



Project no. 032820

Project acronym PRE-FOREST

Project title A new European technology for cost efficient and environmental friendly production of pre-cultivated forest regeneration materials

Instrument CO-OPERATIVE RESEARCH

PUBLISHABLE FINAL ACTIVITY REPORT
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(deliverable D1.4, dissemination level PU)

Period covered: from 10/10/2006 to 8/4/2009

Date of preparation: 1-4-2009

Start date of project: 8/10/2006 Duration: 30 months

List of participants:

Vivai Torsanlorenzo, VT (Italy)

QS Odlingssystem, QS (Sweden)

Dytikomakedonika Fytoria (Western Macedonia Nurseries), DF (Greece)

Università della Tuscia, UNITUS (Italy)

Dalarna University, DU (Sweden)

National Agricultural Research Foundation NAGREF, (Greece)

Name of the coordinating person: Elisabetta Margheriti

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1. Project execution

Project objectives

The project addresses the crucial environmental questions discussed in Europe and the rest of the world today, namely how to reduce green-house gas emissions and subsequent problems with global warming, how to lower the oil consumption and the possibility to expand the production of biomass for energy as a substitution for fossil fuels and how to reduce the use of chemicals and pesticides negatively affecting water and soil quality.

Today the technical development and cost efficiency in the production of forest regeneration material in Europe is often low and burdened with environmental problems. In addition, as plantation forestry, in Europe and the rest of the world, expands into a much broader range of species, there is the necessity for plant growers to adapt to a changing market. Therefore, the standard of European production technology regarding all types of forest regeneration materials has to be elevated. This is crucial for the implementation of EU forest policy aimed at supporting and further developing the principles of sustainable forest management, and re-vegetating and expanding the forest areas for environmental, production and socio-cultural reasons.

The new technology developed within the project will set a new standard both in- and outside Europe compared to state of the art regarding the possibility of a major increase in the volumes of high-quality forest regeneration materials produced in a cost efficient and environmental friendly way.

Regarding this background the main objectives of the project are to:

- introduce an innovative technology for production of forest regeneration material built on a new technology for pre-cultivation (in mini-plugs) of forest regeneration materials in a cost efficient and environmental friendly production unit;
- develop new technology for a grading and transplanting robot adapted to mini-plugs;
- integrate these technologies into a functional, flexible system for large scale production of pre-cultivated forest regeneration materials adapted to mechanical transplanting;
- introduce this system at strategic locations in Europe.

Contractors

Participants of the project are three small and medium sized enterprises (SMEs) from Italy (Vivai Torsanlorenzo), Sweden (QS Odlingssystem AB) and Greece (Ditikomakedonika Fytoria) and three research agencies: Università della Tuscia (Italy), Dalarna University (Sweden) and the National Agricultural Research Foundation (Greece).

Co-ordinator contact details

Co-ordinator is Elisabetta Margheriti (Vivai Torsanlorenzo Società Semplice di Margheriti M. & Co, email: emargheriti@vivaitorsanlorenzo.it)

Work performed

During the first year the objectives were achieved by basic technological, economical and biological studies. These studies included the establishment and testing of the prototype production unit and the integration of a grading and re-plug robot for the suitable distribution system of the pre-grown forest regeneration material to the local nursery. At the same time different technical solutions were tested in combination with various mini-plug container designs and rooting media using reference species of major importance to forest nursery production in Europe (myrtle, wild cherry, strawberry tree, Scots pine, Norway spruce, black locust and Italian cypress) by investigating the biological limits of each species in order to optimise the economic output of the production.

The effects of the different containers and growing media on the quality of the stock produced were analysed using physiological and morphological tests (such as shoot electrolyte leakage, root and shoot dry weight) as well as performance tests (root growth potential). Using the results of the above mentioned experiments protocols for cultural practices adapted to the new approach of pre-cultivation were developed for each experimental species separately. These studies were used as the foundation to the development of a prototype pre-cultivation system adjusted to operational production at each of the SMEs during the second year of the project.

A successful technical validation of all the components and systems in the production unit and their interrelation in the total cultivation process was accomplished. During the technical validation, the function of the different technological components in the pre-cultivation unit, as well as, illumination and heating effects, the irrigation and fertilization system, were evaluated combined with operational tests. In addition, validation of growing media, irrigation, fertilization and plant treatments were performed using morphological and physiological tests. Environmental validation, based on LCA analyses, were conducted by assessing the consumption of non renewable resources and the runoff of compounds encompassed within the production process.

The introduction of the new production system for pre-grown forest regeneration materials will make a drastic change to state-of-the art in forest nursery production in Europe, making possible the abandoning of the use of expensive and high inputs-demanding and habitually unsustainable conventional greenhouse technique.

The new technology will also allow:

- a flexible production chain where changes in the market easily can be intercepted, increasing the competitive value for the SMEs participating to the project;
- reduction of the use of fertilisers and pesticides;
- efficient use of a new mini-plug system allowing a large number of seedlings per square meter and hence energy and space being efficiently used;
- improvement of the cost efficiency in the nursery and, therefore, reduction of production costs;
- transnational co-operation in forest nursery production which has been limited until now;
- scaling down the international commitments within the process of the Ministerial Conference on the Protection of Forests in Europe (MCPFE) to the level of forest management planning and practices for the aspects linked to the conservation and appropriate enhancement of biological diversity in forests;
- contribution to standard directly related to the forest reproductive material, such as certification of conformity of forest reproductive material to the standards settled on by the Directive 1999/105/CE (EC, 2000) and certification of nursery operations, which also includes certification standards of seedling quality that encompass physiological tests;
- improvement of the competitiveness (a key factor of the current EU strategy within the context of the Lisbon agenda) of the SME participants will be enhanced by applying the new technology.

The project results will also make an important contribution to improve sustainable management in the production of forest crops. This includes the important issue to cut greenhouse gas emissions by reducing, for example, future needs for heated greenhouse facilities in forest nurseries all over Europe, as well as by limiting the use of other energy inputs and providing forest reproductive material to establish new planting for bio-energy.

After the emanation of the latest EU common agricultural policy and EU multilateral environmental commitments (including the Kyoto Protocol, in which the establishment of new, sustainable forest plantations is recognised as part of the options to fulfil greenhouse gas mitigation commitments), the EU forest area is expected to enlarge in the near future and forest management is needed to increase the competitiveness for European forestry and related industry concerning employment. In addition, a prompt establishment of new forests in Europe will reduce the impacts on tropical forests, thus helping the international efforts –namely the EC Action Plan on forest law enforcement, governance and trade (FLEGT).

2. Dissemination and use

A project logo has been selected by the partners after a short discussion.
A Web-page for the Pre-Forest project has been created. The project has been presented in a number of conferences, in the press and at workshops during the two years of its duration.

1. EXPLOITABLE KNOWLEDGE AND ITS USE

The plan for using and disseminating the knowledge raised from the results of the project PRE-FOREST is an actual industrial implementation plan, where the SME producing the pre-cultivation unit will entitle the other 2 SMEs as “selling agents” of a product composed by the unit itself and the protocols developed time by time depending from the needs expressed by the buyers.

The protocols will be developed by the research partners.

An actual exploitation agreement has been agreed by the project partners , foreseeing the roles and responsibilities of each subject: the agreement is enclosed in a separate document “Final Plan for using and disseminating the knowledge”

2. DISSEMINATION OF KNOWLEDGE

Planned/actual dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/involved
Dec 2008	Press release (press/radio/TV)	General public	Greece		FRI+DF
Feb 2009	Media briefing	Research	USA & Greece	60	FRI
March 2009	Media briefing	General public	Greece	100	FRI
Nov 2008	Conference	Research	Balkans & South Europe	250	
March 2009	Exhibition	General public	Greece	100	FRI+DF
Oct-Dec 2007	Publications	Research	Greece	600	FRI
	Project web-site				
Sep 2007	Posters	Research	Europe	250	FRI
May 2008	Posters	Research	Europe	250	FRI
Nov 2008	Posters	Research	Balkans, Central & South Europe	250	FRI

March 2009	Flyers	Nursery owners	Greece	50	FRI+DF
Oct 2008	Direct e-mailing	Nursery owners	Greece	50	FRI+DF
May 2008	Film/video	General public	Italy	100	VTs

3. PUBLISHABLE RESULTS

The IPR and patents related to the project are still to be protected

The final conference proceedings are attached in the following



preforest



Under the patronage of the Italian Representation of the European Commission

International Conference

Innovation And New Horizons In Tree Nursery stock Production And Forest Restoration | From Research To Business

EU FP6 Research Programme
Pre-Forest Project

Conference Proceedings Abstracts and Information



Theme 1: Innovative forest nursery management



Theme 2: Contemporary forest restoration

March 12 | 14 2009

Unicef Auditorium
Via Palestro 68
Rome | Italy

www.preforest.eu

organised in co-operation by:

Vivai Torsanlorenzo (Italy) | Dalarna University (Sweden) | Università della Tuscia (Italy) | National Forest Research Institute (Greece) | Dytikomakedonika Fytoria (Greece) | QSodlingssystem (Sweden) | and IUFRO groups:
3.02.00 Stand establishment and treatment | 3.02.01 Silvicultural operations | and 3.02.02 Nursery operations

Organisation

The conference is organised in co-operation between Vivai Torsanlorenzo (Italy), Dalarna University (Sweden), Università della Tuscia (Italy), National Forest Research Institute (Greece) and IUFRO groups 3.02.00 - Stand establishment and treatment, 3.02.01 - Silvicultural operations, and 3.02.02 - Nursery operations.

The Conference was organised under the patronage of the Italian Representation of the European Commission.

Meeting officials

Chairperson

Elisabetta Margheriti (Vivai Torsanlorenzo, Italy)

Organising committee

Rosanna Bellarosa (Italy), Lorenzo Ciccarese (Italy), Fernando Clerici (Argentina), Raquel Ferreira (Portugal), Elisabetta Margheriti (Italy), Anders Mattsson (Sweden), Carlo Polidori (Belgium), Marco C. Simeone (Italy)

Scientific committee

Helena Almeida (Portugal), Alberto Del Lungo (FAO), Lorenzo Ciccarese (Italy), Anders Mattsson (Sweden), Roberto Mercurio (Italy), Conor O' Reilly (Ireland), Kalliopi Radoglou (Greece), Bartolomeo Schirone (Italy)

Citation of this report should be as follows:

Ciccarese L., Ferreira R., Simeone M. C. (Compilers). Innovation and new horizons in tree nursery stock production and forest restoration - From research to business. EC-IUFRO International Conference. Rome, Italy - March 12-14, 2009. 61 p. First published, 2009

Dear Participants,

On behalf of the organising and scientific committee I am pleased to welcome you all to the EC-IUFRO meeting “Innovation and new horizons in tree nursery stock production and forest restoration - from research to business”!

In the last decade considerable changes have occurred in tree forest nursery techniques (from seed handling and processing to planting stock storage) and in forest restoration operations. Main drivers of change are represented by the implementation of sustainable forestry with focus on biodiversity, landscape and climate change, respect of societal and community components, the need to reduce resources—such as fertilisers, pesticides, peat, water, energy—imputed during plant production. This is because of environmental as well as economic reasons. Contemporary forest restoration is a complex task, as it assumes different forms according to diverse ecological, socio-political and historic contexts. Wild and urban foresters have to face particular challenge to harsh growing conditions, diseases, and insects. Forest restoration is under way in order to counteract the negative effects of human activities and it is asked to maintain or enhance biodiversity, mitigate climate change, repair ecosystem functions. Thus, appropriate silvicultural operations can be designed for any forest restoration objective. Yet, forest restoration requires creativity, flexibility in applying silvicultural tools. Also a pragmatic approach is needed, as costs of restoration and scale of degradation are constraints.

Technical innovation and forethought are needed to adapt forest nursery management and forest restoration to this context. Collaboration between forest research and business on a national and trans-national level is needed to build up or enhance the research capacity of enterprises, to generate new knowledge, to transfer technology, to access to venture capital or business and innovation support services, to engage in commercial activities.

This conference intends to be the venue where scientists, forest managers, policy advisors in forestry and private nursery entrepreneurs and producers of nursery equipment, have the opportunity to:

- display the results of research activities and prototypes, innovative biological results and technical solutions regarding nursery management and forest restoration, especially in difficult sites;
- to present new ideas for technological innovation, prototypes and applications to be marketed for businesses, and discuss future development within this area.

The Conference is the final event of a two-year research project named “PreForest”, funded by the European Commission, within the VI Research Framework Programme, Cooperative Research Action For Technology (CRAFT), will be presented.

EC CRAFT programme allows small and medium enterprises to create consortia with research organisations and to formulate highly innovating initiatives, whose results are easily e rapidly useable by the enterprises involved in the project as well as the

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INTERNATIONAL CONFERENCE**
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others operating in the sector. At the field session of the Conference, the results of a the "PreForest" project, will be presented by the research leaders of the project. The visit will be an opportunity to see one of the three robot prototypes shaped by "Preforest" (the other two are located in Greece and Sweden), an innovative technology for production of forest regeneration material in a cost efficient and environmental friendly production unit.

Two themes will thus be developed at the conference:

- Innovative forest nursery management
- Contemporary forest restoration

We are happy to see that the themes for this meeting have brought together NGO representatives, students in forestry and ecology, scientists, forest managers, media associates, forest practitioners and professionals, private entrepreneurs and producers of nursery equipment from all over the world.

Therefore, with regard to all the paper and poster presentations and the following discussions during these days, we are really looking forward to an exciting meeting.

In this publication you will find valuable information under the following headings:

- Agenda for the meeting
- Abstracts of oral and poster presentations
- Field tour information

A selection of papers and posters presented at the conference will appear in a special issue of Scandinavian Journal of Forest Research. Instructions for Authors are available at <http://www.tandf.co.uk/journals/authors/sforauth.asp>

I would like also to thank Unicef Italia and his President for kind hospitality and all sponsors of the Conference for their generosity and all people that made a lot of efforts in organising the Conference.

Finally, to our guests from all over the world, we once again welcome you to the meeting and hope you will enjoy your stay in the wonderful city of Rome!

Elisabetta Margheriti

Conference Chairperson

Agenda for the meeting

Day 1 - Thursday 12/3

8:30 to 9:30 - Registration

9:30 - Opening of the Conference

Welcome

Vincenzo Spadafora, Unicef Italy, President

Elisabetta Margheriti, Vivai Torsanlorenzo, Coordinator of the EU Project "Pre-Forest"

Theme 1: Innovative forest nursery management

Oral presentation and poster session

Chairperson

Lorenzo Ciccarese, ISPRA- Italian Institute for Environmental Protection and Research, chair of IUFRO group "Nursery operations", Italy

Why Improving Ties Between Research & Forest Tree Nurseries is Important

Steve Colombo, Ontario Forest Research Institute, Canada

Research innovations to support plant quality assessment within forest nursery management

Anders Mattsson, Dalarna University

11:00-11:30 - Coffee break and poster session

Innovative forest nursery management - business based on research

Erik Normark, Holmen Skog, Sweden

Innovation in forest seed management

Beti Piotto, ISPRA, Italy

Forest planting stock material in Greece: introduction of a new production technology in mini-plugs

Kalliopi Radoglou, NAGREF, Greece

13:00-14:00 - Lunch

Enhancing seed germination in broadleaf species in bare root nurseries

Conor O'Reilly, University College Dublin, Ireland

Designing seedling morphology using new technological tools

Maria Helena Almeida, University of Lisbon, Portugal

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Jiffy and Preforma: propagation of forest and Mediterranean plants
Lars-Ove Sandberg and Anno Hermes, Jiffy Products International

15:30-16:00 - Coffee break and poster session

Pre-Forest: a new technology for large scale production of pre-cultivated forest regeneration materials

Elisabetta Margheriti, Vivai Torsanlorenzo, Italy; Anders Mattsson, Dalarna University (Sweden); Kalliopi Radoglou, NAGREF, Greece; Bartolomeo Schirone, Università della Tuscia, Italy

Testing different origins to determine the effects of stratification on germination in production of rowan (*Sorbus aucuparia* L.) from seed

Banu Bekci, KTÜ University, Turkey

Hydroponic Nursery Production in Azorean Endemic Species- *Prunus azorica*

Anabela Isidoro, Regional Forest Service, Portugal

Modern Nursery Practises at Alba Trees

Rodney Shearer, Alba Trees, UK

The EU Directive on Forest Reproductive Material: implementation in Italy

Lucia Contri, Regione Emilia Romagna, Italy

17:30 - 18:00 Discussion and remarks

20:00 - Official dinner

Day 2 - Friday 13/3

9:00 - Resume of the Conference

Theme 2: Contemporary forest restoration

Oral presentation and poster session

Chairperson

Annalisa Ceccarelli, Apre - Italian Agency for Promotion of European Research, Italy

Contemporary forest restoration: socially acceptable and sustainable solutions

John Stanturf, Forest Service, USA

Facts and figures for global forest restoration

Jim Carle - Alberto Del Lungo, UN Food and Agriculture Organization

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Sustainable management standards effectiveness for forest plantations

Davide Pettenella - Laura Secco, University of Padova, Italy

11:0-11:30 - Coffee break and poster session

Innovations in afforestation of agricultural bottomlands to restore native forests in the United States

Daniel C. Dey, Forest Service, USA

Forest Landscape Restoration in Mediterranean Cork oak Landscapes: Building Capacity & Partnerships

Nora Berrahmouni, Mediterranean Programme Office, WWF

An economical and compact experimental design to evaluate restoration treatments

John-Pascal Berrill, Humboldt State University, CA, USA

13:00-14:00 - Lunch

Azorean endemic forest: The Importance of a Legacy. A Project for the Future

Josè Mendes, Regional Directorate of Forest Resources, Portugal

New approaches concerning forest restoration in a protected area of Central Italy.

Roberto Mercurio, Mediterranean University, Italy

15:00-15:30 - Coffee break and poster session

Restoration of degraded secondary forest with native species: A case study in the highland of Ethiopia

Girma Abebe Birru, Addis Abeba University

The JIP-test: a tool to screen plant vitality. Application and potentiality in tree growing

Filippo Bussotti, University of Florence, Italy

Effectiveness of Miyawaki method in Mediterranean reforestation programmes

Bartolomeo Schirone, Tuscia University, Italy

Forest resources for biofuels production in the Apennins

Alessio Papini, University of Florence, and Marco Cosimo Simeone, Tuscia University, Italy

17:00-17:30 Discussion and remarks

17:30-18:00 - Sessions and conference syntheses

18:00- Closing

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Day 3 - Saturday 14/3

Field session: Visit to Torsanlorenzo nurseries and to "Pre-Forest", the robot for pre-cultivation of tree planting material (see "Field session" section here above).

Abstracts of oral and poster presentations

Theme 1: Innovative forest nursery management

Why Improving Ties Between Research & Forest Tree Nurseries is Important

Steve Colombo

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Some of the earliest and most successful research applications in the more than century long history of forestry science have been in the fields of reforestation and nursery stock production. Such success is often directly tied to close collaboration between scientists and practitioners, who recognized the value of working together in investigative teams to solve problems. Such teams are built on interpersonal relationships between individuals who are motivated by quite different factors and who usually have very different skill sets. Like any successful relationship, the scientist-practitioner one requires trust, respect, and sacrifice that cannot be packaged, prescribed, or demanded. Such relationships must be encouraged when they spontaneously emerge. The past decade has been relatively quiet in reforestation and nursery development. However, we are entering a time when emerging issues will create many unique and pressing needs that will require scientist - practitioner teams to solve them.

Research innovations to support container design, nursery practices and quality assessment in containerized Swedish forest nursery management

Anders Mattsson
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Forest nursery management in Sweden is deeply dependent on research innovations as in other countries. With a production of over 300 million seedlings during 2008, based on containerized production, new innovations to support container design, nursery practices and quality assessment plays an important role.

In the development of containerized production research innovation regarding container design has been important. The introduction of the containerized concept in Sweden implied problems due to pore container design that caused root spiraling and stability problems after planting inducing stem deformations. By intense research efforts a new generation of container systems were introduced based on air pruning contributing to a uniform distribution of root tips in the hole plug avoiding stability problems and stem deformations after planting.

Regarding nursery practices in general research innovations has also been of importance. This refers to activities such as sowing, germination and early growth, irrigation and fertilization, artificial photoperiod adjustments for growth and initiation of bud set for hardening control and winter storage on on nursery open land or in cold storage.

Research innovations also refers to the development in new techniques in seedling quality assessment. This refers to both morphological, physiological, performance and molecular tests. Besides basic morphological tests, physiological tests such as electrolyte leakage and enzymatic activities has been developed to support nursery management. As an example of performance tests, root growth potential (RGP) has been introduced in many Swedish forest nurseries. Research innovations has also introduced the possibility to use molecular attributes in nursery management to assess seedling quality. This both refers to gene expression and cell cycle activity. Now molecular markers important for the hardening process can be used as a tool for nursery managers to decide when to put nursery crops of different provenances into cold storage during the winter. This technology can not only be used for this purpose but can also be used when identifying seedling infections and stress conditions in the nursery.

Innovative forest nursery management: business based on research

Erik Normark

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Global climate change, intensified forestry and strain on biodiversity are factors that increase the need for new technology and new knowledge in forest nursery management. In containerized nursery management some general questions have to be addressed such as the genetic potential, root architecture and vitality and nitrate leaching in the nursery.

In Holmen the genetic improvement program is focused on stake on the third generation of orchards, selective harvest, harvest in breeding populations and the possibility of using somatic embryogenes. Regarding root development Holmen has developed new container systems to improve root vitality. To improve the situation with nitrate leaching Holmen is looking into the possibility to fertilize using the amino acid arginine that both could reduce the leaching and improve field survival and growth after planting.

To intensify nursery plant production Holmen is also looking into the possibility to introduce the concept of pre-cultivation and transplanting. This concept could increase the cultivation capacity and reduce investments but could also be a concept for a future cultivation based on somatic embryogenes.

In nursery management quality issues are also of great importance. With regard to this Holmen has a program for quality certification not only in the nursery but for the whole regeneration process where seedling quality assessment and field trials plays an important role.

Innovation in forest seed management

Beti Piotto

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Agricultural innovation in seed management has often come before newness in tree seeds, so encouraging the forest sector. A sort of classification of innovation can be tempted as follows.

Testing. Development and harmonization of international rules for seed testing especially by ISTA and AOSA have allowed improvements in the knowledge of seed physiology and sound basis in seed trade.

Magnetic resonance imaging and image discriminating analysis became extremely useful for non destructive tests and permitted to work with images only (even without seeds).

Determination of water activity allows to predict which portion of water may become available for unwanted chemical and biotic reactions within the seed; it seems a strong predictor of orthodox pollen and seed stability during conservation.

Upgrading techniques. Separation of non viable or damaged seeds using IDS or PREVAC method have led to improve seed lot quality (germinability).

Recalcitrant seed storage and studies on seed desiccation sensitivity have resulted in protocols for rapid flash drying of embryonic axes from recalcitrant seeds, ultra-rapid cooling and, finally cryopreservation, so allowing a first way of storing germplasm of recalcitrant seeds.

Studies on seed pre-treatment in highly controlled conditions have made it possible to store non-dormant seeds (after pre-treatment for dormancy removal with a given moisture content) at industrial levels.

Studies on the effects of smoke on germination have improved the knowledge on seed physiology in areas affected by fires and have permitted to identify active components which can enhance germination of a number of species (even not occurring in fire prone environments).

Somatic embryogenesis. It is not a strictly seed innovation but has promoted great research on embryos and nutritive tissues; it has been innovative in making research into these structures more attractive.

Forest planting stock material in Greece: introduction of a new production technology in mini-plugs

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The last decades, expansion of plantation forestry into a much broader range of species is being observed. Public and private owned nurseries are challenged with the need of producing high quality planting stock of various species in high numbers. Aim of this paper is to describe the current situation in nursery production in Greece, as well as the types of planting stock used. New trends in producing high quality forest regeneration materials are also introduced, such as the innovative technology created in the frame of PRE-FOREST project (CRAFT - 6th Framework Programme). Among the project's main objectives was the introduction of a new technology based on pre-cultivation in mini-plugs of forest regeneration material in a cost efficient and environmental friendly production unit, not affected by prevailing climatic conditions. To obtain our objectives we focused on the interaction among mini-plug container density and rooting media, in order to develop cultivation protocols for forest reproductive material of special economic and ecological importance for Greece. Four species were selected for this purpose: black locust (*Robinia pseudoacacia* L.), Italian cypress (*Cupressus sempervirens* L.), black (*Pinus nigra* Arnold) and brutia pine (*Pinus brutia* Ten.). Protocols for seed pretreatments were also produced. The produced technology, combined with the scientific support provided by the research foundations participating in the project, will be commercially exploited and in this way, nurseries could be more competitive both at an economic and quality level.

Enhancing seed germination in broadleaf species in bare root nurseries

Conor O'Reilly

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Seed germination in bare-root nurseries is sometimes variable, leading to understocked, or more rarely, overstocked seed beds. The consequences for plant quality and the economics of nursery operations (e.g. longer growing cycle, fewer target sized plants) may be large. There are many reasons for this, ranging from inadequate seed pretreatments to break dormancy, storage, handling and sowing practices and lack of sufficient moisture during germination. Although good information is available to this end for most conifer species, much less is available for the seeds of most broadleaves. The results of recent research carried out in Ireland and elsewhere revealed that pretreating the seeds of alder (*Alnus glutinosa* Gaertn.), birch (*Betula pendula* Roth and *Betula pubescens* Ehrh), and ash (*Fraxinus excelsior* L.) using a controlled or target moisture content method improved germination, storability and seedling yields in the nursery. In addition to prechilling (and warm phase treatment in ash), priming or freezing treatments may enhance germination further in some species. Unlike the seeds of most other tree species, oak (*Quercus robur* L. and *Q. petraea* L.) acorns are difficult to store even over one winter, but dormancy levels are considered weak in this species. The results of recent research on *Quercus robur* has revealed that soaking acorns for 5 days before storage at -3 °C improved germination and the yield of usable plants in the nursery compared with acorns that were stored in the standard way. Post sowing conditions, especially moisture availability and temperatures also influence seed germinations, but these are more difficult to control in a bare-root nursery.

Designing seedling morphology using new technological tools

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Eucalyptus globulus and *Quercus suber* are important species on Portuguese economy, with an estimated 41 million m³ of standing eucalyptus wood and a cork production of 120.000 tonnes, representing 21% and 23% of total forest area, respectively. Despite being among the nursery's most produced forest species, these are quite distinct in growth characteristics, requiring differentiated production strategies.

The European (Directive 1999/105/CE) and its National (Dec.-Lei nº 205/2003 of 12 of September) transposed rules concerning seedling quality, regulates the dimension and age intervals of allowed *E. globulus* and Cork oak seedling trade. Within those intervals, it is possible to obtain quality seedlings with various morpho-physiological characteristics, in result of the used production models.

A newly developed long-term storage technique (Portuguese patent nº 103611-26/9/2008) allows the storage of Cork oak acorns for at least seventeen months without loss of acorn viability, permitting to plan seedling production of this species; acorn availability for all year-round, also promoted an increase in field survival already recognized by forest stakeholders.

The use of good quality plants is an essential precondition for successful establishments, planting poor quality stock may result in reduced survival and early growth. Therefore, the effect of fertilization was evaluated in both species in order to achieve the production of morphologically balanced, vigorous and healthy plants. This effect was evaluated in Cork oak seedlings, produced from fresh and stored acorns. The monitorization of the *E. globulus* growth process was done along the time; morphological, physiological and chemical traits were evaluated. Field trials were established and tree growth and survival were evaluated.

These new tools, controlling seedling age and nutrition, might be used to plan Eucalyptus and Cork oak seedlings growth in the nursery, and simultaneously improve their field performance.

Jiffy and Preforma: propagation of forest and Mediterranean plants

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Testing different origins to determine the effects of stratification on germination in production of rowan (*Sorbus aucuparia* L.) from seed

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This study evaluates the stratification environments having priority for the production of *Sorbus aucuparia* L. from seed, which is one of the natural species of Eastern Black Sea region of Turkey and Ukraine. *Sorbus aucuparia* L. seeds of three different origins have been kept in 5 different stratification environments (Perlite, Peat, Perlite + Sand (1/1), Sand, Sand + Peat (1/1)) for 4 months. Seeds to be used for control purposes have not been included in the stratification. Since the study evaluates the effects of stratification on seeds, seeds subjected to stratification have been germinated in pH; 7.8, ECx10³; 0.06, P₂O₅; 0.8, P; 0.36 peat environment. According to the data obtained in this study; pre-germination has been observed only in the seeds of Edge origin to have been omitted/subjected to stratification. While pre-germination is recorded mostly in Peat stratification with 11,36 %, no germination has occurred in sand stratification. The highest germination of all three origins has been observed in the seeds included in the Peat stratification. The rate of germination has been recorded as 70,45% in seeds of Ukraine-Edge origin, 9,09% in the seeds of Türkiye-Çaykara-Sultanmurat origin and 4,54% in the seeds of Trabzon-Maçka origin. The lowest germination rate has been observed in sand stratification. While this rate has been calculated as 11,36% in seeds of Ukraine-Edge origin, no such germination has been detected in remaining two origins.

Hydroponic Nursery Production in Azorean Endemic Species- *Prunus azorica*

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The Serviço Florestal do Nordeste (SFN), Direcção Regional dos Recursos Florestais (DRRF), produces for more than 15 years Azorean endemic plants with the purpose of restoring the natural forest in S. Miguel Island. During the last decade, an increasing search of these endemic species has been verified, on the one hand due to its importance in the preservation of this habitat, and on the other hand, to recover areas with forest aptitude, long ago transformed into agricultural land. The aim of the production of endemic species is to answer the challenges of forest restoration placed by projects such as: Life Priolo; Management Plans in the Hydrological Basins of Sete Cidades and Furnas; Scut' s; Management Plans for inert exploration areas, and the "Breeding Forest Program" of the Azorean Forest Services ("Direcção Regional dos Recursos Florestais").

The S.F.N. has done research with the purpose of finding the ideal techniques to produce Azorean endemic woody species. Currently, more than 85.000 plants are being produced every year, mostly by seedling to preserve the genetic resources of the existing populations. Nursery production takes between 2 and 4 years, depending on the species and the propagation method. To improve the propagation methods on endemic species nursery, three systems of hydroponic have been tested: ebb and flow, floating and aeroponia, in a controlled environment. This method was pioneer in the production of these woody plants.

The S.F.N. has come to the conclusion that the ebb and flow system using rigid support containers has proved to be advantageous in terms of the nursery production time, compared to the traditional method. The results offered in this work evidence the behaviour of the species *Prunus azorica*.

Modern Nursery Practises at Alba Trees

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Alba Trees is the largest containerised tree production facility in the UK. Alba Trees produce in excess of 7 million trees per annum for forestry and associated horticultural markets. The nursery facility near Edinburgh, Scotland comprises of 14 multi-span polythene greenhouses for plant germination and early controlled growth plus growing-on and hardening-off areas. All nursery stock is grown in containers ranging from 175cc to 1.8 litres capacity. Species from seed are direct sown by hand or machine or can be transplanted from seed trays. Up to 5 million seedlings are produced in miniplugs then transplanted into larger containers by hand or more recently by robotic transplanter. Vegetative propagation of 1 million genetically improved Sitka Spruce is performed by taking summer cuttings from stock plants. The Alba Trees computerised production management and stock control system ensures complete traceability from seed collection to plant delivery ensuring provenance control.

At Alba Trees constant development of new ideas for technological innovation at the nursery and establishment site are sought. The development of WeeNets and a trial of this protection in combination with a delivery system for Flexcoat insecticide, in high infestation Hylobius site, has provided robust information on the effective (short-term) potential of this method. Alba Trees have also been instrumental in the development of mechanised planting systems utilising the Bracke planting machine for restocking. Alba has also been involved in FRIV Coldtree programme, from which the NSURE™ molecular cold hardiness testing product was developed. The expertise and systems developed at Alba have been successfully applied to nurseries in the Republic of Ireland and Czech Republic.

In this presentation an overview of the Alba Trees production systems will be given and will draw on the extensive understanding of developing the Alba Trees business in line with customer requirements. The knowledge and experience of providing to several markets, including contract growing services.

A new technology for large scale production of pre-cultivated forest regeneration materials

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The project *Pre-Forest* had as main objective the introduction of a new and innovative way to produce forest regeneration material. Good quality, high efficiency, cost savings and environmental friendly production were pursued.

On the project first year three species were studied: *Arbutus unedo*, *Myrtus communis* and *Pinus pinea*. Seeds were sown in mini-plug plastic trays and maintained in growth chambers under controlled conditions (20-25°C, 16 h day, 85% RH). Four mini-plug densities (975 to 3500 mini-plugs/m²), 5 substrate volumes (3 to 18 cc) and two growing substrates (peat and stabilised medium) were evaluated to determine the best growing conditions. After four weeks, growth parameters were measured and seedlings of each treatment were transplanted to conventional nursery containers of 240 plants/m².

The good results obtained served to expand the species list on the second year. As a result, forest species such as *Fagus sylvatica*, *Quercus ilex*, *Carpinus betulus*, *Acer pseudoplatanus* and *Pinus halepensis* were tested.

Germination rate and energy, growing density and growth media performances were assessed. Biological and physiological tests were conducted to ascertain the most suitable protocol for each individual species. By the end of the first experimental phase (germination and growth phase), seedlings were re-assigned to different tests/treatments, namely the cold storage (preceded by a Long Night Treatment), biological/physiological tests, nursery transplanting and field performance.

A special attention was given to cold storage. The objective of this treatment is to store 4-weeks seedlings at low temperatures (2-4°C) by inducing a physiological standstill aimed at an extension of the pre-cultivation period, allowing an increase in the number of seedlings available for the next plantation period.

Prior to cold storage it was necessary to gradually acclimatise seedlings by means of lower temperatures and a new photoperiod. Seedling hardening was obtained, improving their cold storability. The results show that it is possible to cold store seedlings of different tree species for as long as 4,5 months.

Experimentation in *ex-situ* and *in-situ* conservation of procumbent junipers (*Juniperus hemisphaerica* Presl, *Juniperus nana* Willd.) from Pollino National Park (Southern Italy)

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The procumbent junipers, *Juniperus hemisphaerica* Presl and *Juniperus nana* Willd. (fam. Cupressaceae) grow above 1500 m a.s.l. in wide grazed clearings or over the treeline and are characteristic of xeric communities, rich in flora and fauna. Junipers are pioneer species, colonizers of extreme habitats and can be considered forest species suitable for environmental restoration. Upper-level junipers, for their autoecology, are important biological indicators of climatic changes in mountain environment at Mediterranean latitude, therefore it is necessary to investigate their biology of reproduction. These species, moreover, have been never studied in this area before as far as concerns the problem of propagation and conservation.

Nowadays, adult and old individuals are predominant in the procumbent juniper populations of Pollino National Park Mountains; this is a symptomatic characteristic of a difficult natural renovation. As a matter of fact the juniper population stability is often due to the longevity of the plants themselves and not to the birth of new plants. The conservation of these species is certainly threatened because of the dynamism in the patterns of vegetation (climatic global changing, social-economic transformations of soil use) and the extremely scarce natural regeneration (high and variable seeds dormancy, low production of vital seeds).

Nursery and laboratory experiments, still in progress, are being carried out on seed germination and vegetative propagation of autochthonous "dwarf" junipers in the high-mountain areas of the Park to promote *ex-situ* and *in-situ* conservation. The samples of the plants were collected in the studied area in autumn 2007.

Specific protocols were prepared to break seed dormancy when propagating from berries, and to develop best practices for propagation using cuttings. The protocols to break dormancy provided for a series of pre-germination treatments: seed scarification with citric acid or sulphuric acid, cold stratifications of variable time periods (30-180 days). About 2800 seeds from 30 individuals were sown in potting compost of a mixture of grit and peat and *in vitro*, too. Part of the seeds were sown in natural conditions, without any pre-germination treatments.

Variability in juniper germination time is high and we expect to have the germination of seeds between 2 and 5 years from sowing time.

Effect of density and substrate on root growth potential of forest regeneration material cultivated in mini-plugs

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Objective of this study was to detect differences in the root growth potential of forest regeneration material pre-cultivated in mini-plugs during early stages of growth. This study was conducted in the frame of PRE-FOREST project (CRAFT - 6th Framework Programme). Seeds of black locust (*Robinia pseudoacacia* L.), Italian cypress (*Cupressus sempervirens* L.), brutia (*Pinus brutia* Ten.) and black pine (*Pinus nigra* Arnold) were sown in two mini-plug densities (975 and 3500 mini-plugs/m²) in two growing substrates (peat and stabilised medium) and placed in growth chambers (15-20°C, 14 h day, 85% RH). After four to five weeks, growth parameters were measured and seedlings of each treatment were transplanted into mini-plug containers and placed in a bath for 21 days according to the standardised Root Growth Potential (RGP) technique. The four species differed in their root growth capacity; black locust showed 5 times higher RGP in relation to black pine and almost 10 times higher RGP in comparison to brutia pine and Italian cypress. Mini-plug density seemed to play a more important role on RGP than the type of substrate used in the majority of species tested with the exception of brutia pine; the RGP of this latter species was positively affected by the use of stabilised peat. In black locust and black pine higher values of RGP, as well as, of growth traits were found in the lowest density. In Italian cypress root length was higher in the lowest density by the end of the growing period in the chamber. However, after transplanting to the RGP bath, the highest RGP values were detected in the highest density, perhaps due to the formation of lateral roots.

Effect of day length on growth characteristics of *Pinus nigra* and *Cupressus sempervirens* mini-plug seedlings

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This study was conducted in the frame of Pre-Forest project (CRAFT - 6th Framework Programme). Seeds of black pine (*Pinus nigra* Arnold) and Italian cypress (*Cupressus sempervirens* L.) were sown in mini-plug plastic trays filled with stabilized medium and left to grow in growth chambers under controlled conditions. Four to five weeks after sowing seedlings were subjected to three different photoperiods (4, 6 and 8h photoperiod) for one, two and three weeks. Then seedlings returned to control conditions (14h photoperiod) until they reached the 11 (pine) or 13 (cypress) weeks of age. Morphological parameters, bud formation, root growth potential and chlorophyll fluorescence parameters were measured. Seedlings were transplanted to conventional nursery containers of 240 plants/m². By the end of the first growing season seedling morphology and survival, as well as, chlorophyll fluorescence were once more assessed. In pine seedlings no bud formation was detected. After their transplanting to destination trays, seedlings treated with 6h photoperiod for three weeks maintained their superiority, since they continued to have higher root length, shoot height, root collar diameter, root and shoot dry weight. Survival of these seedlings was also the highest (100%). In cypress needle formation was detected only in lateral shoots of short day treated plants. Cultivation of seedlings with 8h of light for three weeks resulted in significantly bigger seedlings with relatively high survival (85%). Subjecting black pine and Italian cypress to short day treatment may not stop growth and cause bud formation, but treated seedlings turn out to be bigger, giving them an advantage after transplanting.

Growth parameters of coniferous planting stock influenced by the principal growing technologies in Estonia

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Nordic countries have several decades of experience in growing and using containerised planting stock and producing multiple research projects. Although the production of containerised seedlings has been carried out in Estonia for nearly 10 years, it has resulted in only a few research projects.

The objective of the present research is to define the growth parameters of containerised Scots pine (*Pinus sylvestris* (L.) Karst.) and Norway spruce (*Picea abies* (L.) Karst.) compare them to their bare-rooted conspecifics. The growing technologies for bare-rooted and containerised planting stock differ greatly from one another but nevertheless, they share a common goal – the production of high quality plants.

The analysis of planting stock started in two bare-rooted nurseries and two containerised nurseries owned by the Estonian state forest management centre (RMK) in 2001. During the following seven years, 2050 coniferous plants were analysed. The plants included 1-year-old containerised Scots pine seedlings, 2-year-old containerised Norway spruce seedlings and bare-rooted Scots pine seedlings, and bare-rooted Norway spruce transplants of both 3 and 4 years of age. The height and root collar diameter of the plants were measured and the dry mass of all parts of plants was determined. The ratios between height and root collar diameter (H/RCD) as well as above-ground and below-ground dry mass were calculated. The ratios are significant for successful reforestation. In addition, the percentage of various nutrients (NPK) was specified. The dry masses were determined after the plants had been subjected to 70°C for 48 hours.

The analysis of the results revealed that the height of containerised Scots pine seedlings exceeded the height of bare-rooted seedlings by 18% and the height of bare-rooted Norway spruce transplants exceeded the height of containerised seedlings also by 18%. The RCD of bare-rooted seedlings and transplants was larger than that of containerised seedlings – 30% larger in Scots pine and 52% in Norway spruce. The ratio H/RCD was 3.6 in bare-rooted Scots pine seedlings and 6.0 in containerised seedlings, and 4.7 in bare-rooted Norway spruce transplants and 8.0 in containerised seedlings ($P < 0.05$). The above-ground dry mass (shoots+needles) of bare-rooted Norway spruce transplants was more than 600% larger than that of containerised seedlings; the difference between below-ground dry masses (roots) was 550%. The above-ground dry mass of bare-rooted Scots pine was 250% larger than that of containerised seedlings; however, there was no difference between below-ground dry masses ($P > 0.05$). The nutrient content in all parts (except needles) of containerised seedlings was larger than in bare-rooted plants. Although the production of containerised planting stock is more efficient, bare-rooted planting stock is generally more resistant to various environmental conditions in fertile site types in the first growing seasons.

Alterations of seed-related variables under storage of nitrous oxide (N₂O) atmospheres for two recalcitrant *Quercus* spp.

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Storage of recalcitrant seeds was and still is problematic. This study investigated the effects of nitrous oxide (N₂O) on storage of recalcitrant oak seeds. Containers of *Quercus alba* and *Q. macrocarpa* seeds were placed under three atmospheric treatments: air, 80/20% and 98/2% of N₂O/oxygen (O₂). For *Q. alba* one parent tree provided adequate number of seeds, while for *Q. macrocarpa* seeds were pooled from three parent trees. Every two weeks (total of 12 weeks), a sample of 5 seeds was used for each atmosphere to evaluate seed respiration (R). Another set of 5 seeds was used for moisture content (MC), seed- (SFW), pericarp- (PFW), and embryo- (EFW) fresh weight and embryo dry weight (EDW). Germination percent was evaluated based on a total of 10 seeds for each treatment each sampling time. Analysis revealed a treatment effect on SFW and MC, with increased values for N₂O treatments. *Q. alba* had greater respiration as oppose to *Q. macrocarpa*. Percent of germination for *Q. alba* showed a consistent pattern, while for *Q. macrocarpa* it gradually increased. Storage time had an effect on the mean values for most of the seed related variables.

Wall-less plug for the improved root formation of eucalypt seedlings in South Africa

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Over the last couple of decades, containerized nurseries replaced their bare-root counterparts in many parts of the world, especially where plantation forestry operations depend on effective establishment and the fast growth of trees. Containerized nurseries helped also to accelerate propagation techniques, especially vegetative propagation, and to reduce prices of the planting material. Despite the fact that these objectives had been largely achieved, many regeneration operations failed due to early tree dieback or windfalls, both resulting from poor root formation of the containerized planting stock. The introduction of copper-based chemicals, sprayed onto the container walls for root pruning, and re-designing container shapes were either environmentally unfriendly or ineffective. Since there are about 250 million plants (seedlings and cuttings) produced every year in South African forest nurseries, improving their qualities is of high importance. A research project has been conducted on innovative nursery methods aimed at improving root formation by growing plants in a rooting medium physically unconstrained by hard walls. The results are summarized in this presentation. A plug was constructed by either (1) mixing, pressurizing and gluing together paper-mache, (2) cutting a block of sponge, or (3) loading a bag of Hessian with the standard medium (composted pine bark). These three treatments were also compared to three types of containers routinely used in commercial forest nurseries: (4) Unigrow, (5) Sappi, and (6) Polly 98 deep. Two species of eucalypts, *E. grandis* and *E. dunnii* were sown and cultivated over a period of 70 days. Later, they were outplanted in the field where their survival and production of lateral roots were compared after nine weeks. The nursery results showed that treatments 1, 5 and 6 yielded the highest plants for *E. grandis*, and treatments 1, 4, 5 and 6 resulted in the highest *E. dunnii*. Only treatment 2 produced significantly lower trees in both species. After outplanting, the survival of trees was close to 100% and there were no significant differences between the treatments. *E. grandis* produced the highest number of lateral roots in treatment 1 but the treatment-induced differences were not significant, except for treatment 2 which resulted in lower number of lateral roots. No significant differences were recorded in lateral roots for *E. dunnii*. There is a need to test performance attributes of the various types of the planting stock under stressful conditions to determine benefits, if any, of producing planting stock in wall-less-plugs.

Innovative forest nursery management in Azores

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The Azorean Forest Services (Direcção Regional dos Recursos Florestais - D.R.R.F.), governmental institution who insure the tree nursery production for reforestation in Região Autónoma dos Açores, annually produce about 4 million of plants, 90% of *Cryptomeria japonica*, the most abundant woody specie planted in this region.

The implementation of Management Plans in the Hydrological Basins, the "Breeding Forest Program" of D.R.R.F., and the Restoration of Autochtonous Forest, are some of the projects that requires a wide diversity of forest species, including woody endemic species.

To reach this increase of search, DRRF have a project for centralize the nursery production at one large unit concept lead to marked improvements in plant quality and many important innovations in the production of endemic woody species.

This new nursey includes a unid with laboratories and cooling chambers for seeds storage, a glasshouse for seedling and multiply vegetative material using different techniques as for example Hydroponic propagation, and outside hardening areas. The glasshouse will have computerized environmental control, ventilation, heating, humidity, shade system, irrigation (overhead watering and misting) and fertilization. Outside, shade, irrigation and fertilization system will be controlled.

The nursery will produce 5 million plants per year by way of containers, certified in accordance with the rules in force. This nursery project will be built in the next 2 years.

Using hydrogel to enhance the water holding capacity of the root plug: an experience in *Quercus suber* seedlings

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Degraded dry and semiarid ecosystems present harsh conditions for natural plant regeneration and forest restoration. Planted seedlings often show high mortality rates during the first year, particularly for drought spells. In addition, global climate change projections postulate an increase of drought periods jointly with a decrease of annual rainfall. Therefore, there is a need to improve forest restoration techniques in these areas. The application of innovative technologies during the nursery period can improve the quality and the performance of the seedlings in the field. An important challenge is to enhance the water holding capacity of the substrate, reducing the transplant shock and improving the water status for seedlings during the first months after outplanting. The aim of this study is to analyze the effect of hydrogel application mixed with the growing medium in a peat-based substrate in order to increase the water holding capacity of the root plug and to improve the water status of seedlings. *Quercus suber* acorns were seeded in four substrate types: control substrate (CS) which is a mixture of limed peat and coconut peat (1:1 v/v), CS mixed with Attapulgate clay (ASG, 10% v/v) and CS mixed with hydrogel Stockosorb (HS) at two doses (0.7 and 1.5% w/w). The container used was forespot of 300 cm³ in volume. Watering regime was moderate according to seedling water demand and similar for all treatments. After one year in the nursery, morphological and physiological characterizations were carried out. In addition, two experimental plots with 20 seedlings by treatment were established in the field (Serra d'Espadà, Castellón, Spain). The results showed that total biomass and allocation patterns were not affected by the treatments. Under optimum water availability conditions, water potential, gas exchange (transpiration, photosynthesis, stomatal conductance) and chlorophyll fluorescence (Fv/Fm) were not affected by treatments. Under water deficit conditions, seedlings cultivated in substrates mixed with Attapulgate clay and hydrogels showed higher water holding capacity (expressed as gravimetric moisture of the substrate) and better seedling water status (expressed as predawn water potential) than seedlings cultivated in the control substrate. Field results confirm the observations in the nursery evaluation. Seedlings cultivated in hydrogels showed better water status and a tendency to show higher survival in relation to seedlings cultivated in the control substrate.

Assessment of the quality of hardwood seedlings of *Fraxinus excelsior* based on field performance

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The demand for performing hardwood seedlings has increased in recent years, and particularly for those plantation programmes oriented to high quality wood production outside forests. The availability of best quality seedlings is stressed as a crucial first step to grow successfully such plantations.

The quality assessment method adopted in this study is based on field performances evaluations by considering the relationships between the morphological attributes of the nursery stock and the survivorship and growth after transplanting to field. These procedures consist on rigorous but easy observations oriented to serve a large scale operational grading of nursery stock.

The species selected was *Fraxinus excelsior* and the nursery stock consists of 1-year old bareroot seedlings lifted by the current mechanical systems adopted in commercial Italian forest nurseries. The field performance was evaluated at the end of the first vegetative season in the field: the plants were lifted carefully in order to minimise the damages to root system and then measured. In order to cross-check the reaction to transplant in the field, the root system development was studied by mean of destructive measurement methods.

The shoot and root system growth pattern was observed by measuring the same plant before and after the season in field: the checked attributes regards either the epigeal part of the plant (including: height, collar diameter, apex diameter, number of the branches) as well as the root system (including: number of first order roots, root system depth and width, length of the first and second order longest root). The dry weight of the roots and the increase in the main shoot and root growth parameters of the 1-year plants were also considered.

Single linear regression techniques comparing shoot and root parameters were used to describe first the traits of the seedlings and then those of the plants after the season in field.

The same statistic analysis was performed to relate the data of seedlings before transplanting and the ones measured 1-season after transplanting and was aiming to test the potential effectiveness of the characters to be used as early indicators of the stock quality and as predictors of the growth pattern.

The seedlings were grouped in size classes and in root morphological categories according to species-specific data sets, and the ANOVA was performed to highlight the differences due to the classes and the categories.

Best indicators for field performance were identified.

Evaluation of growth slow-down nursery treatments on *Prunus avium* seedlings by means of allometric relationships and relative growth rates

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Mediterranean ecosystem has been historically affected by natural and anthropogenic disturbances, which developed and modeled the landscape. Currently, the speed of the cycle perturbation/natural restoration makes difficult the ecosystem's resilience processes. The high interaction between people and nature also promotes the need to restore the affected landscape. In this process, revegetation is central and there is a need to adapt the supply of vegetal material of quality to its demand. The objective of this work is to evaluate the effect of carbonic fertilization and apical brushing on the growth of cherry trees under nursery conditions in order to adapt this production to the supply and demand of the market.

The assay was located in Cabrils (Barcelona), part of the Mediterranean basin of Catalonia with controlled CO₂ application. During the initial growth of nursery production (February-2007/April-2007) CO₂ was fed to some of the plants in order to double ambient levels. Later, carbonic fertilization was withdrawn (if applicable) and apical brushing was applied (April-2007/May-2007) to reduce growth rate. Finally the original conditions were recovered (May-2007/July-2007). Height and trunk diameter were measured in a number of plants, and allometric relations with plant biomass were established in critical moments. Relative growth rate for of each experimental period was calculated. Results showed that apical brushing resulted in increased trunk diameter and, hence, growth rate, and not the growth reduction that was sought after. Carbonic fertilization did not produce differences in the initial growth, probably due to the deciduous characteristics of the species. No evidences were found that carbonic fertilization during the initial phase of development had any residual effect on the growth during the later phases. The application of carbonic fertilization maintained the rate of growth high while no fertilization or its withdrawal reduced the growth rate, but acclimation of the CO₂-fed plants took place by the end of the growing period in May 2007. In conclusion, due to the observed acclimation, carbonic fertilization is not advised throughout the complete period of growth. The tested treatments did not help to accommodate offer to demand of plant material for revegetation.

Technical improvement of propagation by rooted cuttings in transfer of Genetic Gain

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Mass vegetative propagation has become an important tool for increasing the competitiveness of forestry based industry. This method reaches its highest potential when is used to establish clonal forests of hybrids endowed with better wood quality and higher volumetric growth. However, in *Eucalyptus* species, the popular method of rooting stem-cuttings has limitation, like quick loss of rooting competence due to ontogenetic aging, intra-clonal variation resulting from topophysis, and poor quality root system, that negatively affect genetic expression of several clones.

This article reports an alternative super-intensive systems, micro- and mini-cutting, for cloning *Eucalyptus* at commercial scale. These systems have shown great potential of substituting, rooting stem-cuttings with technical and economical advantages. Micro-cutting uses the spices obtained from micro-propagated plantlets, while the mini-cutting is based on the rooting of axillary sprouts from rooted stem-cuttings. In both systems the plants are managed intensively to produce mini-cuttings. The success of the systems also is dependent upon the optimal nutrient concentration of the resulting mini-cuttings.

Compared to stem-cuttings, the rooting of micro- or mini-cuttings improves rooting potential, rooting speed, root system quality, and reduces costs. Additionally, these systems offer the opportunity of physiological homogenization of propagules and drastically reduce topophysis effects. The development of these super-intensive cloning systems has set the stage for a new phase of mass vegetative propagation of *Eucalyptus* and other woody species.

A study of the root systems of one year old poplar clones I-214 and 77/51 (Samsun)

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This study was carried out in the fields of Izmit nursery, Turkey in 2007 and 2008. Poplar stem cuttings of clones I-214 and 77/51 (Samsun) were planted in the experimental plots. The experimental plots were fertilized with nitrogen and phosphorus fertilizers. A control plot was also planted in order to observe rooting and plant growth under unfertilized conditions. In May 2007, July 2007 and May 2008, some of the experimental plants grown from stem cuttings were uprooted with great care to avoid damage to the root system and the developmental trends of the roots and plants were investigated. Numbers of roots in diameter classes of less than 2 mm, 2-5 mm and more than 5 mm were determined for each sample plants. The lengths of the cuttings and the shoots were also measured. The roots, cuttings and shoots including twigs and leaves were left to dry in a drying oven at a temperature of 65 °C for a period of 24 hours and then their oven-dry weights were determined. The following results were obtained after a year long investigation from May 2007 to May 2008:

- The numbers of roots on plants of clones of I-214 and 77/51 (Samsun) grown in the fertilized plots were greater for all diameter classes than on those in the control plot.
- Plants in plots fertilized with nitrogen and phosphorus fertilizers were not observed to have superior root development to those in unfertilized plots.
- In general, rooting occurred in the lower part of cuttings so as to leave a 10 cm long root free section in the upper part of cuttings.
- Roots from cuttings of clones I-214 and 77/51 (Samsun) grow horizontally, but roots growing from the bottom of the cuttings grow downward into the soil at an angle.
- The lower roots from cuttings of clone 77/51 (Samsun) grow somewhat more vertically compared to the lower roots from cuttings of I-214 clone.

Seed propagation of alpine willow species

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The project aims is to improve knowledge about propagation of Alpine willow species by seed, in order to avoid damage to natural populations of rare species due to cuttings' collections.

Alpine species of genus *Salix* includes trees, shrubs, and suffrutex, many of them useful in ecological restoration. Usually, they use cuttings collected in the surroundings of the area to be restored, but this restricts the choice to few species, often used outside of their occurrence area. The use of willow container-grown planting stock gives a wider selection of species, so the planner can choose the best one for the local ecological conditions. Moreover, if we use plants obtained by seed and not by vegetatively propagated material, we safeguard the genetic diversity and ensure a greater resistance to pathogens.

The project takes place in the Veneto Agricoltura forest nursery, located in "Pian dei Spini", Veneto Region, Eastern Italian Alps.

The species listed below include riparian species, mountain slope species and other restricted to particular alpine niches. Some rare species are propagated with a conservationist approach or for a teaching aim.

- | | |
|------------------------------|-----------------------------------|
| - <i>Salix alpina</i> | - <i>Salix hastata</i> |
| - <i>Salix appendiculata</i> | - <i>Salix hegetschweileri</i> |
| - <i>Salix breviserrata</i> | - <i>Salix helvetica</i> |
| - <i>Salix caprea</i> | - <i>Salix herbacea</i> |
| - <i>Salix caesia</i> | - <i>Salix laggeri</i> |
| - <i>Salix daphnoides</i> | - <i>Salix mielicchoferi</i> |
| - <i>Salix eleagnos</i> | - <i>Salix nigricans</i> |
| - <i>Salix foetida</i> | - <i>Salix nigricans alpicola</i> |
| - <i>Salix fragilis</i> | - <i>Salix rosmarinifolia</i> |
| - <i>Salix glabra</i> | - <i>Salix waldsteiniana</i> |
| - <i>Salix glaucosericea</i> | |

The main goals of the project are:

- 1) the realization of a table with the best periods for seed collecting of all species (capsules have to be collected in a immediately pre-ripening stage - see the example below)
- 2) the implementation of techniques of seed preparation and cleaning (air or water cleaning)
- 3) the production of thousands of young plants in container.

Irrigation regime as key factor to improve growth performance on *Quercus suber* L.

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Naturally restricted to the Western Mediterranean (s.l.) regions, the cork oak (*Quercus suber* L.) is an emblematic Mediterranean sclerophyllous tree, occurring in three out of ten biodiversity hotspots detected in the Mediterranean Basin. Preciousness cork production is a specific issue that regards cork oak stands several years after their planting. In fact, first stripping is allowed only after 18-30 years, depending on soil fertility, but wild cork is considered of poor quality because of its technological features, and it is commonly used as grinding material. Henceforth, commercial cork is removed each time the bark reached 25 mm in thickness since the second bark stripping that could be done after ten years from the first one, as well as the followings, according to the laws in force. In this way it is possible to get useful results in terms of product to launch in the market only after thirty-forty years from stand plantation. Therefore, it is easily to understand how important is minimizing the time between cork oak planting and first bark stripping. This aim could be attempted by forcing plant growth with appropriate irrigation, fertilization, topdressing and stand density.

In this study the objective was to determine the influence of different irrigation regimes on cork oak growth, setting an appropriate irrigation regime, in order to anticipate the first bark stripping, thus making available the commercial cork earlier. For that reason, experimental field was established closed to Tarquinia (Tuscia District, North Latium), within the natural cork oak range, to test the relevance of irrigation regime as factor determining better growth performance of cork oak. Three thesis were performed, different in water support, with three replicas each one. Dendrometric and biomass parameters were collected in three steps and statistical descriptive analysis, as well as ANOVA one-way, were implemented. Preliminary analysis will be showed and several results will be discussed.

Effects of pH on the production from seed and on the adaptation of *Rhododendron ponticum* L. and *Rhododendron Luteum* L.

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Rhododendrons are the plants which are part of seedy plants of plant world, belong to a type called *Rhododendron* - a member of heathers (*Ericaceae*). They patch off in winter and are woody plants that may rarely be in a tree form (1,2). In addition to its esthetic usage such as having flowers that have many different colors and bloom at different times, autumnal staining in some taxons and its beauty of leaves; it is used as boundary elements and an element for creating a living barrier. It is also used for stabilization of slope and planting of traffic islands as a functional visual covering (3).

With this work, finding appropriate atmosphere for adaptation of produced seeds of *Rhododendron luteum* Sweet. and *Rhododendron ponticum* L., which are inherently found in our country and seed a big amount every year, is purposed. Also by searching effects of pH, we aim at shedding light on both producers and applying people about this two types which haven't evaluated yet and distinguish them in the terms of urban landscaping. First collected seeds are germinated in different environments then the seedlings that is obtained are taken to a peat environment for 1st replikaj, after 4 months taken to 2nd repikaj in 7 different environments and with this process their growth in soil and living state is examined. Measurements are associated with solid analysis, thus their relationship with each other is clarified by graphics and statistically.

As a result, it is determined that both of the types grow better in the soil which is substantial in the terms of asicid (PH) and organic substances. Also half-shadowed and humid areas are the ohyer points that play role in a better evolution.

Theme 2: Contemporary forest restoration

**INNOVATION AND NEW HORIZONS IN TREE NURSERY STOCK PRODUCTION AND FOREST RESTORATION - FROM
RESEARCH TO BUSINESS
INTERNATIONAL CONFERENCE**

Rome, Italy
March 12-14, 2009

Contemporary forest restoration: socially acceptable and sustainable solutions

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Forest restoration is a complex task, complicated by diverse ecological and social conditions, that challenges our understanding of forest ecosystems. Generally, restoration connotes some transition from a degraded state to a more “natural” condition. In the narrowest sense, restoration requires a return to an ideal natural or historic ecosystem with the same species diversity, composition, and structure as occurred before human intervention. Because this ideal state is probably impossible to attain, I have proposed an alternative approach, using the term forest restoration broadly to describe situations where forested land-use and land cover are restored (reconstruction or reclamation), as well as instances when an existing forest is rehabilitated (no change in land cover) such that structure or species composition are modified. I call re-creation the attempt to return to a pristine natural or historic condition. All the restorative activities described (re-creation, reconstruction, reclamation, and rehabilitation) have been called forest restoration, although to the purist only re-creation would qualify as true restoration.

Restoration goals vary, but in most countries, restoration is undertaken within the policy framework of increasing sustainability by enlarging the area of specific ecosystems, enhancing biodiversity, or repairing ecosystem functions. Although most restoration practice has focused on sites or stands, there is increasing interest in broad-scale restoration of landscapes, often of mixtures of land uses. Forest landscape restoration presents several challenges, and perhaps the most problematic is the need to collaboratively develop restoration goals with other interested parties and the general public, usually accompanied by the need to integrate forests with other land uses. Restoration practitioners are further challenged by the need to restore forests for an uncertain future. To be successful will require shifting focus from attempts to restore past conditions to looking forward toward restoration of robust forests capable of adjusting both to gradual changes in climatic means as well as resilience in the face of abrupt changes and extreme events.

In this presentation, I will briefly present an overview of contemporary forest restoration. This will set the stage to consider how to respond to the two challenges presented above, namely scaling up efforts to the landscape level and facing the uncertainty of future conditions under global change. The fourth part of the presentation will present some brief guidelines for successful restoration programs.

Planted forests: status, trends and outlook. Guidelines for responsible management

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In 2005, the global planted forests area was estimated at 271 million hectares which constituted only 2 percent of the global land area, but which contribute to a significant proportion of overall forest goods and services. Planted forests produce about 65% of the Industrial wood production and play a significant role on both Carbon Sequestration (1.4 G tonnes/year) and Carbon Storage on wood products (0.5 G tonnes/year).

An outlook study, based upon modelling with data from a survey of 61 countries and three scenarios, indicated that the area of planted forests will increase in the period 2005 - 2030. From an initial area of 271 million hectares, the area increase in Scenario 1 (Pessimistic) will be 16 percent to 303 million hectares and in Scenarios 2 (Business as usual) and 3 (Higher productivity) an increase of 32 percent to 345 million hectares in year 2030.

Among regions, the highest absolute increase will be in Asia and the highest relative increase in Southern Europe. Among species groups, the highest absolute increase will be in pine forests.

Planted forests are now acknowledged for multiple roles depending upon local context and drivers but adaptive management systems are necessary to respond to changing social, cultural environmental and economic expectations. In 2004 FAO was asked to coordinate a multi-stakeholders process to define principles and guidelines for responsible management of planted forests, as a basis for translating international commitments into strategic decision-making on planted forests at the national and sub-national levels (FAO 2006). FAO is also undertaking a capacity building process to implement the voluntary guidelines for responsible management of planted forests in developing countries through a number of regional workshops conducted in different regions of the world.

Sustainable management standards effectiveness for forest plantations

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Since the first definitions of sustainable development have been launched in the '80s a large range of standards (sets of Principles, Criteria and Indicators) have been developed worldwide for the purpose of promoting and enhancing the sustainable management, use and trade of natural resources, products and services provided by different ecosystems and human activities, included the creation and management of forest plantations.

Some of the standards have been specifically developed for addressing forest plantations management practices towards the environmental, economical and social sustainability goal. Among them, those approved by FSC and PEFC for the purpose of forest management and chain-of-custody third-part certification, as well as those developed by CIFOR as a generic template for formulating Sustainable Forest Management Criteria and Indicators for plantations can be mentioned.

In addition, other sets of Criteria and Indicators have been defined by different organisations which can directly and indirectly affect the management of planted forests, even if they are not specifically referring to forestry, and the use and trade of products and services deriving from such planted forests. Among them, it is worthwhile to mention at least: the IFOAM standards for organic farming; the FAO Voluntary Guidelines for Responsible Management of Planted Forests; the principles, criteria and indicators developed by the UNCTAD BioTrade Initiative for promoting trade and investment in biological resources in support of sustainable development according to the CBD goals; the standards for sustainable wild collection of medicinal and aromatic plants (ISSC-MAP) which are under development by the WWF/IUCN initiative; those developed by FLO for promoting fair trade.

All these standards can apply, to different extent and for different purposes, to activities of cultivation, harvesting, production, transformation, use and commercialisation of products and services deriving from planted forests.

The paper compares the relevance by virtue of being effective to the forest plantations matter of different sets of international standards for sustainable management. Final recommendations are reported in order to highlight the role that key-factors (adequate market conditions e.g. consumers awareness, wood industry demand of certified wood; favourable legal and institutional setting framework; positive attitude of forest owners towards collaborative and adaptive management; effective communication and marketing strategies; horizontal and vertical integrations; etc.) can play in guaranteeing good business performances to those forest managers that are investing and innovating by implementing sustainable management standards over their plantations.

Innovations in afforestation of agricultural bottomlands to restore native forests in the United States

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Establishing trees in agricultural bottomlands is a challenge because seedlings must maintain dominance in areas of intense competition, flooding, and herbivory. Regeneration failures are due, in part, to planting small seedlings. Research is underway to produce seedling quality standards based on morphological attributes for different site conditions and management systems. Such standards can also guide nursery production of seedlings.

Survival and growth are significantly increased by planting larger seedlings with well-developed root systems. Taller trees are more likely to (1) keep their crowns above growing season flood waters, (2) have terminal shoots out-of-reach (1.5 m) of browsing deer, and (3) have crowns above the competition. Seedling basal diameter is correlated with the size and structure of the root system, and seedlings with large diameters exhibit significantly greater survival and growth. Early rapid growth is important to the success of species in the genera *Quercus* and *Carya* that inherently have slow juvenile shoot growth. Advances in nursery techniques to produce large (e.g., 1-2 m tall; 1.5-2.0 cm basal diameter) bareroot and container seedlings have led to increases in survival and growth, and early fruit and nut production.

Managing vegetation is critical to regeneration success. As an alternative to herbicides and other methods that require annual or more frequent application, cover crops such as redtop grass (*Agrostis gigantea*) are used to control competing vegetation and manage habitat to reduce small mammal damage to seedlings. In fields of redtop grass, seedling survival and growth is greater, and damage by eastern cottontail rabbits is reduced compared to trees in old field vegetation.

Bottomland forests have been regenerated to monocultures of mid-late seral species (e.g., *Quercus*). An innovative strategy has been developed that simulates natural succession by interplanting pioneer species such as *Populus deltoides* with later seral species such as *Quercus nuttallii*. The *Populus* grows rapidly to provide early structure needed for songbirds and produce an early fiber crop that improves the economics of restoration. The lightly-crowned *Populus* acts as a nurse crop for *Quercus* by attaining crown closure early, thus, reducing the biomass of competing ground vegetation without seriously limiting *Quercus* seedling growth or function. Harvest of the short-rotation *Populus* crop releases the well-established *Quercus* trees. Success in afforestation requires planting high quality seedlings using management practices that promote survival and growth. Restoration based on

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ecosystem processes and that combines tree species that have complementary ecological requirements will be more successful and affordable.

Forest Landscape Restoration in Mediterranean Cork oak Landscapes: Building Capacity & Partnerships

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**INNOVATION AND NEW HORIZONS IN TREE NURSERY STOCK PRODUCTION AND FOREST RESTORATION - FROM
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An economical and compact experimental design to evaluate restoration treatments

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At one time, longleaf pine (*Pinus palustris* Mill.) stands occupied an estimated 24 million ha in the southeastern USA. Fire suppression, timber harvest, and land conversion have reduced its extent, with less than 3% remaining today. As a shade-intolerant species, longleaf pine's characteristic "grass stage" presents a challenge to restoration: height growth is postponed prior to emergence from the grass stage, and competing vegetation quickly overtops the seedlings. Hardwoods such as sweetgum (*Liquidambar styraciflua* L.) are widespread, prevalent, and vigorous competitors that re-sprout after disturbance. Grasses and vines also develop quickly to occupy growing space in the warm humid southern climate. Thus, we sought to study effects of competition on longleaf seedling survival and test weed control strategies for areas where use of prescribed fire – the restoration tool of choice – was not acceptable.

We present an innovative replicated experimental design and first-year mixed-model analysis of longleaf pine survival in a restoration project. Longleaf pine seedlings were planted in large gaps created by catastrophic southern pine beetle attacks on mature mixed pine-hardwood forests in the piedmont of Georgia. The split plot design with randomized complete blocks of four treatments was replicated on four study sites. Main treatments were: herbicide applied once (HERB1), same herbicide re-applied in second year (HERB2), mowing (MECH), and no treatment (CONTROL). Nested within each fixed-area treatment plot were individual-tree plots. Treatments applied to individual tree plots comprised three different "spot sizes" of sprayed area around seedlings in HERB1 and HERB2 plots. Mowing treatments applied once, twice, or three times around individual trees in the MECH plots test removal of above-ground competition. Both above- and below-ground competition was checked in HERB1 and HERB2 plots by mowing in conjunction with herbicide treatments. A total of approximately 600 trees were sampled across the four replicate sites.

To facilitate adoption of our design, we present diagrams of the compact, powerful experimental design and detailed explanation of the analysis procedure. The flexible design is amenable to different treatments imposed at the plot or individual-tree scales, e.g. mulching, seedling or container size, fertilization, fencing, or weeding. The main treatment plots are fixed-area plots that can be used to monitor growth and yield or test spacing over the long term.

Azorean endemic forest: The Importance of a Legacy. A Project for the Future

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In the Autonomous Region of the Azores, the natural or semi-natural spaces occupy an area of 22.960 ha, which represents about 32 % of the regional forest. It is in those spaces that are inserted the 25 natural protect areas of the Azores, which are exceptional places, of high botanical, fauna, ecological, landscape and geological interest and occupy an area of 13.551 ha.

The Sectorial Plan for Natura 2000 Network in the Autonomous Region of Azores, concluded in 2006, has the first instrument of the kind in the bio-geographical region of Macaronesia, and allows the Regional Government to implement measures of protection and conservation in locals classified as Sites of Community Interest (SCI) allowing the development of economic activities.

The Azores encompass 23 SCI (17 marine areas and 6 land areas), which cover a total area of 33.639 ha and 15 Special Protection Areas (SPA), 11.825 ha in total, which correspond about 19,6% of the regional territory.

In the last 12 years and as a result of various tests/studies conducted in forest stands, forest nurseries (glasshouse and outside) and the improvements already achieved in the techniques of endemic plants propagation, the Azorean Forest Department (DRRF) has increased the production of woody endemics plants, which now is 120,000 plants per year, that are being used in restoration of autochthonous forest, reforestation plans in the hydrological basins of Sete Cidades and Furnas, management Plans for inert exploration areas, "Breeding Forest Program" of the DRRF, improvement of Forest Reserves for Recreation, etc.

It will present the more appropriate techniques and production systems for the main woody endemic species, like the, *Ilex azorica*, *Laurus azorica*, *Picconia azorica*, *Juniperus brevifolia*, *Prunus azorica*, *Vaccinium cylindraceum*, *Erica azorica*, *Viburnum tinus* ssp. *subcordatum*, *Frangula azorica*.

Finally it will be presented the strategy and measures of the forest policy in the program of the X Government of Azores to increase the production of endemic forest plant to preserve and enhance the Azorean Natural Forest.

Seed quality of Siberian larch (*Larix sibirica* Ldb.) and Scots pine (*Pinus sylvestris* L.) from geographically diverse seed sources of Mongolia

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The rehabilitation of degraded forests in Mongolia showed very low success and the total reforested area successfully represented only 5 percent of the total degraded forests. One of the reasons for such poor results may be attributed to the low quality of planting stock due to the poor quality of seeds. The objective of this study was to determine the seed source variation in seed quality of Siberian larch (*Larix sibirica* Ldb.) from sixteen different locations and to select the most promising seed sources for reforestation of degraded forest lands of Mongolia.

Seeds of Siberian larch (*Larix sibirica* Ldb.) were collected from the natural stands of eight (8) different geographical locations in Mongolia between 2002 and 2004. Seed quality was examined using purity test, weight of 1,000 seeds, germination test, seed viability by soft x-ray photography, and tetrazolium test.

Seed quality traits of diverse seed sources of *L. sibirica* revealed the existence of considerable geographic variation in seed quality traits (germination capacity, germination energy, seed viability, weight of 1,000 seeds, and seedling emergence). Seed viability had significantly affected seed germination characteristics like germination capacity, germination energy and seedling emergence in both nursery conditions. Among the studied seed quality variables, except for seed weight, strong negative correlation was found with altitude of the seed source origin in *L. sibirica*. Germination emergence (GE) and seedling emergence contributed to the total variation in the seed viability among *L. sibirica* seed sources. Overall, Source No. 5 (Binder) had excellent performance in seed quality traits among the studied seed sources, whereas Source No. 3 (Tuul river) was lowest.

Restoration of degraded secondary forest with native species: A case study in the highland of Ethiopia

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Deforestation rates in the tropics and sub-tropics has continued at alarming rates, leading to an increase of secondary forests. Human activities, timber extraction, slash and burn agriculture and fuel wood extraction are the well known important deforestation factors. Similarly, Ethiopia is losing a significant cover of natural forest every day, yet surprisingly little field-based information exists on the ecological requirements and silvicultural strategies for the majority of species, which could be translated into plans for conservation, enhancement, restoration of biological diversity and increase productivity. Systems of canopy manipulation to suit seedling recruitment/establishment of species, particularly those depleting locally and those producing recalcitrant seeds, keeping in view the shade tolerance/intolerance syndrome for seedling growth, on the basis of specifically designed field experiments is vital. In other words, knowledge of population structure and regeneration of woody species; response of species to the different environmental factors are critical for secondary forest restoration and to design specific silvicultural technique in order to optimize the delivery of goods and services from secondary forests and to enhance sustainable secondary forest management.

Munessa Dry Afromontane forest is heavily degraded and characterized by many gaps. It has been disturbed, either by illegal logging and/or subsistence farming by the local people. What remains is a fragmented, logged-over and despoiled forest, situated among a growing rural population with ever sharper sights on it as their next livelihood option.

To this end a study was conducted under the multidisciplinary project 'Functional Ecology and Sustainable Management of the Munessa Forest, Ethiopia' funded by DFG (German Research Foundation) with a grant code number GU 406/12-1 and GU 406 /13-1. The specific study "Silvicultural contributions towards sustainable management and conservation of forest resources in the highlands of Ethiopia" was undertaken to design sustainable forest management strategy for the utilization of Munessa forest. Under the project, vegetation survey, growth and photosynthesis response of four native tree species seedlings under variable light environment in a gap was analyzed. Silvicultural management proposal for Munessa Dry Afromontane Forest was made.

The vegetation survey result indicated the differences in species population structure. Although the regeneration of the forest as whole looks good, the regeneration of some of the commercially valuable species including *Aningeria adoifi-friederici* and *Olea hochstetteri* was very poor or absent. Poor uniformity in the growth pattern of individual species was exhibited. As confirmed by our study, different species exhibited different survival strategy in forest understory and open environment. Planting in gap center had resulted high light intensities allowed for a significantly higher increase in RCD and height, but this advantage was short lived because high light environments had the lowest survival rates due to desiccation in the dry period resulted in the death of most seedlings as a result of reduction in rainfall. Therefore, it is possible to conclude that, by strategically planting the native tree

species on suitable target areas with desired spatial configuration, the maximum potential of natural condition could be captured.

The JIP-test: a tool to screen plant vitality. Application and potentiality in tree growing

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Current methods in ecophysiology allow the researchers to characterize the vitality and the physiological status of plants. Different kind of instruments are applied for research purposes, but their possible use for routine analysis in agriculture and tree growing is very limited. Several factors conditions limit their practical application, for ex.: the costs of acquisition are often high, measures are time consuming, their use in field conditions may be difficult, data may be scarcely comparable. Concepts and analytical techniques funded on the analysis of the fluorescent properties of the chlorophyll are evolving very fast and, at the state-of-the-art, rapid and non-destructive analysis are possible. Among these techniques, special importance is assumed from the analysis of the fluorescence transient (FT), called the JIP-test. The JIP-test refers to a translation, through simple formulae, of the original data to biophysical parameters, providing informations about the photosystem (PS) II functionality in terms of trapping capacity of excitation energy (TR), conversion of excitation energy to electron transport (ET) and energy dissipation through heat (DI). Finally, the Performance Index (PI) is a multi-parametric expression of three independent steps contributing to photosynthesis, i.e, energy trapping, electron transport and density of reaction centers. The original data for the JIP-test are obtained with fluorimeters at high time resolution capacity. Each singular measure take 1 s, consequently it is possible to obtain hundreds of data each working day, thus allowing an adequate statistical representation of samples also in field conditions. The JIP-test has been widely used in stress physiology studies, providing insight about the characteristics of stress induced from drought, UV, high light, salinity, ozone and other pollutants. In the agricultural field, that technique was applied to screen plant species and/or varieties resistant to different kind of abiotic and biotic stressors, and to test the effectiveness of cultural practices. These characteristics make the JIP-test a method very flexible, rapid, inexpensive and useful to solve problems in tree nursery and growing.

New approaches concerning forest restoration in a protected area of Central Italy

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After a review of the traditional afforestations in the Mediterranean area (central-southern Italy), the problems concerning the afforestation in protected areas are addressed.

In the last decade considerable changes have occurred in afforestation techniques. In the past the objectives of these plantations were mainly to increase forest productivity, but also to protect watersheds. In addition these plantations contributed to provide employment in rural areas.

Traditional procedures concerned the plantation of pines in regular patterns. The results consisted in large and homogeneous areas covered with flammable even-aged pines.

In the last decades, afforestation rates have been maintained and enhanced by the EU Common Agricultural Policy (CAP) in order to abandon marginal agricultural land prioritising (by subsidising) hardwood plantations.

New forest restoration techniques require creativity with a solid scientific knowledge and further aims are pursued: to maintain or enhance bio-diversity, mitigate climate change, repair ecosystem functions.

A case study (Valle del Bove) in the Gran Sasso and Monti della Laga National Park (Central Italy) concerning biodiversity and landscape restoration of abandoned agricultural lands has been analyzed.

Some innovative criteria were taken in consideration. The choice of the native species was carried out according to the principles of vegetation dynamics; the vegetation restoration may be accelerated through early successional tree species belonging to the same series of vegetation. This choice follows a phytosociological analysis. The cultural techniques concerned partial releasing of shrub vegetation invading abandoned lands, site preparation techniques of low environmental impact (i.e. clustered arrangement, curved rows) applied according to soil morphology. The problem of the supply of forest reproductive materials was taken into account. Results five years after planting concern: disturb of game, survival rates, vitality status, and height growth of different tree species, effects of competition by shrub vegetation on tree growth.

Effectiveness of Miyawaki method in Mediterranean reforestation programmes

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In the 80's Prof. Akira Miyawaki introduced a new forest restoration approach in Japan, fully innovative instead of traditional ones. Miyawaki method involves the survey of potential natural vegetation, planting mid-successional and late successional stages or climatic ones at the same time. Stand establishment are planned with high planting density and soil between them is accurately mulched. Theoretical principles of Miyawaki method should be found in self-organized criticality theories and in cooperation. Natural vegetation successional stages (from free soil to climax forest) are practically forced and reproduced accelerating natural successional times.

Miyawaki method has been applied in the Far East, Malaysia and, for several cases, in South America. Results are very impressive, allowing quick environmental restorations of strongly degraded areas. However, those applications have been always made in sites characterized by high precipitation. The same method was never used in a Mediterranean context, distinguished by summer aridity. First test was executed by University of Tuscia (Department D.A.F.) 10 years ago in Sardinia, choosing an area where traditional reforestation methods failed. For an appropriate Miyawaki application in the site, original method was modified, but maintaining its principles.

Results obtained after 10 years from implantation are positive; in particular, compared to the classic reforestation techniques, vegetal biodiversity in Miyawaki method is very high and the new coenosis is able to evolve without any other operative support after implantation. Therefore, further technique implementation along with cost reduction, should provide a new and innovative tool to foresters and ecological engineering specialists for Mediterranean environmental-oriented reforestation programmes.

Forest resources for biofuels production in the Apennins

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Forest resources for producing biofuels are of large use in tropical countries where oil producing trees are extensively cultivated. Particularly the oil palm - *Elaeis guineensis*, Arecaceae - and some other species more recently introduced, as *Jatropha curcas* (Euphorbiaceae). The cultivation of such plants is causing damage to the natural environment, while most of the produced oil is exported for production of biodiesel in Europe.

Within a project financed by Cassa di Risparmio di Pistoia, we are studying the possible use of biofuels producing plants in marginal lands of the Apennine mountains. The use of marginal land would avoid the conflict with food agriculture, which is one of the main problems linked to biofuel production. Apennine marginal land is suited for forest restoration, but to our latitude there is no tree species which may guarantee a high oil yield.

One of the aim of our study will be the evaluation of the use of wood biomass for second generation biofuels, that is, ethanol production starting from wood biomass via enzymatic degradation of lignin and cellulose. The theoretical productivity would be higher than with first generation biofuels (oil and cereals-derived ethanol); moreover, second-generation biofuels produced from non-food plants may perform better in environmental terms.

Zah et al. (*Ökobilanz von Energieprodukten: Ökologische Bewertung von Biotreibstoffen*, Empa, Switzerland, 2007) proposed a new conceptual scheme for evaluation of different biofuels using just two criteria: greenhouse-gas emissions and overall environmental impact. However, they excluded from their analysis the so-called second-generation biofuels, such as those made from the breakdown of plant cellulose or lignin, because of insufficient data. In this field, investigation is needed and probably a correct assessment of environmental impact should be at very local concern.

A preliminary evaluation of the EROEI (Energy Return on Energy Income) is provided, together with the potentiality of marginal land in the Province of Pistoia for producing forest-generated biofuels and an assessment of the percentage of potential energetic autonomy for public services (bus, railway -limited to not electric engines-, waste collection, rescue means), by using exclusively locally produced biofuels.

Potential of mechanical forest planting in Latvia - preliminary results

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The pilot studies of productivity of two planting machines - Bracke P 11.a and M Planter in Latvian conditions were carried out during years 2007 and 2008. A work efficiency of both machines in different planting conditions by using different planting stock is compared based on the time studies. The factors influencing establishment costs by using mechanical planting machines has been analyzed. The overall statistics about planting stock production and the main numbers characterizing the forest regeneration in Latvia are presented.

Possibilities of afforestation of cut away peatland by waste water sewage sludge and wood ash fertilizers.

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In cut away peat lands are unbalanced content of plant nutrient elements. Soils usually are acid and dry. Wood ash could be good liming agent and resource of potassium. Waste water sewage sludge (WWSS) and compost is effective fertilizer and source of phosphorus. It is important to investigate such economic activity impact on environment and effect of WWSS doses allowed using by current legislation on tree growth. There were established two experiments. The first on field with WWSS application 10 t_{dm} at 2005, where had been planted pine, birch, black alder and willows. And the second as laboratory study in pots. The wood ash addition of 10 g l^{-1} and 20 g l^{-1} to WWSS compost mix with peat from used query in proportions 1:1 and 4:1 were tested for growing of willow cuttings.

Aims of the research were to determinate impact of WWSS and ash fertilization on soil properties and concentration changes of the main nutrient elements N, P, K, and Ca, Mg in different depth during 2005 -2007 on emptied peat fields after peat output. Concentration of S and total C and heavy metals in soil top layer were determinate to clear up impact of fertilization on environment.

Effect of fertilization on trees growth and stock in field conditions were determinate by non-destructive method. Growth data were calculated by measuring data of height and root collar diameter of trees. The length of shoots and dry mass of shoots and roots from pots were assessed to determine the effect of fertilization on growth of crops.

Fertilization by WWSS significantly increased growth of trees and caused germination of seeds, after three years of sludge application there were 60-70 000 tree seedlings ha^{-1} . Naturally ingrown seedlings of pine during three years reached height of planted trees. After second year of WWSS application vegetation occurred. Willows were not suitable for abundant peat cut away areas with depth peat layer and high groundwater level.

The positive effect of fertilization on growth of willows in pots was observed - an optimum dose for willows is (10 g l^{-1}) equivalent to $10 \text{ t}_{\text{DM}} \text{ ha}^{-1}$ wood ash with mix of WWSS compost with peat.

Black locust (*Robinia pseudoacacia* L.) improvement in Hungary

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In Hungary, the increase of the forested area and that of the productivity and the improvement of the quality of the forests is still a determining social, economic and environmental strategic aim in the 21st century. According to the Hungarian national afforestation plan about 700 thousand hectares of abandoned agricultural fields are to be afforested in the following 50 years in order to increase the ratio of the forested area of the country from 19% to 24-25%. About 30% of the new plantations are to be established with black locust (*Robinia pseudoacacia* L.), mostly on the Great Hungarian Plain.

Black locust was the first forest tree species introduced and acclimated from North America to Europe at the beginning of the 17th century. It is a fast growing, nitrogen fixing, site tolerant, excellent coppicing species with frequent and abundant seed production and relatively high yielding potential. It has a durable and high quality wood, which is used for many purposes. Although native of North America, black locust is now naturalized and widely planted throughout the world from temperate to subtropical areas.

Black locust covering about 23% of all forested area (about 430 thousand hectares) in Hungary can produce timber of good quality only on sites with adequate moisture, well-aerated and loose structured soil, and rich in nutrients and humus.

Black locust afforestation and artificial regeneration can be established with seedlings. The most popular planting spacing for black locust in Hungary is 2.4 m by 0.7 to 1.0 m, requiring at least 4500 seedlings/ha. Black locust stands can also be regenerated by coppice (from root suckers). Volume of black locust crops varies between 150 and 300 m³/ha in function of yield classes at the age of 30-35 years.

To improve the wood quality of black locust new cultivars have been selected. This research programme is coordinated by the Hungarian Forest Research Institute. With respect to the volume expected at felling age (30-32 years), the 'Jászakiséri', 'Kiscsalai', 'Nyírségi', 'Ülloi' and 'Szajki' cultivars proved to be the best.

The role of black locust is significant in establishing short rotation energy plantations and in improving the quality of honey production as well.

In the future there are two bigger regions, where the fast spread of black locust can be expected. In Europe the Mediterranean countries, while in Asia China and Korea may become the most prominent black locust growers.

Long periods of warm pretreatment improve germination in ash seeds

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Inadequate or unsuitable pretreatments to break seed dormancy may be leading to low yields and lack of size uniformity in ash (*Fraxinus excelsior* L.) crops grown in bare-root nurseries. Ash seeds require warm treatment followed by cold treatment to release dormancy and these are most effective if carried out in a medium. The objective of this study was to determine if a seed moisture content (MC) lower than the fully imbibed (FI) state over longer periods of warm treatment would enhance germination. Seeds of two seed lots were adjusted to 57% MC (FI state) and a lower target MC (TMC) level of 45% either in a medium (peat, perlite and sand) or without a medium for 10-30 weeks warm treatment, followed by 10, 20 or 30 weeks chilling. The seeds were allowed to germinate at 15°C for 8 hours (light) and 16 hours (dark) at 5°C. The seeds responded better to warm phase treatments than to chilling, with the longer warm phase periods giving the best results. Seeds that received short (= 14 weeks) periods of warm treatment germinated better following the longer periods of chilling, but the germination response was lower than that achieved using long warm phase treatments. Seeds treated in the FI state or in a medium responded better to suboptimal periods of warm treatment, but germination following the optimal warm periods was similar in both treatment groups. In a separate experiment, long warm phase reduced the sensitivity of seeds to germination temperatures.

Combined dendroecological and NDVI analysis to detect Regions of Provenance in forest species

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In the last fifteen years several European countries have defined Regions of Provenance for forest species, in order to a better management of genetic resources. Criteria established by the law for marketing and reforestation programmes focused about the importance in detecting and certificating plant material origin. Both in some Italian Districts and in Europe, Regions of Provenance have been delimited using classic ecological parameters (e.g., climatic, pedological, fitoclimatic indexes) supposed as homogeneous within each area, thus detecting several eco-provenances for a species as a consequence of evolutionary differentiation according to the natural selection effects.

In this study new bioclimatic approaches in defining Regions of Provenance have been tested, compared and implemented to the common used methods in Latium Region. A dendroecological test has been performed checking the relationship between plant growth and climatic parameters; similar bioclimatic responses from different forest stands in altitude and location have been statistically grouped in 4 homogeneous belts using PCA and Cluster analysis.

Moreover, phenological characters of forest species have been quantified using photosynthetic activities signals expressed into NDVI (Normalized Difference Vegetation Index). NDVI is a numerical indicator with a values ranging between -1 and +1, but the typical range is 0.5-0.9 for photosynthetic active vegetation. NDVI allows decadal monitoring of terrestrial vegetation, at regional to global scales. Here it has been used satellite images obtained from European joint programme "VEGETATION PROGRAMME". This dataset is freely available and it's based on the SPOT satellite, collecting 11 years time series (1998 - today) with a resolution of 1 km. NDVI index has been computed for Latium forest stands partitioned in cells of 100 ha. Only cells with a forest cover above 60% have been implemented in the analysis. A Cluster analysis has been performed and two classification obtained: the first one discriminates forests into 4 classes, while the second one in 5. Results of dendroecological and NDVI methods have been compared using GIS software, getting high correspondence in overlapping, and underlying the importance of altitude as main factor to define homogeneous spatial vegetation dynamics, thus delimiting ecological Regions of Provenance based on vegetation responses.

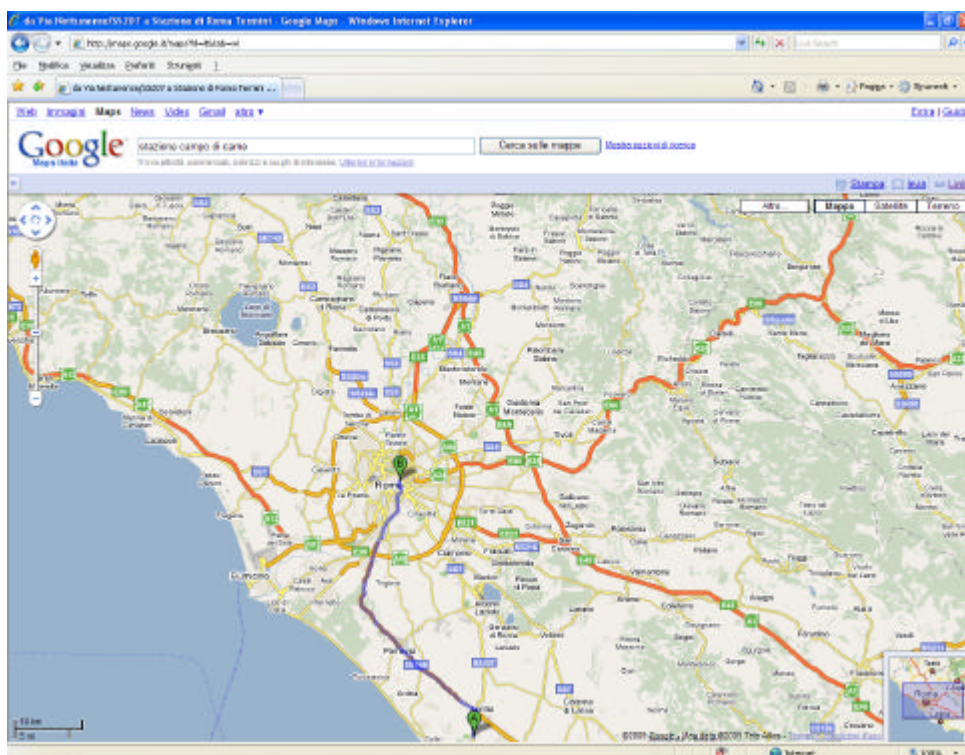
Field tour information

**INNOVATION AND NEW HORIZONS IN TREE NURSERY STOCK PRODUCTION AND FOREST RESTORATION - FROM
RESEARCH TO BUSINESS
INTERNATIONAL CONFERENCE**

Rome, Italy
March 12-14, 2009

The 14th of March a visit at Torsanlorenzo nurseries, Via Campo di Carne 51, 00040, Tor San Lorenzo - Ardea (RM), will takes place. At the field visit the results of a the "PreForest" project, funded by the European Commission within the VI Research Framework Programme will be presented by the research leaders of the project. The visit will be an opportunity to see one of the three robot prototypes shaped by "Preforest" (the other two are located in Greece and Sweden), an innovative technology for production of forest regeneration material in a cost efficient and environmental friendly production unit.

The nursery will be reached by train (from Termini station). The organisers opted for train as mean to get to Vivai Torsanlorenzo as it is much faster than coach (and more environmentally sustainable!). The train does take only 38 minutes to get from Rome Termini station to Campo di Carne and costs Euros 5.4 (return). A shuttle provided by the organisers will connect Campo di Carne station to the nursery. A brunch will be served at the nursery. Detailed information on the visit will be given by the organizers the first day of the conference.



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Venue and additional information

**INNOVATION AND NEW HORIZONS IN TREE NURSERY STOCK PRODUCTION AND FOREST RESTORATION - FROM
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Venue

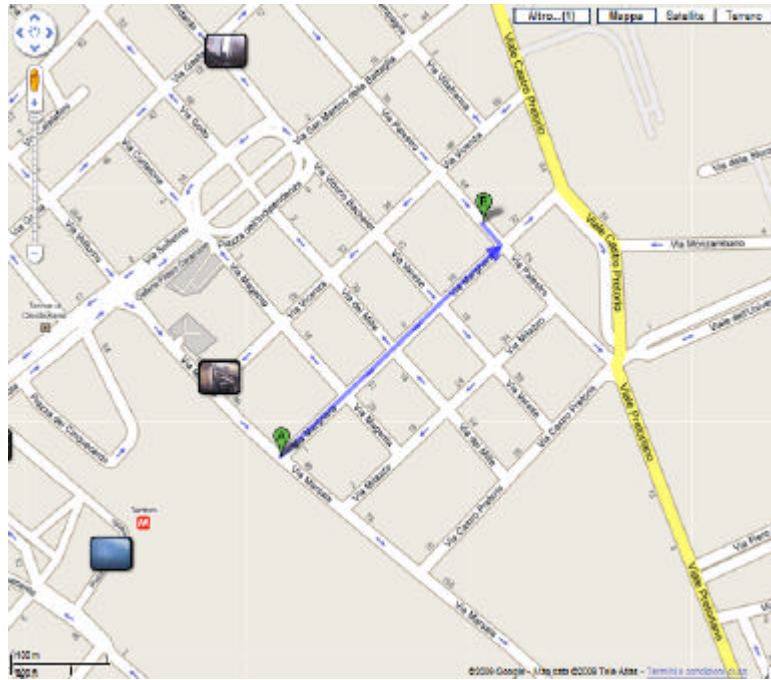
The conference will take place in Rome centre, at the Auditorium of UNICEF, Via Palestro 68, located near the main railway station in Rome "Roma Termini" (see maps below).



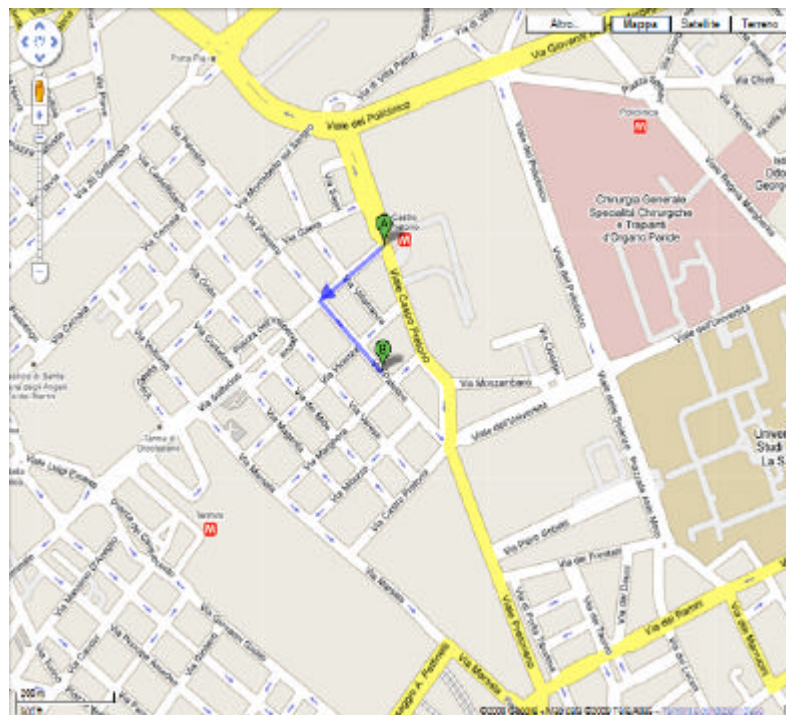
Rome is served by two international airports: "Leonardo da Vinci" and "Ciampino". From "Leonardo da Vinci" airport it is possible to get by train to "Roma Termini" in approximately 30 minutes. Ticket costs 11.00 Euros and can be purchased at the terminal of the airport. Service runs every 30 minutes.

From "Ciampino" airport it is possible to get to "Roma Termini" by shuttle, provided by the air companies. Ticket costs approximately 8.00 Euros and can be purchased at the terminal of the airport.

"Roma Termini" railway station, on the way to Via Marsala, is about 300 m far away from the conference venue, 4 minutes by walking (see map below).



From “Termini” railway and underground station (line A and B) to the Conference Venue



From “Castro Pretorio” underground station (line B) to the Conference Venue

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By underground, the nearest tube stations to the Conference Venue are "Termini" station, line A and B; and "Castro Pretorio" station, line B.

By bus, the nearest bus stop to the Conference Venue is Piazza Indipendenza, served by several lines: 75, 86, 92, 217, 360, 38, 649, 310, M, 16, 40, 92, 105, 170.

For information about the city of Rome view the web sites at www.060608.it, www.comune.roma.it, www.wantedinrome.it or call 060606

Currency / Banks/ Credit Cards

The local currency is Euro. There are several banks located around the conference site. Money can also be exchanged at the airport and the "Termini" railway station. Credit cards are generally accepted by hotels, restaurants and most department stores and shops. However, small shops and cafés prefer cash.

Restaurants and cafés.

There are many restaurants and cafés in the neighbourhood of the conference site. We will provide you with a list of restaurants and cafés located near the congress site at the time of registration.

Shopping Hours

Shops are usually open from 09:00 to 19:30 (also on Saturday). On Sunday some shops are open. On Monday morning, almost all shops are closed.

Italian Electric Plugs

Italian electric power voltage is 230V and frequency is 50 Hz. For more details please see the following link: <http://kropla.com/electric2.htm>

Assistance and information

For further assistance you may contact:

Dr Elisabetta Margheriti
Vivai Torsanlorenzo

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