	very low	**no**

Calla Lily
Zantedeschia aethiopica

Evaluation parameters	Percentage of ST	
	25%	50%
Vegetative development	very good	very good
Heavy metal content in the leaves	very low	very low
Flower production	high	high
Sediment suitability	**yes**	**yes**

Protea
Protea cynaroides cv. Little Prince

Mixture	Vegetative development	Heavy metal content in the leaves	Flower production	Suitability of the sediment
25% ST 75% SBT	medium	low	medium	**not optimal**
50% ST 50% SBT	poor	low	low	**no**
25% ST 75% $SBFC_A$	medium	low	medium	**not optimal**
50% ST 50% $SFBC_A$	poor	low	very low	**no**
25% ST 75% $SBFC_B$	poor	low	low	**no**
50% ST 50% $SBFC_B$	poor	low	very low	**no**

Basil
Ocimum basilicum cv. Genovese e Valentino

Evaluation parameters	Percentage of ST			
	12.5%	25%	50%	100%
Vegetative development	good	good	poor	very poor
Heavy metal content in the leaves	low	low	low	low
Suitability of the sediment	**yes**	**yes**	**not optimal**	**no**

Blueberry
Vaccinium corymbosum cv. Bluecrop e Duke

Evaluation parameters	Percentage of ST	
	50%	100%
Vegetative development	poor	poor
Fruit production	absent	absent
Sediment suitability	no	no

Wild strawberry
Fragaria vesca cv. Regina delle Valli

Evaluation parameters	Percentage of ST	
	50%	100%
Vegetative development	good	reduced
Fruit production	high	medium-low
Heavy metal content in fruits	low	low
Fruit quality	good	good
Suitability of the sediment	yes	fruits with a less pleasant taste

Lemon
Citrus limon cv. Fino 49 (in nursery) e cv.Verna 52 (in production)

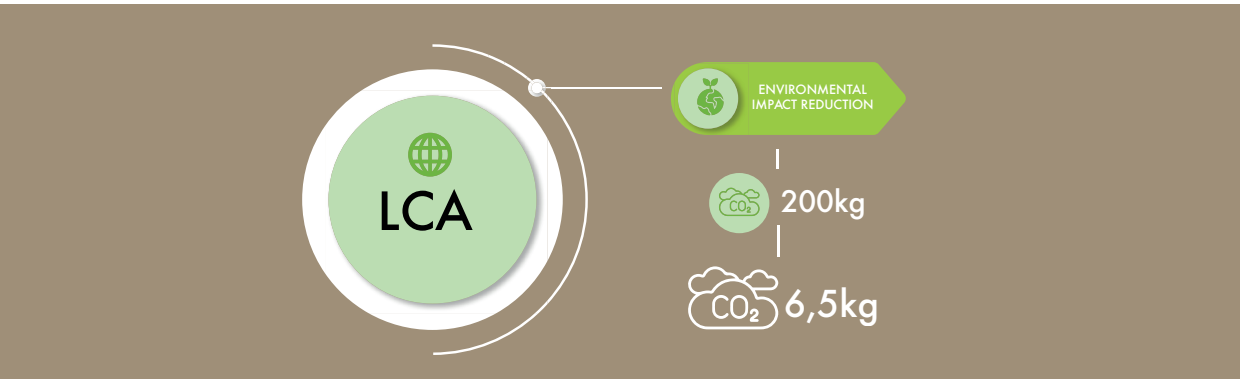
Mixture	Vegetative development	Suitability of the sediment
25% ST 75% SBFC	good	yes
50% ST 50% SBFC	good	yes
75% ST 25% SBFC	not optimal	not optimal
100% ST	poor	no

Mixture	Vegetative development	Fruit production	Heavy metal content of fruits	Suitability of the sediment
25% ST 75% SBT	good	medium	low	yes
50% ST 50% SBT	good	high	low	yes
75% ST 25% SBT	smaller trees	low	low	not optimal

Olivo
Olea europaea cv. Frantoio

Mixture	Vegetative development	Suitability of the sediment
25% ST 75% SBT	good	yes
50% ST 50% SBT	good	yes
75% ST 25% SBT	good	yes
100% ST	not optimal	no

SBT = peat substrate (control)
SBFC = substrate based on coconut fiber
SBFL = wood fiber substrate
ST = treated sediment



The LCA analysis highlighted a significant reduction in environmental impact, resulting from the non-exploitation of peatlands and the reduced logistics requi red to obtain the substrate.
The project studied the cultivation of different products divided into different impacts (impact on climate change, impact on water consumption, impact on toxicity and others).
The first result that can be found from the environmental impact analysis is that the transformation of dredged sediments as a culture substrate has a much lower environmental impact in absolute terms than the production of peat-based substrate. By verifying the yield of each product, a great increase in productivity is noted for Olive, Laurel, Calla Lily and Strawberry when these are grown on the dredged sediment substrate. Protea and Blueberry, on the other hand, prove less suitable for this type of substrate, recording lower yields, however, peat proves not to be the best substrate for these last two crops: valid alternatives in terms of impact and yield are substrates based on coconut fiber and wood fiber. The impact deriving from transport has practically disappeared, going from about 200 kg of CO_2 equivalent for the transport of 1 kg of peat, to about 6.5 kg of CO_2 equivalent for the transport of 1 kg of dredged sediment from the port of Livorno to Italian sites.
The business plan prepared during the LIFE SUBSED project has shown that the proposed solutions can be economically sustainable for the target market analyzed.
Over 300 people took part in the workshops and technical days organized by the consortium as part of the LIFE SUBSED project. Furthermore, the consortium has produced more than 10 scientific articles and appeared in more than 20 specialized journals and others on a local, national and international scale. The consortium has produced over 7000 LIFE SUBSED personalized gadgets and participated in more than 35 national and international events and fairs.


HAVATEQ
SUB SED
Sustainable substrates for agriculture from dredged remediated marine sediments: from ports to pots




Consulting and Agrotechnology
SUB SED


REGIÓN DE MURCIA
Huerta de Europa
SUB SED


SUB SED


LIFE Subsed
"From ports to pots"
FLORA TOSCANA
Your closest link to production
Sediments
Analysis

CONCLUSIONS

The results of the project are extremely promising: phytoremediation sediment has been successfully used as a constituent of a culture substrate to replace peat and coco, in the proportions varying between 25-50% in most of the crops tested. Plants grown on sediment-based substrates showed no symptoms of phytotoxicity, and although sediment-based substrates were rich in metallic elements, particularly Zn, these elements were found at very low concentrations in the plants' leaves.

The results therefore showed that the properties of the individual components of the substrate are not as important as the overall effects of the final mixture. Thus, we can conclude that this project opens the doors to a wide replicability capable of involving various areas in Europe and worldwide and numerous crops.
On the legislative and authorization level, a path has been clarified and identified that will allow passing from the experimentation phase to the application and commercial phase. The actual environmental legislation does not allow the use of drained sediments, as constituents of a cultivation substrate, because they are considered waste. The fact that a phytoremediation process has made them "non-hazardous" is not enough to remove them from the category of waste.

Therefore, the intervention of a recovery plant authorized for the management and treatment of dredging sediments is necessary. Following this treatment and analyses that certify compliance with the limits established by environmental legislation, the sediments lose their qualification as waste and are classified as by-products of the "topsoil" type. At this point, after being suitably mixed with organic amendments, they can contribute to the formation of a cultivation substrate in compliance with the legislation on fertilizers.

In this regard, the Consortium is preparing an After LIFE plan that will involve dredged river sediments, previously subjected to an "End of Waste" process, to be used and tested as a constituent of a growing substrate on new crops in the horticultural sector.





This project was co-financed by the European Union under the LIFE program.
The contents of this publication are the sole responsibility of the LIFE SUBSED consortium and do not necessarily reflect the opinion of the European Union www.lifesubsed.com

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