Growing pine sustainably

Professor of Biochemistry and Molecular Biology at the University of Malaga, **Francisco M Cánovas** explains how the SUSTAINPINE project's results will help to boost Europe's forest-based sector

Could you begin by outlining the overall purpose of SUSTAINPINE and what the project hopes to achieve?

The main objective of this project is to develop and integrate multidisciplinary genomic research in the maritime pine species. Our research activities aim to increase genomic resources and to study candidate genes involved in the regulation of maritime pine development, growth, and the response to environmental stress, capitalising on data from previous projects. The expected major outcome is to propose practical, market-based strategies to maintain the competitiveness of forest industries by improving biomass and wood productivity of conifer forests, even under stress conditions. We also aim to specifically provide new knowledge for the European forest-based sector, which promotes the use of renewable resources in the context of global climate change.

In what way does this project support the principles of the EU Forest Technology Platform?

An important aim of this proposal is to promote the rapid transfer of knowledge to new and established industries in the forest sector, thereby increasing competitiveness and innovation within the EU. The project reinforces European leadership in conifer genomics, providing advantages to the European forest-based sector in the global market, as indicated in the research agenda of the Forest-based sector Technology Platform (FTP).

One of the project's two private partners is the support body of the FTP for France, who are directly addressing several key points of the strategic research agenda of the EU-FTP.

Could you outline the work you do at the University of Malaga and how you can relate it to SUSTAINPINE's goals?

Our research group has extensive experience in gene identification, and structural and gene expression analyses, which investigates the roles of key genes for plant growth and development. The laboratory has gained a reputable status in the study of nitrogen metabolism, with major contributions to the understanding of the molecular regulation of ammonium assimilation and amino acid metabolism. In the last few years we have also been studying the transcriptional regulation of this process. We integrate our expertise and experience with other partners in the SUSTAINPINE project to reach the proposed objectives.

What are some of the challenges or obstacles you expect to face and how will you work to overcome them?

An important challenge of this project is to incorporate genomic technologies into a maritime pine improvement programme, in order to efficiently capture genetic gain for relevant traits. The identification of genomic areas associated with a given trait is particularly challenging in conifers such as maritime pine, which have extremely large genomes. However, with the accumulation of information on pathways controlling important breeding characteristics, the candidate gene approaches we are following appear promising.

Do you hope to apply the project's work to forests outside of Europe and collaborate further internationally?

Yes, the integration of research capacities will strengthen the international position of European research in forest genomics in general, and in particular with the International Initiative for Conifer Genome Sequencing. The project also aims to strengthen an international collaboration with North American initiatives: research groups in the U.S. and Canada working in the genomics of conifers such as *Pinus taeda* or *Picea glauca*.

What have been the notable achievements of the project so far?

We now have a better understanding of the maritime pine transcriptome, and new advances have been made to determine the function of relevant genes involved in tree growth, wood formation and the response to environmental stress.

What possible economic benefits will the EU and the forest industry see as a result of SUSTAINPINE's work?

The project is generating novel genomics-based, bio-analytical tools that will improve our ability to assess tree growth and development. In the mid and long term, this will results in improved quantitative and qualitative sustainable wood production. It is expected that new knowledge and genomic technologies developed in this project will be easily transferred to other tree species of economic and ecological interest. The potential benefits of this project are scientifically and economically important to Europe.

A sustainable future

The **SUSTAINPINE** project aims to provide new knowledge for the European forest-based sector about the maritime pine tree; research hoping to overcome some of the effects of climate change on forest regions

MANY ENVIRONMENTS AND resources are facing new issues with the threat of climate change, and forests are amongst those most affected. Forests play a fundamental role in the regulation of the Global Cycle of Carbon, climatic change, control of erosion and biodiversity maintenance. Acting like sponges for excess carbon dioxide, they are a key factor in reducing global warming. The European forest-based sector has to cope with the progressive impact of global climate change in the context of increasing economic competition amongst industrial forest areas. There is also an ever-rising international demand for wood, as wood constitutes an attractive biomass as a sustainable energy source. In this scenario, genomics and biotechnology are needed to accelerate forest management in order to enhance sustainable and competitive production. Therefore the primary aim of SUSTAINPINE is the application of the latest technologies towards the identification of key genes determining adaptive traits in conifers, which are crucial for forest productivity, conservation and management.

THE PERFECT PINE

Pine trees are important for several reasons. They have a simple structural design, with straight trunks and an almost geometrical branching habitat that makes them ideal for timber production. They also grow faster than many other trees, and are therefore easier to manage in plantations. SUSTAINPINE focuses on the maritime pine – a model tree species of high ecological interest in nearly every Mediterranean and Atlantic country in Europe.

The French, Portuguese and Spanish maritime pine forests cover more than 4 million hectares and constitute a vital area for the strong integration of the forest industry and sustainable natural resources management, generating a range of scientific activities. In addition to this, more than any other species of tree, the maritime pine also has a capacity to sustain salinity and drought, making it increasingly important to countries outside of Europe such as South Africa, New Zealand and Australia. The tree's resin also confers a high calorific value to its wood, making it an excellent biofuel. Previous projects demonstrate that wood formation and drought tolerance could be efficiently described in trees by molecular biology and physiology tools.

BRANCHING OUT WITH KNOWLEDGE

SUSTAINPINE aims to identify the key genes that determine adaptive traits in the maritime pine, using the latest technologies available. The first aim is the isolation of novel maritime pine expressed sequence tags (ESTs), with the hope to extend the number of maritime pine ESTs from approximately 26,000 to at least 80,000. The second task will be to perform a large-scale expression analysis to identify candidate genes to determine the temporal and spatial distribution of transcripts. Next, functional studies of about 50 selected candidate genes will be performed, with the choice of genes determined by the regulation of development, growth, and response to environmental stress; these selected candidate genes will then be submitted to genetic mapping.

Work will subsequently be concerned with the exploration of natural diversity of the selected candidate genes in maritime pine populations, and finally candidate genes for growth and wood quality will also be selected for association mapping. The project will also apply bioinformatics methods to store, process and excavate all data delivered by the project. This will especially facilitate the coordinated analysis of structural, expressional and functional data.

The ultimate goal of the research is to deliver multiple integrated data from existing, or newly discovered, candidate genes. When applied practically, the results will benefit pine breeders, presenting them with new molecular selection criteria to ensure more efficient design of adapted varieties for improved productivity through improved growth and wood properties, as well as superior sustainability through adaptation to drought or nutritional stresses. Such a better control of tree productivity will ultimately benefit the forest industries and other wood and biomass users. This project is strongly aimed at contributing to the development of a forest crop with the potential of resource cascading for different energetic and industrial applications in a sustainable bioeconomy.

SUSTAINPINE

GENOMIC TOOLS IN MARITIME PINE FOR ENHANCED BIOMASS PRODUCTION AND SUSTAINABLE FOREST MANAGEMENT

OBJECTIVES

To propose practical, marker-based strategies to maintain the competitiveness of forest industries by improving biomass and wood productivity of conifer forests even under stress conditions.

PARTNERS

Universidad de Malaga - Biologia Molecular y Bioquimica, Spain
Centro de Investigaciones Forestales, Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria, Spain
Universidad de Alcala, Spain
Universidad de Valencia, Spain
Instituto de Tecnologia Química e Biológica, Portugal
INRA Pierroton, France
INRA Orleans, France
FCBA, France
Göttingen University, Germany
Humboldt University of Berlin, Germany
TRAGSA, Spain

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CONTACT

Francisco M Canovas
Project Coordinator

Molecular Biology and Plant Biotechnology
Faculty of Science
University of Malaga
Campus Universitario de Teatinos,
29071 Málaga
Spain

T +34 9521 31942
E canovas@uma.es

www.scbi.uma.es/sustainpine

FRANCISCO M CÁNOVAS is a Professor of Molecular Biology at Malaga University where he has been responsible of the Research Facilities and the PhD programme in Molecular and Cellular Biology. He is currently the head of the Molecular Biology Laboratory and the Unit of Functional Genomics.

EVERGREEN COLLABORATIONS

One key to SUSTAINPINE's success is the cooperation between those European laboratories with unique and complementary expertise to develop the proposed research, and subsequently a number of useful partnerships and collaborations have been put in place to ensure the project meets its aims. The research consortium is supported by wood-based industries of several countries and includes input from some of the top scientists from France, Germany, Portugal and Spain, including world leaders in different aspects of conifer tree biotechnology, such as nitrogen metabolism and photosynthesis, wood formation, stress, tissue culture and gene transfer, and bioinformatics. By combining all of its facilities, resources and technical expertise to study the problem, the consortium greatly increase the probability of significant scientific discovery. No single nation in Europe has the necessary expertise and technical infrastructure to carry out the proposed research programme alone, and subsequently a collaborative approach is the best strategy.

One of the most significant advantages open to the consortium is the availability of the research facilities of Andalucia Tech, an International Campus of Excellence with a sustainable impact on the cultural, social and economic environment. Andalucia Tech specialises in Communications and Information Technologies (CIT), Production Technologies (PT) and Biotechnology. Project Coordinator Francisco M Canovas is eager to stress the quality of the work carried out at the site: "Our laboratory has been involved for more than 20 years in functional genomics studies in higher plants by using a variety of experimental approaches and including biochemical, immunological, recombinant-DNA techniques and more recently transcriptomic, proteomic and bioinformatic analyses," he states. SUSTAINPINE is one of the most representative biotechnology projects of Andalucia Tech, and this research facility looks set to act as an important place hub to attract new scientific talent at international level.

The project expects to assemble a great deal of dispersed data. Successful coordination of data requires the integration of all datasets into a single database via a web interface where all project members can deposit and share information. The Second Work Package (WP2) of the project is concerned with this task, and is one of major achievements of the project to date, with a web portal already online. The portal also provides useful links to the partners' pages and information about the project available for the general public. Database tables will be constructed using sequences as the key to build relations, and will be hosted by the 8 Oracle Database Servers at the PAB. The project is set to conclude in April 2013, by which time it is hoped that the objectives of the project shall be met, and the future of maritime pine, its productivity, and its role in helping with climate change will be greatly fortified.

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