



EUROPEAN COMMUNITY
SUBSED LIFE17 ENV/IT/000347:



**“Sustainable substrates for agriculture from dredged
remediated marine sediments:
from ports to pots”**





LIFE17 ENV/IT/000347



SUBSED TIMETABLE

Action		2018				2019				2020				2021			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Number	Name of the action																
A	Preparatory actions																
A1	Review of the EU and national regulations on the use of sediments for plant nursery and analytical protocol																
B	Implementation actions (obligatory)																
B1	Phytoremediated sediment treated via landfarming process																
B2	Demonstration of the use of remediated sediment as a substrate for nursery production																
B3	Demonstration of the use of remediated sediment as a substrate for non food crop cultivation																
B4	Demonstration of the use of remediated sediment as a substrate for food crop production																
B5	Training courses, workshop and guidelines for project replicability and transferability																
B6	SUBSED business plan																
C	Monitoring of the impact of the project actions (obligatory)																
C1	Monitoring and validation of the treated sediment																
C2	Monitoring and validation of the use of remediated sediment as a substrate for plant nursery and cultivation: non food crops																
C3	Monitoring and validation of the use of remediated sediment as a substrate for plant nursery and cultivation: food crops																
C4	Monitoring of socio-economic impact of the project and LCA																
C5	Performance indicators monitoring																
D	Public awareness and dissemination of results (obligatory)																
D1	Project dissemination plan (materials, web-site, articles, video, Layman's report)																
D2	Project dissemination plan (events and networking)																
E	Project management (obligatory)																
E1	Project management (FLORA)																
E2	SUBSED audit																
E3	SUBSED after-life																

Action B2: Demonstration of the use of remediated sediments as a substrate for nursery production

Action		2018				2019				2020				2021			
Number	Name of the action	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
B	Implementation actions (obligatory)																
B2	Demonstration of the use of remediated sediment as a substrate for nursery production																

Foreseen start date: 01/04/2019 Actual start date: -----

Foreseen end date: 31/03/2021 Actual end date: -----

- Action performed by CREA and FLORA
- Nursery production of semi-hardwood cuttings of *Prunus laurocerasus* (laurel)

Evergreen ornamental:
Prunus laurocerasus 'Novita'



Action B2: Demonstration of the use of remediated sediments as a substrate for nursery production

B2.1: Nursery production of ornamentals

Procedures for *Prunus laurocerasus* (rooted cuttings)

Common name: Cherry Laurel

Cultivar: Novita



Experimental design

The initially defined and planned experimental design (i.e. substrate mixtures, number of plants and water regimes) was subsequently modified (as follow).

In particular, CREA and FLORA decided to select different water regimes in order to evaluate the best irrigation schedule able to achieve good plant productive and growth performances.

The use of multiple water regimes will produce different scenarios in terms of water saving as well as environmental impact.

The experimentation will start in early Spring and will last one vegetative cycle (one year).

During plant cultivation, conventional cultural practices such as fertilization, weed control and pest control will be performed as typically done in the area of production (Tuscany) throughout the cultivation cycles

Action B2: Demonstration of the use of remediated sediments as a substrate for nursery production

B2.1: Nursery production of ornamentals

Procedures for *Prunus laurocerasus* (rooted cuttings)

First experimental design planned in April 2019	Final experimental design planned in April 2020
Environment	Environment
open field	greenhouse
Substrate mixture	Substrate mixture
PB100	PB100
PB75/TS25	PB75/TS25
PB50/TS50	PB50/TS50
CB75/TS25	CB75/TS25
CB50/TS50	CB50/TS50
WB75/TS25	WB75/TS25
WB50/TS50	WB50/TS50
Water regime	Water regime
R1 – normal	R1 – normal
R2 – low-water	R2 – low-water
R3 – very low-water	
Rooted cuttings/substrate * water regime plot	Rooted cuttings/substrate * water regime plot
20 (2 in 8.5-Lpot)	8 (2 in 8.5-Lpot)
Plot replicates	Plot replicates
3	3
Total plants	Total plants
1260 laurel rooted cuttings	336 laurel rooted cuttings

Action B3: Demonstration of the use of remediated sediments as a substrate for non-food crops cultivation

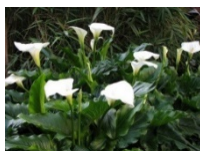
Action		2018				2019				2020				2021			
Number	Name of the action	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
B	Implementation actions (obligatory)																
B3	Demonstration of the use of remediated sediment as a substrate for non food crop cultivation																

Foreseen start date: 01/04/2019 Actual start date: -----

Foreseen end date: 31/03/2021 Actual end date: -----

- Action performed by CREA and FLORA
- Non-food crops cultivation (from plantlets to final production: flowers/ornamentals)
- The experimental design were modified as for Laurel. CREA and FLORA decided to select different water regimes in order to evaluate the best irrigation schedule able to achieve good plant productive and growth performances.

Cut flower: Calla lily
(*Zantedeschia aethiopia*)



Potted plant: King Protea
(*Protea cynaroides*)



Evergreen ornamental:
Prunus laurocerasus



Action B3: Demonstration of the use of remediated sediments as a substrate for non-food crops cultivation

B3.1: Flower and ornamentals

Procedures for *Zantedeschia aethiopica* (cut flower production)



Common name: Calla lily

Experimental design

Calla rhizomes will be planted in 30-L containers, obtained from a specific arrangement of benches (21 m² surface, 20 cm depth), respecting a distance of 50 cm from each other, in early Spring.

Calla lily plants will be cultivated over two vegetative cycles (2 years).

During plant cultivation, conventional cultural practices such as fertilization, weed control and pest control will be performed as typically done in the area of production (Tuscany) throughout the cultivation cycles

Action B3: Demonstration of the use of remediated sediments as a substrate for non-food crops cultivation

B3.1: Flower and ornamentals

Procedures for *Zantedeschia aethiopica* (cut flower production)



First experimental design planned in April 2019	Final experimental design planned in April 2020
Environment	Environment
greenhouse	greenhouse
Substrate mixture	Substrate mixture
PB100	PB100
PB75/TS25	PB75/TS25
PB50/TS50	PB50/TS50
Water regime	Water regime
R1 – normal	R1 – normal
	R2 – low-water
	R3 – very low-water
Rhizomes/substrate plot	Rhizomes/substrate * water regime plot
30 in benches	14 in benches
Plot replicates	Plot replicates
3	3
Total plants	Total plants
270 calla lily rhizomes	378 calla lily rhizomes

Action B3: Demonstration of the use of remediated sediments as a substrate for non-food crops cultivation

B3.1: Flower and ornamentals

Procedures *Protea cynaroides* (flower pot plant)



Common name: King Protea

Cultivar: Little Prince

Experimental design

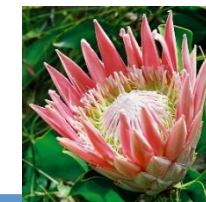
The trials will start at the beginning of Spring under protection and potted plants will be cultured over two vegetative cycles (2 years).

During plant cultivation, conventional cultural practices such as fertilization, weed control and pest control will be performed as typically done in the area of production (Tuscany) throughout the cultivation cycles

Action B3: Demonstration of the use of remediated sediments as a substrate for non-food crops cultivation

B3.1: Flower and ornamentals

Procedures *Protea cynaroides* (flower pot plant)



First experimental design planned in April 2019	Final experimental design planned in April 2020
Environment	Environment
greenhouse	greenhouse
Substrate mixture	Substrate mixture
PB100	PB100
PB75/TS25	PB75/TS25
PB50/TS50	PB50/TS50
CB75/TS25	CB75/TS25
CB50/TS50	CB50/TS50
WB75/TS25	WB75/TS25
WB50/TS50	WB50/TS50
Water regime	Water regime
R1 – normal	R1 – normal
	R2 – low-water
	R3 – very low-water
Rooted cuttings/substrate plot	Rooted cuttings/substrate * water regime plot
25 in 2-Lpot	10 in 2,8-Lpot
Plot replicates	Plot replicates
3	3
Total plants	Total plants
525 protea rooted cuttings	630 protea rooted cuttings

Action B3: Demonstration of the use of remediated sediments as a substrate for non-food crops cultivation

B3.1: Flower and ornamentals

Procedures *Prunus laurocerasus* (rooted cuttings)



Common name: Laurel

Cultivar: Novita

Experimental design

The laurel cultivation tests will be carried out on the same plants used in the propagation phase for a further vegetative cycle. Same growing substrates, water regimes, replicates and experimental design will be applied as described in action B2.

Action C2: Monitoring and validation of the use of remediated sediments as a substrate for plant nursing and cultivation: non food crops

Action		2018				2019				2020				2021			
Number	Name of the action	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
C	Monitoring of the impact of the project actions (obligatory)																
C2	Monitoring and validation of the used of remediated sediment as a substrate for plant nursery and cultivation: non food crops																

Foreseen start date: 01/07/2019 Actual start date: -----

Foreseen end date: 01/06/2021 Actual end date: -----

- Action performed by CREA
- This action was started two month in advance for better preparing field and laboratory protocols
- Sub-action C2.1 regarding the monitoring of nursery ornamental plants (i.e. laurel)
- Sub-action C2.2 regarding the monitoring of non-food crops cultivation (i.e. calla, protea and laurel)

Action C2: Monitoring and validation of the use of remediated sediments as a substrate for plant nursing and cultivation: non food crops

C2.1: Procedures for laurel nursery production (rooted cuttings)

1. Plants and leaves

Data collection (non-destructive analysis). Recurrence: every 60 days from planting time (included) or more

- Plant mortality (number; percentage)
- Base stem diameter
- Maximum plant height
- Number of vegetative sprouts
- Length of primary vegetative shoot
- Number of fully expanded leaves on primary vegetative shoot
- Leaf blade colour (L, a, b coordinates) and chroma index $(a^2 + b^2)^{1/2}$
- Photosynthetic activity by CIRAS-2

Data collection (destructive analysis) - Recurrence: only at the end of the trial

- Leaf area
- Chlorophyll content
- Malondialdehyde (MDA) analysis for oxidative stress
- Heavy metal analysis

Action C2: Monitoring and validation of the use of remediated sediments as a substrate for plant nursing and cultivation: non food crops

C2.2: Procedures for *Zantedeschia aethiopica* (cut flower production)

1. Plants and leaves

Data collection (non-destructive analysis). Recurrence: according to the phenological phases (vegetative initial growth/ re-growth, full bloom, vegetative dormancy)

- Plant mortality (number; percentage)
- Number and maximum height of stems
- Number of flowers
- Length of spathe
- Spathe colour and leaf blade colour (L, a, b coordinates) and chroma index $(a^2 + b^2)^{1/2}$
- Photosynthetic activity by CIRAS-2

Data collection (destructive analysis). Recurrence: only at the end of the trial

- Leaf area
- Chlorophyll content
- Fresh and dry weight of the aerial part, stem and whole plant
- Length, fresh and dry of root system
- Malondialdehyde (MDA) analysis for oxidative stress
- Heavy metal analysis

2. Phenology

- Re-growth time (second year)
- Flowering time (first flower - first two completely open flowers in one plant; peak of flowering - 50% of completely open flowers; last flower)

Action C2: Monitoring and validation of the use of remediated sediments as a substrate for plant nursing and cultivation: non food

C2.2: Procedures for *Protea cynaroides* (flower pot plant)

1. Plants and leaves

Data collection (non-destructive analysis). Recurrence: according to the phenological phases (vegetative initial growth/ re-growth, full bloom, vegetative dormancy)

- Plant mortality (number; percentage)
- Number of stems with flowers
- Number, base diameter and maximum height of stems
- Number of flowers
- Shape and size of inflorescence
- Colour of flower cluster, surrounding bracts and paddle-shaped leaves (L, a, b coordinates) and chroma index ($a^2 + b^2$)^{1/2}
- Photosynthetic activity by CIRAS-2

Data collection (destructive analysis) - Recurrence: only at the end of the trial

- Leaf area
- Chlorophyll content
- Fresh and dry weight of the stem and whole plant
- Fresh and dry weight and length of root system
- Malondialdehyde (MDA) analysis for oxidative stress
- Heavy metal analysis

2. Phenology

- Re-growth time (second year)
- Flowering time (first flower - first two completely open flowers in one plant; peak of flowering - 50 % of completely open flowers; last flower)

Action C2: Monitoring and validation of the use of remediated sediments as a substrate for plant nursing and cultivation: non food crops

C2.2: Laurel nursery production (evergreen ornamental)

1. Plants and leaves

Data collection (non-destructive analysis). Recurrence: every 60 days from planting time (included) or more

- Plant mortality (number; percentage)
- Base stem diameter
- Maximum plant height
- Number of vegetative sprouts
- Length of primary vegetative shoot
- Number of fully expanded leaves on primary vegetative shoot
- Leaf blade colour (L, a, b coordinates) and chroma index $(a^2 + b^2)^{1/2}$
- Photosynthetic activity by CIRAS-2

Data collection (destructive analysis) - Recurrence: only at the end of the trial

- Leaf area
- Chlorophyll content
- Fresh and dry weight of the whole plant
- Fresh and dry weight of stem (aerial part)
- Length, fresh and dry weight of root system
- Malondialdehyde (MDA) analysis for oxidative stress
- Heavy metal analysis

2. Phenology

- Re-growth time
- Sprouting time