



**European Cooperation
in the field of Scientific
and Technical Research
- COST -**

Brussels, 22 November 2013

COST 063/13

MEMORANDUM OF UNDERSTANDING

Subject : Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action FP1305: Linking belowground biodiversity and ecosystem function in European forests (BioLink)

Delegations will find attached the Memorandum of Understanding for COST Action FP1305 as approved by the COST Committee of Senior Officials (CSO) at its 188th meeting on 14 November 2013.

MEMORANDUM OF UNDERSTANDING
For the implementation of a European Concerted Research Action designated as
COST Action FP1305
LINKING BELOWGROUND BIODIVERSITY AND ECOSYSTEM FUNCTION IN
EUROPEAN FORESTS (BIOLINK)

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4114/13 “COST Action Management” and document COST 4112/13 “Rules for Participation in and Implementation of COST Activities” , or in any new document amending or replacing them, the contents of which the Parties are fully aware of.
2. The main objective of the Action is to create a forum where current understanding of functional belowground biodiversity at different scales and trophic levels in European forests can guide the development of prescriptions for sustainable forest and tree crop management..
3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 84 million in 2013 prices.
4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.
5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of section 2. *Changes to a COST Action* in the document COST 4114/13.

A. ABSTRACT AND KEYWORDS

European forests are of immense importance to both society and the environment, providing a range of products and ecosystem services many of which are threatened by climate change. Our understanding of forest diversity, especially belowground, is currently limited and spread over distinct trophic levels. Little is known about the redundancy and functional diversity in forest soils. Numerous factors threaten existing belowground biodiversity, the simplification of forest ecosystems in pursuit of higher productivity being one of the prominent ones. There is an urgent need to link up existing scientific expertise at different levels to fully explain the connection between diversity, stability and function. Concurrently, forest modelling lacks coordinated activity aimed at bringing biodiversity into the fold - current emphasis is on yield and forest gap models. Elsewhere, food web models and ecosystem network models are well developed, but their application to forests is limited. This COST Action will provide a forum where current understanding of functional belowground biodiversity in European forests will be synthesised and its role communicated in a form suitable for modellers, policy makers and end-users.

Keywords: belowground diversity, ecosystem function, ecosystem services, climate change, forest management, tree crops

B. BACKGROUND

B.1 General background

Over two thirds of the world's terrestrial biodiversity occurs in forests. Forests contain numerous groups of organisms, each performing a function essential to the survival of the ecosystem. There is increasing awareness that the diversity of such groups (i.e. functional diversity) is important in maintaining ecosystem services which are of immense importance to both society and the environment. Rapid climate change has the potential to endanger the supply of many of these ecosystem services. Although functional diversity can enhance ecosystem stability and ecosystem service delivery, current understanding of the importance of belowground biodiversity in ecosystem function in forests is at best limited to mixtures of tree species.

The positive effect of diversity on ecosystem stability and function is known, there is also a growing understanding that looking at the diversity at distinct trophic levels is insufficient. To reflect forest ecosystem functioning and to fully understand and explain the connections between

diversity, stability and function, we need to link up scientific expertise which currently focuses at different trophic levels. Knowledge is spread across diverse groups of researchers who concentrate their effort at a specific type of organism or a functional group. By bringing together expertise on tree and belowground diversity in forest ecosystems, this COST Action will dissect the contribution of diversity within trophic levels to overall ecosystem function and stability. The Action will link the latest understanding of forest biodiversity and ecosystem function from various subject areas. Cutting edge knowledge of the links between biodiversity and ecosystem function exists in fields as diverse as evolutionary ecology, aquatic biology, food web modelling, or indeed forest ecology. The COST Action framework offers a unique opportunity to bring together leading experts from these fields to inform the community focusing on belowground biodiversity in forests and to stimulate further progress.

B.2 Current state of knowledge

The distinguishing feature of the Earth is the existence of life in its myriad forms. Currently, we are coming to realise that the diversity of life is the only guarantee for a habitable planet for future generations. At the first Earth Summit, more than 20 years ago now, an overwhelming majority of nations agreed that humanity is dismantling world's ecosystems and eliminating functional and genetic diversity contained within them. The intervening period has seen the rise of a great interest in answering the question of how the loss of biodiversity will affect ecosystem functioning and ultimately survival. Past research has shown that organisms can influence the physical formation of habitats, fluxes of elements in biogeochemical cycles, and the productivity of ecosystems. Such research resulted in the current awareness that loss of certain life forms can substantially alter the structure and functionality of whole ecosystems. Forest ecosystems offer a stark example, any simplification of tree species diversity, or indeed a complete replacement of existing tree species by plantations, alters their productivity, resource utilisation efficiency, stability and the capacity to self-regulate.

Recent focus on ecosystem service provision by forests and forest plantations has brought to the fore the role of biodiversity in maintaining these functions which underpin the existence of human society. We understand that high biodiversity, whether genetic or functional, usually provides for high resource use efficiency and, by extension, for optimal ecosystem service delivery. We know that maintaining multiple ecosystem processes at multiple places and times requires higher levels of biodiversity than does a single process at a single place and time. Coupled to that, the impact of biodiversity on any single ecosystem process is nonlinear and saturating, such that change

accelerates as biodiversity loss increases. The majority of evidence in support of these findings, however, relates to biodiversity observable and quantifiable aboveground. In forests, but also in the wider terrestrial context, knowledge of belowground biodiversity and its role in ecosystem function is currently fragmented and/or newly emergent. Interactions between soil organisms are inherently complex; supply limitation, competition and predation act simultaneously at any trophic level. Biotic relationships are further modified by climate and physical factors within the soil. Unsurprisingly, the ultimate controls of belowground trophic structure are still heavily debated. Given the complexity of belowground systems, most research so far has been focused on simplified ‘model’ communities. Natural food webs, however, are complex networks with dozens to hundreds of thousands of species, all linked in a web characterised by high spatial and temporal dynamics of interacting organisms.

Relatively recent advances in methods such as high-throughput pyrosequencing and the use of genomic and meta-genomic approaches have allowed for the identification and description of individual species of soil dwelling organisms at virtually any trophic level. The characterisation of complex microbial communities has been expanded to the field of meta-transcriptomics, allowing us to reach towards *in situ* activity and function. Until now these techniques have been used in environmental monitoring and biotechnology, but are increasingly being applied to study ecosystem functioning. For the first time, we have the capacity to describe biodiversity present in the ‘hidden half’ of forest ecosystems. The huge complexity of belowground food-webs exposed by the new methods may seem to preclude predictability at first. Recent advances, however, suggest that food-web structure, functionality and stability can be predicted by focusing on a small subset of traits. The innovative approach of this COST Action lies in identifying the key findings relating to such traits in other areas of science and in bringing them to bear in the quest to link belowground biodiversity to forest functionality.

B.3 Reasons for the Action

A significant proportion of forests and intensively managed plantations in Europe may be threatened by environmental change in the near future. Whether due to climatic change, nitrogen deposition or invasive species, functionality and delivery of ecosystem services by these ecosystems is likely to be undermined. Biodiversity, much of which inhabits the belowground part in tree dominated ecosystems, probably is the key factor in maintaining ecosystem stability. This COST Action will link established information about diversity of forest soil biota (genetic and functional) with theoretical concepts emerging in other areas of biodiversity science and adapt them for use in

forest models. The major advantages of developing this project within the COST framework are:

- A full understanding of the link between belowground biodiversity and function in forests is hindered by the lack of communication between the different fields of research which generate theoretical, but also observational knowledge. The COST framework is the best platform for putting together scientists and experts from different backgrounds and research fields.
- Numerous scientific papers have been published on the topic of biodiversity and ecosystem function, some providing contradictory results. The contradictions and uncertainties observed for some aspects of the role of belowground biodiversity hinder the application of established principles to policy and practice. A four-year COST Action offers a very good opportunity to clarify some of the issues and communicate established knowledge to end-users.
- There is a need for communication between scientists focusing on belowground biodiversity, experts in related fields, policy makers at European level and industry. The role of belowground biodiversity in underpinning forest ecosystems, which is increasingly recognised by science, needs to be brought into the policy agenda and utilised by practitioners in the field.
- We need to improve existing models and statistical tools that help science to move from experiments that detail local biological processes to landscape-scale patterns, where management and policy take place. By bringing together science communities involved in belowground biology and forest ecosystem modelling, this COST Action will stimulate the exchange of knowledge and ideally will foster a generation of ecosystem models better representing belowground diversity and its influence on productivity, resource use and function.

The COST Action framework is an ideal place to discuss and develop novel approaches and research ideas. By bringing together scientists and experts working on forest soil biodiversity, experts from other fields and interested stakeholders, the COST Action will identify priorities and challenges for future research in this field.

B.4 Complementarity with other research programmes

Starting within the COST domain, this Action will strongly complement several recently concluded and existing COST Actions. Aspects of forest ecosystem modelling relevant to biodiversity were covered in COST Action FP0603 “Forest models for research and decision support in sustainable forest management”. The strong focus on mycorrhizal fungi and on carbon sequestration as an ecosystem service during the recently concluded FP0803 “Belowground carbon turnover in European Forests” presents an important building block to this COST Action. Looking at active COST Actions within the FPS domain, this COST Action will strongly complement FP1203

“European non-wood forest products (NWFPs) network” and FP1103 “*Fraxinus* dieback in Europe: elaborating guidelines and strategies for sustainable management (FRAXBACK)” – both topics where biodiversity is one of the most important aspects under consideration. Certain aspects of this COST Action are relevant to the newly established FP1204 “Green Infrastructure approach: linking environmental with social aspects in studying and managing urban forests “. The question of re-creating biodiversity to support urban forest functioning is prominent; a collaboration on this topic will be sought.

Moving into the area of current research activity in Europe, the great interest in the role of forest biodiversity in maintaining forest ecosystem services is reflected by a wide range of research projects. Current 7th framework featured several calls for research proposals, which focused on forest biodiversity (e.g. ENV.2009.2.1.6.2, ENV.2010.2.1.4-1, KBBE.2012.1.2-07). Further, FunDivEurope and BACCARA research projects funded by FP7 will strongly complement this COST Action. Casting the net a little wider reveals numerous ongoing research projects actively pursuing the link between biodiversity and ecosystem functioning; ‘Bio-LCA: Introducing biodiversity in Life Cycle Assessment (LCA)’, ‘MICRODIVE: Biodiversity and ecosystem services in the microbial realm’, ‘DIVERFOR: Functional implications of inter- vs. intraspecific trait diversity in European forests’, ‘TEEMBIO: Toward Eco-Evolutionary Models for BIODiversity Scenarios’ or ‘LINKTOFUN: Linking tree and belowground biodiversity to forest Ecosystem function’, to name a few.

Co-ordination and integration of this research activity at European level is urgently required. There is a need to consolidate recent advances and communicate these beyond scientific audience. A further task is to enhance the interaction between research groups working on empirical scientific evidence, ecosystem modellers and forest managers, practitioners and forest companies. This COST Action has the potential to add excellence to European research by strengthening European networks in an area of high priority policy needs for Europe.

C. OBJECTIVES AND BENEFITS

C.1 Aim

To create a forum where current understanding of functional belowground biodiversity at different scales and trophic levels in European forests can guide the development of prescriptions for sustainable forest and tree crop management.

C.2 Objectives

- 1) To summarise current knowledge of belowground biodiversity in forest ecosystems across a management intensity gradient. The Action will assess the role of soil biodiversity as a determinant of ecosystem stability. The deliverable for this objective will be the provision of a platform for knowledge integration and identification of cross-cutting issues and facilitation of exchange of ideas between members of different research communities. The syntheses will be published in scientific publications.
- 2) To integrate new theoretical and technological advances in biodiversity research in the forest ecosystem research community. Emerging analytical and modelling approaches will be showcased by inviting world-leading speakers to each of the annual Action meetings. The main deliverable for this objective will be the creation of a European research community of forest scientists aware of the potential uses of new technologies and their application to forestry practice.
- 3) To provide a focal point for the dissemination of information about forest biodiversity and ecosystem function. A deliverable for this objective will be dissemination of information designed for end-users such as forest owners and managers, policy makers or private companies through a website. In collaboration with national forestry organisations and trade bodies, knowledge synthesised by the Action will be disseminated at appropriate level of detail and complexity.
- 4) To collate and exchange recent findings from experimental and observational studies of belowground biodiversity in perennial tree crops and simplified ecosystems. These will be contrasted to those from forest ecosystems. The main deliverable will be to establish an expert network specifically dedicated to the study of diversity gradients in forest ecosystems, from 'natural' forests to intensively managed crop plantations.
- 5) To compare experimental and model results from natural forests and tree crops concerning effects on soil biodiversity. Further inclusion of know-how from related modelling research (aquatic food-web modelling, agricultural soil modelling) will boost the development of new forest ecosystem modelling concepts that include soil functional diversity in a more mechanistic way.
- 6) To identify new cross-disciplinary research areas. This objective will be delivered in a series of review and opinion publications in peer-reviewed journals. The Action will consolidate existing knowledge and indicate avenues of future research.

C.3 How networking within the Action will yield the objectives?

This COST Action is based on a multidisciplinary approach from its onset, it will integrate groups of scientists and experts involved in belowground, but also invited experts in aboveground

biodiversity research, conservation, ecosystem modelling, social science and economics. The main mechanism of the Action to achieve its objectives is the singular focus on effective networking and exchange of ideas. Alongside ‘within topic’ presentations and workshops, meetings will always feature keynote presentations by experts from fields of biodiversity research other than forest soil biodiversity. The structure of the Action will promote exchange of ideas between the Working Groups by ensuring a common thread during each of the meetings, but also throughout the Action. The objectives of this Action will be achieved by:

- 1) Bringing together scientists with expertise relevant to forest belowground biodiversity and its application in models and practical uses. The networking facilitated by the action will promote assessment and adoption of best practice sampling and analytical methodologies, as well as encourage interdisciplinary assessment of their applicability.
- 2) Stimulating an exchange of early-stage researchers and research students among Action participants, through the provision of travel funds for STSMs and training schools. This will enable integration across scientific, management and policy spheres, in addition to the interaction between scientists working towards similar goals within the Action.
- 3) Bringing in experts working on the cutting edge of biodiversity research, but not necessarily in forest setting, the Action will facilitate an exchange of ideas, methodologies and cross-disciplinary application of principles and biodiversity theory.
- 4) Pulling together experts with relevant stakeholders, including forests and tree crop practitioners, managers and producers. This will allow participants to adapt and develop management strategies for improving production while maintaining or improving ecosystem service provision.
- 5) Aggregating and disseminating knowledge of belowground biodiversity and functional diversity by organising training schools for researchers and modellers, by compiling peer-reviewed scientific publications, and by organising conferences.

C.4 Potential impact of the Action

The Action will be a conduit for the provision of complex biological information in a synthesised form, suitable for adaptation to forest ecosystem models and accessible to policy makers and end-users. Faced with impending environmental change, forest managers and tree crop practitioners will need to adjust existing management practice to reflect changing climatic conditions.

Moving to the policy arena, European Commission has organised numerous public events dedicated to forest soils, including major conferences on soil, climate change and biodiversity. It

also involved in publishing a number of soil atlases, including the Soil Atlas of Europe and the European Atlas of Soil Biodiversity. The principles of forest soil functioning, which are the remit of this COST Action, do have clear relevance and applicability to many other terrestrial ecosystems and should contribute to policy formation.

Within the premise of improving resource-use-efficiency and sustainability of European businesses involved with or dependent upon ecosystem services supported by belowground biodiversity, the European Commission is now reflecting on how the Business @ Biodiversity Platform could continue in the future. By inviting stakeholders associated with the B@B platform, but also by reaching businesses which utilise belowground biodiversity and its functions, this COST Action will create a bridge between biodiversity science and end-users. It will be used as a forum for engaging in discussions with businesses that would encourage business to increase its investment in protecting biodiversity and the many services in supports.

C.5 Target groups/end users

Target audience of this COST Action can be divided into the following three groups, according to the type of interaction with the Action outputs:

- Scientists and researchers in Europe will benefit by having first-hand access to the latest expertise and knowledge in this field
- Policymakers will benefit by gaining access to clear and concise information about the role of belowground biodiversity in forest ecosystems and its link to ecosystem services
- Business will benefit from having access to information about how belowground biodiversity can be harnessed to improve resource use efficiency in productive ecosystems

Representatives of all three groups of stakeholders were consulted during the preparation of this proposal.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

The Action will focus on describing the role of belowground biodiversity and functional diversity in ecosystem functioning and stability of forests and tree crops. The first and the foremost – this Action is intended to provide an open and efficient networking vehicle for researchers, policymakers and end users. To this end, the Action will involve not only forestry experts, but also researchers from disciplines such as agriculture, microbial ecology, conservation and network

modelling, policy experts and members of the business community. The main goal is to create an efficient knowledge exchange platform aimed at establishing belowground diversity as a major determinant of ecosystem productivity and stability. Following on from the aforementioned main goal, the scientific tasks of the Action are as follows:

1) To develop a synthesis of existing information on belowground biodiversity in European forests and tree crops and its role in the maintenance of ecosystem resilience and stability. Much of the European area covered by trees has been utilized for many centuries. Current management is designed primarily for productivity and has led to the reduction of tree species diversity. As trees are by far the most dominant primary producer in this type of ecosystem, any manipulation of tree species diversity is likely to be reflected at other trophic levels, particularly belowground. Soil microorganisms such as fungi and bacteria are taxonomically highly diverse and are a key to ecosystem function. An example of the connected nature of these systems is the link between mycorrhizas and forest trees; one of the best understood relationships in forest function. Since tree diversity exerts key influence over the diversity of ectomycorrhizal communities, the potential for feedbacks between mycorrhizal fungal functional diversity and host diversity are considerable. However, their role in forest ecosystem stability is currently little understood. Despite their obvious ecological importance, little is known about the redundancy and functional diversity within the major taxonomic groups of soil dwelling organisms and how their diversity underpins forest function. It is widely accepted that only a small fraction of the microbial species has been described thus far and that a significant fraction of species remains unknown. These are mainly uncultivable bacteria, potentially accounting for a huge fraction of soil microbial diversity. Collecting and integrating data from research employing recent advances in next generation sequencing (NGS) is one of the tasks of the Action. Any increase in our knowledge of the soil microbiome will widen the window onto the real biodiversity levels occurring in forest and agroecosystems, as well as on their roles and services in different environments. Recent methodological developments, both analytical and modelling, allow for an assessment and analysis of functional links within the soil-dwelling community, the task for the Action is to create a clear overview of methods and their potential.

2) To foster the development of the next generation of soil biodiversity experts. One of the scientific tasks of the Action it to create a learning environment for early-stage scientists. It is imperative that the Action utilises all means available to foster efficient exchange of knowledge and advice between established and early-stage scientists. The Action aims to provide the early-stage scientists with an opportunity to come across the latest developments in the field, but also to be exposed and become aware of the commercial applicability of biodiversity science. Throughout the four years, the Action will invite leading experts from closely related fields (theoretical, aquatic,

agricultural, socio-economic backgrounds) to provide early-stage researchers with an exposure to a wide range of views on biodiversity, its importance and utilisation.

3) To create an opportunity for forest model users to explore the integration of growth- and network-based models. Although considerable effort has been made to improve mechanistic models of forests at different scales, many are still focused on management-yield relations and consider the soil as a black box. As yet, these models are unable to simulate the consequences of changing biodiversity (incidentally, both above- and below ground) on ecosystem performance and behaviour. Existing (aquatic) food-web models, LCA (Life Cycle Analysis) models and agricultural soil models are far better at simulating interaction between trophic levels. The implementation and integration of at least some of the algorithms used in these models can substantially improve existing forest models. The stability and functionality of the soil is of prime importance to ecosystem functioning, improving - or even starting on - the simulation of this component must improve overall model performance. For the modelling community, the opportunity to work directly with experimentalists, end-users and modellers from related fields creates a unique opportunity for advancement of their efforts. This framework will also present an opportunity for young scientists to be trained in ecosystem modelling.

4) Promote knowledge on the role of soil biological communities in fostering resilience in agroecosystems across Europe which feature tree crops such as walnut, chestnut, olives, oak or other perennials. These crops often represent an intensively managed succession to previous forest ecosystems in many parts of Europe and/or form the basis of productive agroecosystems integrated with contiguous forests. The resilience and productivity of these agroecosystems is primarily driven by the stability of the soil component, which in turn is probably generated by soil biodiversity inherited from earlier forests. The 'biodiversity insurance hypothesis' applicable to these simplified ecosystems will be assessed by the Action through a systematic and critical knowledge exchange. The Action aims to find appropriate and innovative recommendations as to the feasibility of harnessing the belowground biodiversity to support productivity. These are currently highly required by the practitioners, managers and policy makers and are likely to form the basis of knowledge-based agroecosystem management strategies.

5) Link current understanding of functional belowground biodiversity at different scales and trophic levels in European forests in order to provide a basis for the development of prescriptions for tree ecosystem management. The Action will contribute to the ongoing debate about the economic and social costs of biodiversity loss within, but also outside Europe. EU Biodiversity Strategy to 2020 states that 'The Commission will continue its work to fill key research gaps, including on mapping and assessing ecosystem services in Europe, which will help improve our

knowledge of the links between biodiversity and climate change, and the role of soil biodiversity in delivering key ecosystem services'. The COST framework provides the perfect opportunity for aggregating and linking existing expertise with the view of contributing to the 2020 strategy. This COST Action will significantly enhance the provision of evidence-based guidance and support relating to belowground biodiversity in European forest ecosystems. Crucially, this COST Action will adopt a multidisciplinary approach, bringing together experts in biodiversity at different trophic levels within forest ecosystems, ecosystem modellers, tree ecology and management specialists, supplemented with leading experts on biodiversity in other types of ecosystems.

6) Assess how knowledge of biodiversity function can be utilised to strengthen ecosystem resilience and of ecosystem service provision, as well as its utilisation in support of EU climate change adaptation policies. A significant effort has been put into biodiversity conservation, both at national and at EU level (Natura 2000, Biodiversity Strategy to 2020, CAP reform). Current science indicates that loss of biodiversity is likely to diminish ecosystem service provision and therefore takes on social and economic dimensions. Whether it is timber or fruit production, carbon sequestration, water filtration or soil protection, it is likely that all these services are dependent on belowground biodiversity, with microbial communities playing a key role. The output of this COST Action will have a direct relevance to these efforts. Soil biodiversity provides numerous essential services, including releasing nutrients, purifying water, contributing to the composition of the atmosphere, and providing a major source of genetic and chemical resources (e.g. antibiotics). The EU Joint Research Centre is working on improving its preliminary assessment and mapping of locations where soil biodiversity is threatened, his COST Action will contribute to this undertaking by providing information about the functional importance of soil dwelling organisms. Further afield, the European Commission is developing a European Innovation Partnership on Agriculture Productivity and Sustainability, with a particular focus on land management.

D.2 Scientific work plan methods and means

The work programme of WGs 1-3 will focus a specific topic, WG1 will link diversity to function, WG2 will look at the structure of belowground food webs and WG3 will assess the importance of belowground diversity in intensively managed forest ecosystems. WG4 will utilise the information gathered by other working groups to evaluate novel modelling concepts to include biodiversity and functional diversity indices. By aligning the work effort of all WGs against the same objectives, the Action will guarantee effective collaboration of all experts involved. The Steering Committee will set the agenda for each of the meetings and ensure efficient collaboration between the WGs. The

work programme will focus on synthesis of current data and assessment of potential uses, but not on data generation, thus clearly distinguishing the COST Action from past and present research projects upon which the Action will draw. Training schools of new technologies will be organised during the Action and strong emphasis will be placed on the use of STSMs. To promote early-stage researchers and gender equality, pairings of young and experienced researchers will be used as Action Chairs and Working Group leaders.

The outputs of the Action will be structured and disseminated as standalone publications, but also in publications covering the core message of the Action focusing on the strong link between belowground diversity and forest functionality. The Action will invite representatives of end-user groups to the final meeting of the Action, but also will continuously communicate its activity and findings via a purpose-built website. The main reason for the very wide scope of dissemination is the emerging role of belowground biodiversity as a determinant of forest ecosystem stability in the face of expected climatic change. The notion of conservation and utilisation of belowground diversity in forests is becoming prominent in the policy arena of Member States, but also EU as a whole. It is imperative that the importance of biodiversity and functional diversity is communicated clearly and backed up by scientific evidence.

Within the EU, there is currently great interest in the role of forest biodiversity in maintaining forest ecosystem services. This is evidenced by a number of calls with the current 7th framework (inter alia ENV.2009.2.1.6.2, ENV.2010.2.1.4-1, KBBE.2012.1.2-07). This COST Action will strongly complement FP7 projects FunDivEurope and BACCARA by providing a platform for exchange of information and feedback between groups of scientists studying the role of diversity at varying trophic levels. The Action is open to and will actively pursue links with national projects or centres of excellence which work on belowground biodiversity. The Action will identify emergent methodologies aimed at improving soil resource use efficiency in natural and simplified ecosystems and build capacity for joint initiatives and new research projects on this subject. By shedding light on the relationship between belowground diversity and stand stability, the Action will complement the predictions of the impact of invasive species, effects of gradual climate change on taxonomic and functional properties of ecosystems and help to uncover issues critical to conservation planning and ecosystem management.

By participating in this COST Action, European research groups which study the role of biodiversity – and belowground biodiversity in particular – will benefit from having access to an efficient knowledge exchange platform. By bringing together leading experts in this field and facilitating information exchange with global experts working on theory and methodology advances, the COST Action will be very well positioned to generate new ideas, research proposals

and review papers. The action aims at producing high quality outputs; creating an environment where experts in forest soil biodiversity and biodiversity can discuss novel ideas and approaches with researchers from other fields and stakeholders will facilitate that. In addition, the progress of work on outputs publishable in scientific literature but also press communications and policy recommendations will be regularly reviewed by the Steering Group during annual meetings, but also via email communication.

E. ORGANISATION

E.1 Coordination and organisation

The COST Action will be coordinated by a Management Committee (MC) defined according to the "Rules and Procedures for Implementing COST Actions". The responsibility for the planning and execution of the activities will be delegated by the MC to a Steering Group (SG), consisting of the Chair, the Vice-Chair of the Action, the coordinators of Working Groups (WG) and the STSM manager.

The core of activities will be carried out at the WG level, where knowledge resulting from research carried out in and financed by the participating countries will be shared, reviewed and synthesised. For this purpose, the coordination of activities will be implemented through annual WG meetings, where state of the art reports and other activities will be initiated, organised and eventually reviewed. One Action participant will be designated and act as the STSM manager, this person will be responsible for calling, selecting (together with SG) and reviewing STSMs.

Milestones of the Action include:

- Kick-off meeting, where the MC, WG coordinators and SG will be defined, as well as work plan implementation and task distribution will be decided upon.
- Action website will be set up shortly after the kick-off meeting (e.g. www.bio-link.eu). The website will be used as the focal point of networking between Action participants and will ensure the dissemination and exploitation of the results delivered by the Action. The site will be used to announce activities (e.g. training schools, WG meetings, conferences), facilitate communication between the participants (e.g. discussion papers, databases) and disseminate results (e.g. state-of-the-art reports, review articles).
- Annual meetings, where an evaluation of the activities carried out by members of each WG will take place. Presentations by invited experts, discussion of state-of-the-art reviews and knowledge transfer plans will be made during these meetings.
- Networking event – to promote successful collaboration and to maximise the networking potential

of the action, a professional networking facilitator will be brought in during the first of the annual meetings (e.g. <http://www.idenk.co.uk/>)

- Training schools, the Action plans to organise two training schools in year 2 and 3. The focus of the first will be on analytical methods, while the second will concentrate on ecological modelling.
- Final conference, where a comprehensive review of state-of-the-art, achievements of the action and dissemination of the results will take place.
- Peer-review scientific publications, the Action aims to publish at least 3 major reviews of the state-of-the-art by the conclusion of the Action.

E.2 Working Groups

Close collaboration and communication between all participants of the COST Action irrespective of their expertise and research interests will be encouraged and supported. However the following formal structure will be put in place to reflect the goals and to deliver the objectives of the Action:

WG 1 Linking belowground biodiversity to ecosystem function.

WG 2 Microbial and faunal functional biodiversity in belowground food-webs.

WG 3 Belowground biodiversity in plantations and tree crops.

WG 4 Functional diversity in forest models.

All participants will take part in WGs according to their field of expertise or interest. Each WG will be coordinated by a WG coordinator, helped by two vice-coordinators, one of which will be an early-stage scientist. Further, the participation of early-stage scientists in the activities of the WGs will be encouraged through STSMs. Alongside coordinating the work of the respective WG, each WG coordinator will be responsible for reporting the work progress to the SG.

E.3 Liaison and interaction with other research programmes

The liaison with other COST Actions and other European and international research programs will be managed by the SG. This COST Action will strongly link with FP1203 “European non-wood forest products (NWFPs) network” and FP1103 “*Fraxinus* dieback in Europe: elaborating guidelines and strategies for sustainable management (FRAXBACK)” – both topics where biodiversity is one of the most important aspects under consideration. FunDivEurope and BACCARA research projects funded by FP7 will strongly complement this COST Action. In addition, liaisons shall be established to other initiatives, e.g. ‘Bio-LCA: Introducing biodiversity in Life Cycle Assessment (LCA)’, ‘MICRODIVE: Biodiversity and ecosystem services in the

microbial realm’, ‘DIVERFOR: Functional implications of inter- vs. intraspecific trait diversity in European forests’, ‘TEEMBIO: Toward Eco-Evolutionary Models for BIODiversity Scenarios’ and ‘LINKTOFUN: Linking tree and belowground biodiversity to forest Ecosystem function’.

Numerous participants of the aforementioned COST Actions and research projects have taken part in preparing this proposal.

The Action will ensure that researchers involved in aforementioned Actions or research projects will be offered an opportunity to become active participants of the Action. The Action will include presentations and posters showcasing the research output of relevant projects currently carried out in Europe during its meetings. Researchers will be encouraged to share and discuss new knowledge within the framework provided by the Action and to actively collaborate with the Action.

E.4 Gender balance and involvement of early-stage researchers

The Action pledges to make certain that suitable gender balance of the SG is achieved. Same principle will be applied to the selection of early-stage researchers for STSMs and training schools. Each WG will have a leader, whose task of organising the activities of the WG will be aided by two vice-leaders. One of the vice-leaders in each WG will be an early-stage researcher. Early-stage researchers will be encouraged to become members of MC and to contribute to decision making of the Action. In presentation sessions and workshops organised by the WGs, the Action will allocate time to early-stage researcher presentations to showcase their work and upcoming publications. Each presentation by an early-stage researcher will be followed by a review by an expert in the area. The motivation for this is to provide instant expert feedback and comments and to provide an opportunity for starting researchers to confront their research ideas with experts in a friendly and supportive setting.

F. TIMETABLE

The Action will have duration of four years. A tentative timetable below outlines the timing of core activities of the Action:

	Year 1				Year 2				Year 3				Year 4			
Kick-off	X															

meeting																
Annual meetings			X				X				X					
STSMs			X	X			X	X			X	X			X	X
Training schools						X				X						
Technical reports by WGs								X								X
Review papers					X	X	X	X	X	X	X	X				
Final conference																X
Web site		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, BE, BG, CH, CZ, DE, EE, EL, ES, FI, FR, HR, IT, NO, PL, PT, SE, SI, SK, TR, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 84 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

H. DISSEMINATION PLAN

H.1 Who?

The target audience of this COST Action is potentially very large and includes scientists and researchers, practitioners and members of the business community, as well as public officials involved in policy formation both at national and EU levels. Due to the iconic status of tree ecosystems in Europe, the general public also stands to gain from improved understanding of the link between belowground biodiversity and ecosystems services the society is dependent upon. Scientific syntheses and state-of-the-art summaries produced by the Action will clearly be relevant to researchers. They will also gain from having access to networking possibilities with leaders in the

many facets of biodiversity science, but also from review papers and standardisation of methodologies.

The fact that soil biodiversity has a clear relevance to soil fertility and stability of function has been accepted some time ago. The COST Action will collate emergent information on harnessing the beneficial effects of soil fertility and communicate it to the business community and practitioners who stands to gain from the application of such knowledge (e.g. forest managers, tree crop growers).

H.2 What?

The dissemination plan of the Action includes a public website for general dissemination of the Action activities and results. An e-mail opt-in network for people interested in the topic of the Action will be created. This will allow dissemination to the audiences hardly reached by scientific publications and will be utilised during the entire duration of the project and beyond.

In addition, the Action will have various dissemination methods specific to target audiences:

- Target audience 1: Researchers and modellers: Compiling of articles and review-articles in scientific journals during participation in WG meetings and conferences, participation in STSMs and training schools for early-stage researchers.
- Target audience 2: Forest practitioners and tree crop growers: State-of-the-art reports, final reports and case study reports in technical journals to be developed within WG activities.
- Target audience 3: Government representatives and decision/policy makers: Compilation of non-technical publications within WG activities, introductory of non-technical sessions during the final conference.
- Participation of the members in the WG meetings with the delivery of abstract books of the oral and poster contributions.
- Peer-reviewed scientific publications in international journals, to be compiled and developed within the WG activities by the end of the Action.
- The organization of two Training Schools aiming to provide to young researchers and modellers the state-of-the-art.
- The organisation of a several conferences and a final conference at the end of the Action in order to disseminate the Action's conclusions and results, and advertising review articles.

H.3 How?

The Action will advertise all its activities, engagements and outputs on its website. In order to maximise traffic on the website, the participants will link their institutional and personal webpages to the Action website. During the first year, the Action will place short articles and placeholders advertising its aims and goals in trade publications, such as scientific magazines, expert periodicals and leaflets. The Action expects most of its participants to be members of national, European and global scientific bodies and trade organisations, there should therefore be no cost associated with this activity. University departments feature Facebook and Twitter feeds to publicise their work, the Action will utilise this channel of communication to reach audience normally beyond the scope of scientific publishing.

Review and opinion (e.g. on future challenges) articles will be published in scientific journals, the Action aims to use the Open Source Publishing model to maximise the impact of the publications. Looking at forestry and tree crop management community, the Action will contact Schools and Universities which feature relevant qualifications to ensure dissemination of the results to the next generation of forest managers, organization of technical sessions during the final conference. A significant overlap between Action participants and University teaching staff, as well as research organisations is expected, the Action will use such contacts to publicise its work and outputs. The topic of biodiversity, the functions it fulfils and especially the utilisation of biodiversity is very pertinent and features regularly in popular press. The action will use the press officers which normally support the work of Action participants to publicise key finding of the WGs and to expose them to general public.

The Action, via the SC, will review the dissemination plan during its annual meetings. Impact and interest generated by the various communication channels outlined above will be reviewed and activity and resources focused on the most efficient platforms.