

Sustaffor comes to an end...here are some of the main conclusions

Sustaffor project has been developed from September 2013 to December 2015. Hereby we present the most relevant conclusions and key messages from the project.

Sustaffor project: novel techniques and field trials

The aim of SUSTAFFOR is to conceive, produce, develop and on-field validate novel techniques aiming at improving affo/reforestation projects from an environmental, technical and economic point of view, as well as to explore the synergies between them.

These novel techniques aim at mitigating the negative effect of drought and competitive vegetation, while minimizing the need for maintenance. They include a new generation of soil conditioners and innovative mulching models, either biodegradable or reusable:



Soil conditioner, 20+ components including new hydroabsorbent polymers (TerraCottem Internacional)



Recycled rubber mulch, long-lasting (10-15 years, thus reusable), not requiring fixation to the ground (EcoRub)



Woven jute cloth treated with furan bio-based resin for increased lifetime, 100% biodegradable (La Zeloise)



Black new biopolymer-based semi-rigid plate, 100% biodegradable, easy fixation to the ground (DTC)



Black new biopolymer-based frame, 100% biodegradable, fused to a commercial biofilm (DTC)

This **fifth and last newsletter** presents the main results of the project field trials (2014-15), installed in four contrasted bioclimatic areas in NE Spain: Semiarid, Mediterranean Continental, Mediterranean Humid and Montane. The [Newsletter 2](#) provided a whole description of the network of field trials and the experimental design, [Newsletter 3](#) described the monitoring performed and [Newsletter 4](#) introduced the preliminary results from the first vegetative period.

We invite you to check the whole range of results and the different project publications and dissemination materials at: www.sustaffor.eu

Field trials, treatments and variables considered

Table 1. Main features of Sustaffor field trials (complete description in [Newsletter 2](#))

Bioclimate	Semiarid	Mediterranean continental	Mediterranean humid	Montane
Location	Mequinenza	Solsona	Banyoles	Fontanals Cerdanya
Altitude (m o.s.l.)	210	672	215	1,430
Site type	Forest area burnt in 2005	Abandoned arable field	Abandoned arable field	Abandoned grazing area
Aspect, slope	South - 40%; North - 60%	Flat	Flat	North - 30%
Mean annual temperature (°C)	15.0	12.0	14.0	7.5
Annual / summer precipitation (mm)	371 / 69	683 / 165	872 / 213	887 / 272
Climate type (Köppen)	BS: Steppe climate, cold	Csb: temperate, dry mild summer	Cfb: Maritime temperate	Cfc Temperate/ Dfb Continental
Soil texture	Loamy-sandy	Loamy-clayish	Loamy-silty	Loamy-sandy
Tree species	<i>Pinus halepensis</i>	<i>Juglans x intermedia</i> , <i>Quercus ilex</i> with <i>Tuber melanosporum</i>	<i>Juglans x intermedia</i> , <i>Pinus pinea</i>	<i>Fraxinus excelsior</i> , <i>Betula pendula</i>

Table 2. Techniques studied in the project

Technique	Description	Code
Soil conditioning	Innovative soil conditioner (TerraCottem Internacional) Utilized at 3 doses: 20, 40 and 80 g/tree	TCU+20g TCU+40g TCU+80g
	Commercially available soil conditioner TerraCottem Universal®. Dose: 40 g/tree	Std40g
	No application of soil conditioner	Control
Weeding techniques	New biopolymer-based framed mulch (DTC)	BIOPOLYMER
	Woven jute cloth (La Zeloise)	JUTE
	Recycled rubber based mulch (EcoRub)	RUBBER
	Commercial black polyethylene film, anti-UV treated, 80 µ	Polyethylene
	Commercial green biodegradable woven biofilm	Commercial biofilm
	Herbicide application (glyphosate, 14.4 cm ³ /tree at 1.25%)*	Herbicide
	No application of weeding	Control

* Herbicide was not applied in Semiarid nor in Montane conditions, because of the absence of significant weed competition during 2014 and 2015.

Table 3. Treatments (combinations of soil conditioning and weeding techniques) evaluated in the project, indicated by an X.

Soil conditioner Weeding technique	TCU+20g	TCU+40g	TCU+80g	Std40g	Control
BIOPOLYMER		X			X
JUTE		X			X
RUBBER		X			X
Polyethylene	X	X	X	X	X
Commercial biofilm		X			X
Herbicide		X			X
Control		X			X

The results presented below are a **summary of the most relevant effects of the studied techniques on tree survival, root and aerial growth, tree water status and soil moisture.**

The results of **other variables measured during Sustaffor project**, as specific leaf area, nutrition status, soil temperature, variables related to soil fertility and organic matter dynamics or mulch durability are presented in other publications of the project, available at www.sustaffor.eu



Monitoring Sustaffor field trials: measurement of tree diameter with digital calliper and soil moisture with TDR probe

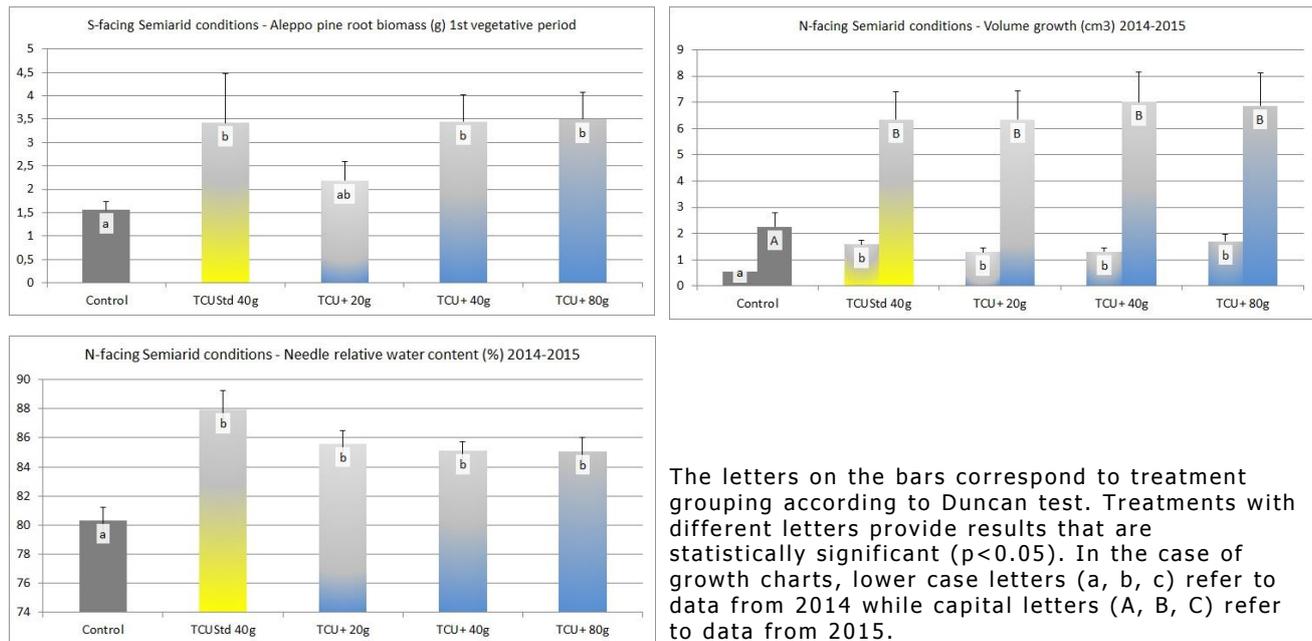
The following sections show the most relevant results of the field trials, for each bioclimate.



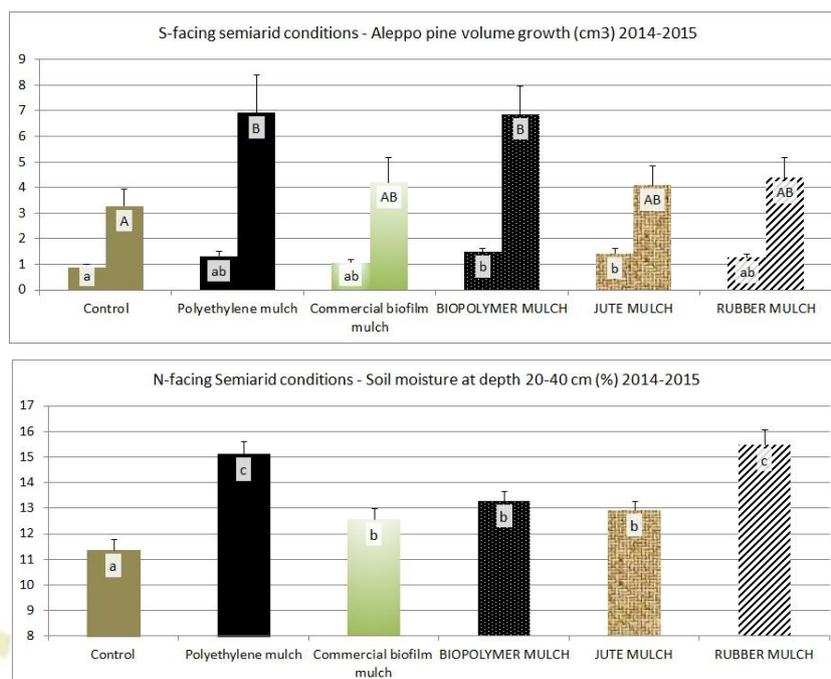
Results from the semiarid field trials (species: *Pinus halepensis*)

The conditions at the semiarid field trials are especially limited by the severe water deficit and the poor and light soil. After two vegetative periods, overall survival amounted for 77% and 88% in the south-facing and north-facing field trial, respectively. Both soil conditioning and weeding had a positive effect on survival rates.

Soil conditioning: positive effect on tree growth and tree water status



Mulching: positive effect on tree growth and soil water content



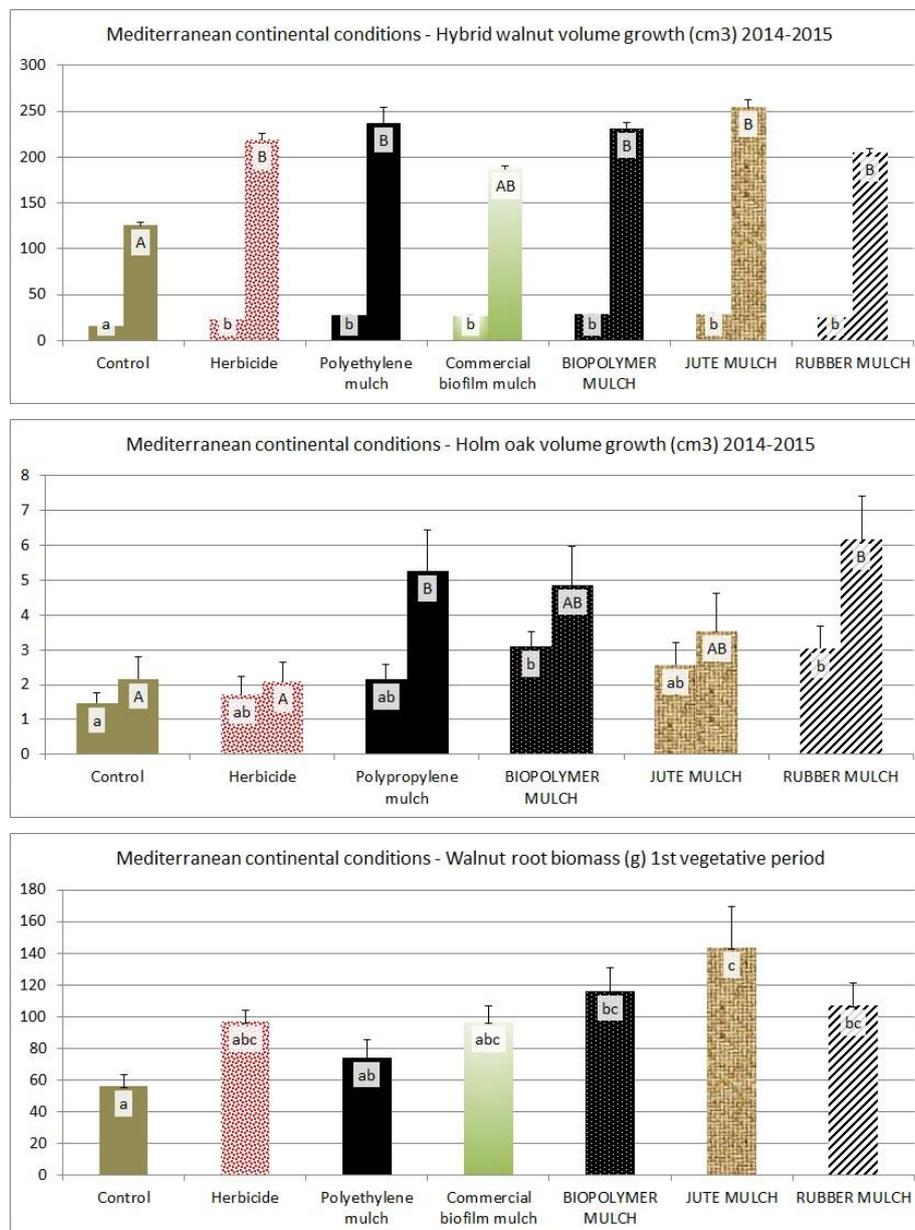
Results from the Mediterranean continental field trials (species: *Juglans x intermedia*, *Quercus ilex* mycorrhized with *Tuber melanosporum*)

These field trials have been established on fertile former agricultural fields. The most limiting factor for tree growth is summer drought, which is moderate.

Survival after 2014 and 2015 amounted for 96% considering both field trials altogether. The only perceivable effect from the study treatments is a slight increase of holm oak survival linked to the use of the new soil conditioner.

The other monitored variables were not affected by the use of soil conditioner.

Weeding: positive effect on tree growth



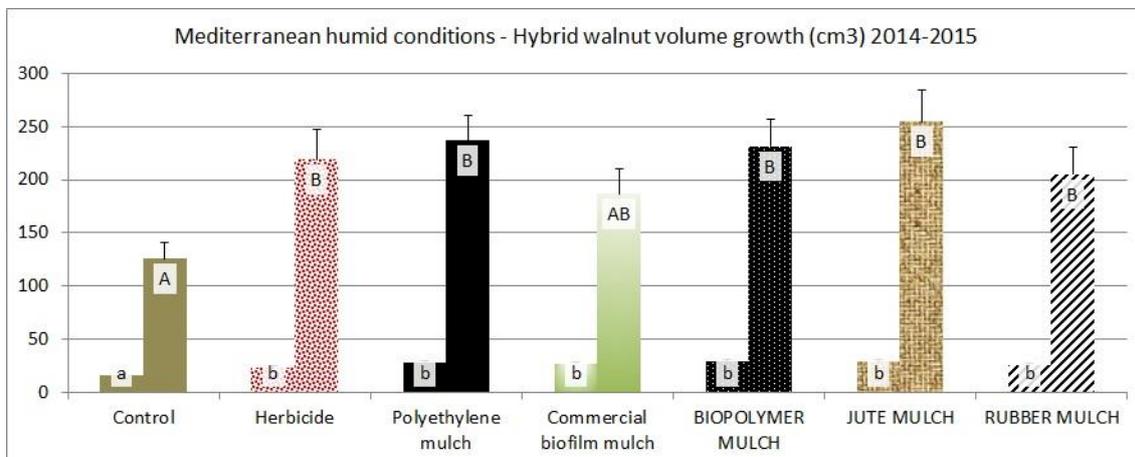
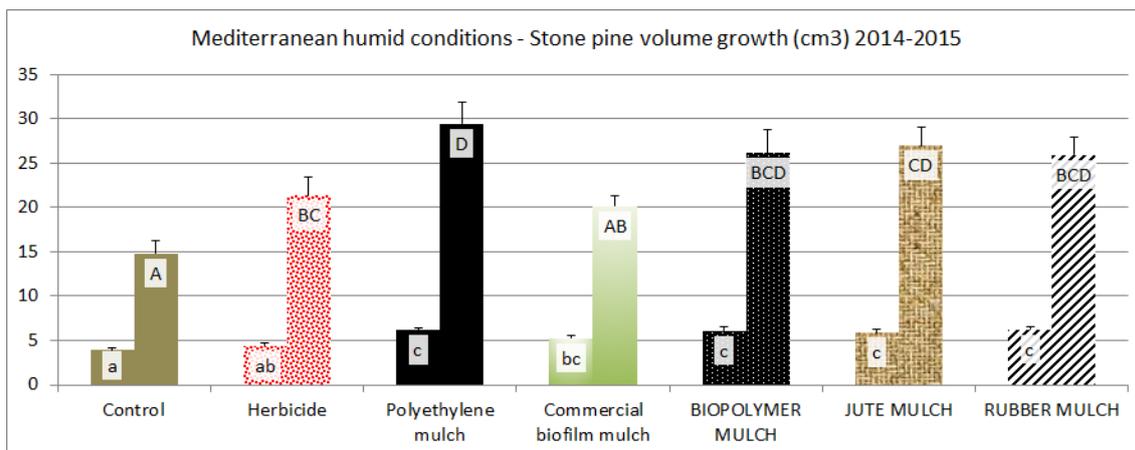
The letters on the bars correspond to treatment grouping according to Duncan test. Treatments with different letters provide results that are statistically significant ($p < 0.05$). In the case of growth charts, lower case letters (a, b, c) refer to data from 2014 while capital letters (A, B, C) refer to data from 2015.

Results from the Mediterranean humid field trials (species: *Juglans x intermedia*, *Pinus pinea*)

Mediterranean humid conditions are the most productive among those tested in the project. The soil is rich and fertile, while the intensity of summer drought is very low.

After two vegetative periods, survival was 100% for hybrid walnut and 94% for stone pine. Similar to Mediterranean continental conditions, the soil conditioner did not have a noticeable influence on the monitored variables.

Weeding: positive effect on tree growth



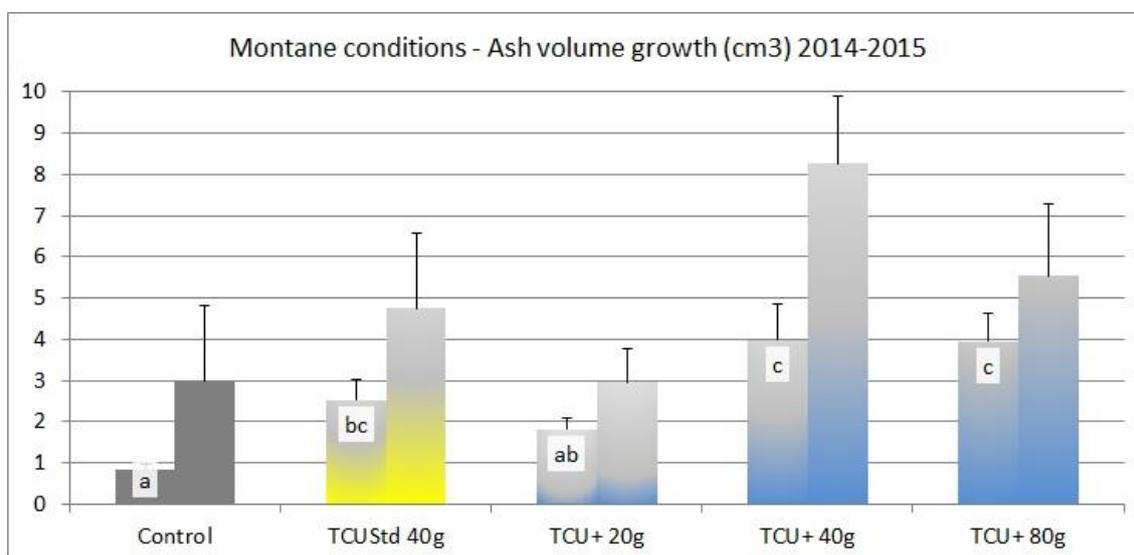
The letters on the bars correspond to treatment grouping according to Duncan test. Treatments with different letters provide results that are statistically significant ($p < 0.05$). Lower case letters (a, b, c) refer to data from 2014 while capital letters (A, B, C) refer to data from 2015.

Results from the montane field trials (species: *Fraxinus excelsior*, *Betula pendula*)

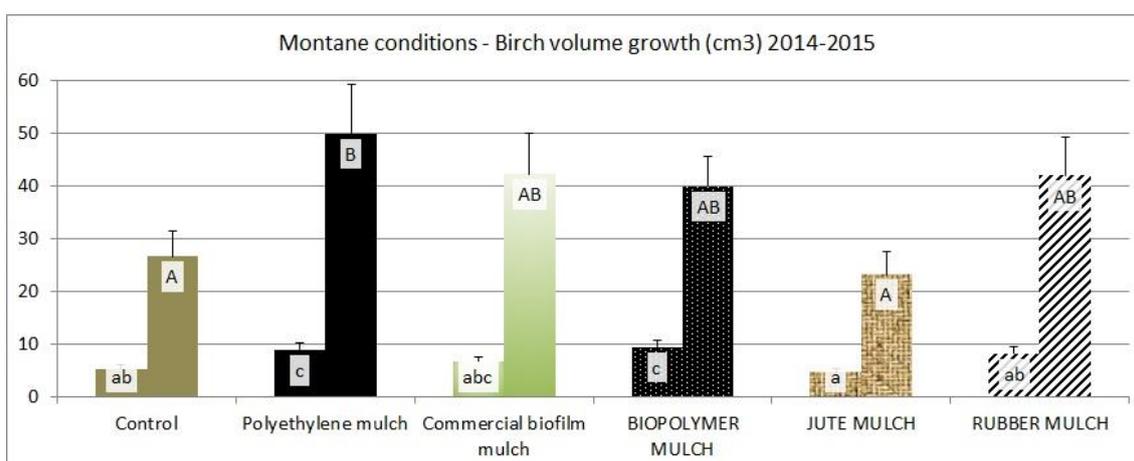
These field trials are established in an area characterised by a soil with poor water and nutrient holding capacity, because of its light texture and significant content of stones. The precipitation regime is rather stable throughout the year, without a severe drought period, but the low temperatures pose a difficulty to tree growth.

Survival amounted for 93% (ash) and 92% (birch), at the end of the second vegetative period. In these conditions both soil conditioning and mulching techniques had a positive effect on tree growth, while not affecting remarkably other variables.

Soil conditioning: positive effect on tree growth



Weeding: positive effect on tree growth



The letters on the bars correspond to treatment grouping according to Duncan test. Treatments with different letters provide results that are statistically significant ($p < 0.05$). Lower case letters (a, b, c) refer to data from 2014 while capital letters (A, B, C) refer to data from 2015.

Main conclusions of Sustaffor field trials

In general, the novel techniques developed during Sustaffor project represent interesting options for sustainable tree planting in a wide range of conditions. The new techniques bring interesting advantages (technical, environmental and economic) compared to commercially available options against drought and competing vegetation.

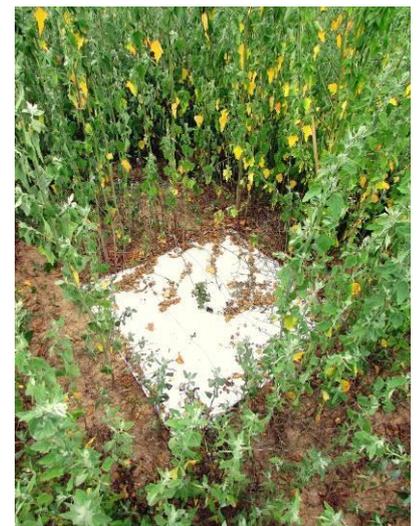
Conclusions about the new soil conditioner:

- **Excellent performance in areas with poor and light soil**, especially when subject to severe drought, such as semiarid conditions.
- The new formulation is at least **as effective as the commercially available** one.
- The best **dose considering cost-effectiveness is 40 g/tree**, which is the dose prescribed for trees up to 60 cm high at the moment of planting.
- This technique is **installed in few seconds** during tree planting. Moreover, it does not require maintenance.
- The new soil conditioner represents a **promising alternative to reduce or avoid the need for applying repeated support irrigations**.



Conclusions about the new groundcovers:

- **Excellent performance in productive sites**, leading to results at least similar to herbicide application and commercial mulches (polyethylene & biofilm).
- **New biopolymer mulch & new jute mulch: both are 100% biodegradable, which make them especially interesting** for tree planting or forest restoration in sites **where the investment in maintenance is intended to be minimized** (poorly accessible areas, minimal management schemes, etc.)
- **Recycled rubber mulch: its enlarged durability makes it especially interesting for urban landscape and tree planting in gardening**.
- The new groundcovers represent a **promising alternative to reduce or avoid the need for applying repeated chemical and mechanical weeding, and to the use of plastic mulching**.



Dissemination and Communication activities

The main dissemination and communication activities performed during the project are:

- A **technical guide** titled "Soil conditioners and groundcovers for sustainable and cost-efficient tree planting in Europe and the Mediterranean", in English, Spanish and French (currently under editorial process).
- A set of **articles** in journals with various target audiences and geographic scopes: [Unasyva](#), [Catalunya Forestal](#), [Navarra Forestal](#), [Silvicultura](#), [Forêt-Méditerranéenne](#), [Technical Textiles](#). Moreover, three papers were submitted to scientific journals, to be published in 2016.
- Participation in different **national and international seminars**:
 - [EU 1st Textile Flagship Conference](#) (Brussels, Oct'14)
 - [IV Mediterranean Forest Week](#) (Barcelona, Mar'15)
 - [Euratex](#) (Brussels, Mar'15)
 - [Reforestation Challenges](#) (Belgrade, Jun'15)
 - [SISEF National Congress](#) (Florence, Sep'15)
 - [Joint SECF-AEET reforestation meeting](#) (Lugo, Oct'15)



Moreover, a **final seminar** ([link](#)) was organized in Solsona, Spain (December 2015) during which the main project results were transferred, including a field visit.



- Two **training activities** addressed at the project SMEs and their commercial partners: "Reforestation in Europe: trends, techniques and economics" (Poznan, Feb'15) and "Performance of Sustaffor novel techniques, labelling, market opportunities" (Navarra, Spain, Oct'15).
- Participation of Sustaffor SMEs in **commercial fairs** to present the project objectives and the novel techniques: Gardenia 2014 and 2015 (Poznan, Poland), Green is Life 2014 and 2015 (Warsaw, Poland), International Gardening days 2014 (Gołuchów, Poland), GreenExpo 2014 (Gent, Belgium) and BioNoain 2015 (Noain, Spain).



Acknowledgements

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Further information: www.sustaffor.eu sustaffor.info@ctfc.cat