agence d'évaluation de la recherche
et de l'enseignement supérieur

Research Units Department

AERES report on unit:

Tree-Microbe Interactions

IAM

Under the supervision of the following institutions and research bodies:

INRA

University of Lorraine

January 2012

agence d'évaluation de la recherche
et de l'enseignement supérieur

Research Units Department

President of AERES

Didier Houssin

Research Units Department

Department Head

Pierre Glaudes

Unit

Name of unit:	Tree-Microbe Interactions / Interactions Arbres-Microorganismes
Acronym of unit:	IAM
Label requested:	UMR
Present no.:	UMR 1136
Name of Director (2009-2012):	Ms Pascale FREY-KLETT
Name of project leader (2013-2017):	Mr Eric GELHAYE

Members of the committee of experts

Chair:	Mr Thierry HEULIN, Saint-Paul-lez-Durance
Experts:	Ms Odile BERGE, Avignon
	Mr Peter JEFFRIES, Kent, England
	Ms Claire NEEMA, Montpellier
	Ms Uta PASZKOWSKI, Lausanne, Switzerland
	Mr Pierre SAUMITOU-LAPRADE, Lille
	Mr Jan STENLID, Uppsala, Sweden
	Ms Birte SVENSSON, Lyngby, Denmark
	Mr Bruno TOURAINE, Montpellier

Representatives present during the visit

Scientific Delegate representing AERES:

Mr Steven BALL

Representative(s) of the unit's supervising institutions and bodies:

Mr Jean-Marc GUEHL INRA

Mr Pierre MUTZENHARDT University of Lorraine

Report

1 • Introduction

Date and conduct of visit:

The review committee visited the UMR IAM in Champenoux and Vandœuvre-les-Nancy on January 26-27, 2012. The first day, the presentation of research results and projects of the different teams/themes was made at Inra Campus located in Champenoux, in sessions opened to all members of the Unit. The program for the visit was organized with the scientific delegate of the AERES, the committee president and the present Director of the UMR IAM. The organization of the visit was fully satisfactory and the presentations were of very good quality. Starting the first day, a general presentation by the Director was given, including an interesting analysis of the positive consequences of the previous recommendations of the 2008 AERES evaluation on the improvement of the Unit management. In a second part, the research project of the Unit was presented by the future Director. Subsequently, scientific presentations were made team-by-team for results, and theme-by-theme for the projects (5 in total). The UMR IAM was organized in four teams during the last period, and will be composed of three teams working on five themes in the project. After each presentation of the team activities (results) and research themes (projects), the review committee discussed with the presenting team leader or his representative, with additional discussions including other members of the teams. A strict time schedule was maintained in which all team and theme speakers gave a 20 min (team) and 15 min (theme) presentation followed by 15 min for questions. At the end of the presentations of each team/theme, the review committee discussed the relative merits of each team/theme in a closed-door discussion. At the end of the first day, a one-hour general discussion meeting of the review committee was dedicated to global discussion during which first conclusions for each team/theme were collected. The second day was organized at the University Campus of Vandœuvre-les-Nancy. In the morning, the review committee received the different categories of the UMR IAM staff, namely technicians/engineers, post-docs/PhD students/masters, staff scientists, and present and future directors, as well as the deputy-director. The review committee had also a meeting both with the vice-president for Research of the Henri Poincaré University, representing the Head of University of Lorraine (UdL), and with the Head of the Department EFPA (Inra) accompanied by three staff members and by the president of the Inra Champenoux Campus.

History and geographical location of the unit, and overall description of its field and activities:

The UMR IAM was created in 2001 by Inra and the University Henri Poincaré (Nancy I), and is located on two sites: the main site is located at Inra Champenoux Campus (20 km East of Nancy, approx. 20-30 min by car) harboring about 75% of the personnel, and the second at the University Campus in Vandœuvre-les-Nancy, hosting the remaining 25% of the personnel. Approximately half of the research staff is from the University (eleven professors and assistant-professors), four of them performing their research activity in Inra Champenoux Campus. The UMR IAM is presently the largest French Institute devoted to integrative biology and ecology of tree-microbe interactions. The Unit has outstanding research in a number of areas including the redox regulation and metal homeostasis in plant, ecogenomics of the interactions (between plant, fungi and bacteria), and ecology of forest fungal pathogens. Most of the research projects use the tree Populus as a model. The UMR IAM has two main technology platforms: an ecogenomics platform in Champenoux including genomics, bioinformatics, cytology and fluorescent imaging, and a protein engineering platform in Vandœuvre, including production and purification of recombinant proteins and biochemical and enzymatic characterization.

Management team:

According to the 2008 evaluation recommendations, the management of the Unit has been improved during the last period: a Scientific Advisory Board including the management team (director and deputy-director), the four team leaders and 5 Inra representatives (1 DR, 1 CR, 1 ITA, 1 PhD Student, 1 Post-doc/CDD) and 5 University representatives (1 professor, 1 assistant-professor, 1 IATOS, 1 PhD student, 1 Post-doc/CDD), and a Service Council including 5 Inra representatives and 5 University representatives. There were three meetings per year of the Scientific Advisory Board and the Service Council. The reports are diffused to all the members of the Unit.

Unit workforce:

Workforce	**Number** on 06/30/2011	**Number** on 01/01/2013	2013-2017 **Number of producers****
N1: Professors or assistant professors	12	10	10
N2: EPST or EPIC researchers	11	10	10
N3: Other professors and researchers	1	1	1
N4: Engineers, technicians and administrative staff ***on a permanent position	22 (18.8)	21 (19.8)	
N5: Engineers, technicians and administrative staff * on a non-permanent position	2		
N6: Postdoctoral students having spent at least 12 months in the unit	17		
N7: Doctoral students	18		
N8: PhD defended	21		
N9: Number of Habilitations to Direct Research (HDR) defended			
N10: People habilitated to direct research or similar	10	9	
TOTAL N1 to N7	**83**	**42**	**21**

* **If** different, indicate corresponding FTEs in brackets.

** Number of producers in the 2008-2011 period who will be present in 2013-2017.

Definition and downloading of criteria:

http://www.aeres-evaluation.fr/Evaluation/Evaluation-des-unites-de recherche/Principes-d-evaluation.

2 • Assessment of the unit

Overall opinion on the unit:

The main goal of the UMR IAM is to investigate the complexity of the biotic interactions in agro-forest ecosystems, with special emphasis on integrative biology of the tree-fungi-bacteria interactions and the ecology of the corresponding associations. The review committee considers that the Unit has perfectly accomplished this mission. In these fields of research, the scientific impact of the Unit can be considered as outstanding, considering the quality and the impact of the journals in which the researchers have published their results. The UMR IAM is one of the world's leading laboratories in these research areas.

The overall feeling of all members of the UMR IAM with respect to the the previous management period is one of full support. They clearly are greatful to the management, and especially the director, implementing the Scientific Advisory Board and the Service Council, and for reorganizing the administration staff in a fashion well accepted by all Unit members.

Strengths and opportunities:

The UMR IAM has achieved an excellent scientific production, in particular in the fields of research of "genomics of plant-microbes interactions" and "redox regulation", evidenced by both the quantity of papers and also the high average impact factor of the journals in which they are published.

Their contribution to the paper recently published in Science (August 2011) on plant cell wall-degrading enzymes constitutes a new perspective for their studies on fungal diversity using genomics and metagenomics approaches, with potential applications in the field of second generation biofuels.

The establishment of the plaforms reinforced collaborations between the two sites and their functionning is appreciated by users.

The ratio "(assistant)-professors/researchers" is well-balanced ensuring efficient teaching in plant biochemistry and genomics.

The new director (January 1st, 2013) will be a Professor from the University of Lorraine. After several mandates of Inra directors since 2001, it represents an opportunity to reinforce the co-direction of the Unit by Inra and the University.

Weaknesses and risks:

The establishment of the UMR IAM in the two campuses of Inra and University of Lorraine is a great opportunity to maintain simultaneously close collaborations with ecology and plant research laboratories located in the Inra Campus and biochemistry laboratories located in the University Campus; furthermore, the presence in University Campus is important for an efficient involvement in teaching and for visibility towards students. However, the separation of its members in the two sites is also a weakness for the UMR IAM. The consequences on internal communication and collaboration difficulties were clearly laid out by the technicians-engineers and by the students (Masters, PhD, postdocs) during the meeting with the committee.

The new director will be a Professor of the University of Lorraine. It will be a big challenge for him to be present for a significant part of his time at Champenoux, and for that, he will need to be discharged of his teaching tasks at the University.

There is an important need of reinforced technical support from the University for the group located in Vandœuvre. The close retirement of several techicians/engineers will put at risk about the maintenance of critical technical competences.

The need to discharge the next director from his teaching tasks will require a compensation by recruiting an (assistant)-professor.

Whilst the reviewer committee appreciated the introduction of a Postgraduate Committee for each PhD student, there is no opportunity for the student to discuss concerns with the Postgraduate Committee in the absence of the supervisor.

Recommendations:

The excellent level of publication and the strategy of high impact publishing must be encouraged to further increase international visibility of the Unit.

The new organization of the Unit in five themes appears to be a strong motivation for all members the Unit.

This must be submitted to internal evaluation at mid-course of the next period (in 2 years) to ascertain its scientific added value with respect to the still existing three teams that are seemingly maintained for everyday life.

Internal communication must be improved through the organization of more frequent seminars of interest to all unit members on each site and through a more active intranet communication.

The excellence of the research has positive consequences on attractiveness. In the face of the ever increasing difficulty to recruit, the welcoming of technicians, engineers and researchers in the frame of national motility thanks to the Unit's attractiveness can be an appropriate answer to their ambition of reinforcing manpower.

Although funding seems secured for several years, applications to the national ANR grants or to European networks must be encouraged as well as the recruitment of foreign post-docs or the welcoming of international visiting scientists.

The unit should make sure that PhD students get a chance to discuss concerns with their Postgraduate Committee in the absence of their supervisor.

3 • Detailed assessments

Assessment of scientific quality and production:

During the period under consideration (from January 1, 2007 to June 30, 2011), the UMR IAM had an excellent output in term of publications (245 articles ranked A), representing an average of 3.5 publications per full-time scientist and per year. During this period, they published in 111 different journals with average impact factor equal to 4.7 (30 % with a IF greater than 6.0). Seventy percent of the publications have a scientist or a student of the Unit as a first and/or last author ("Unit papers", category 1 according to the AERES classification). Eighty percent of the publications involve at least one collaboration.

The most frequent journals are *New Phytologist* (32), *Soil Biology Biochemistry* (12), *Fungal Genetics and Biology* (8), *Plant Physiology* (7), *Journal of Biological Chemistry* (6) and *Applied Environmental Microbiology* (6). They also published in "generalist" high standard journals such as *Nature* (2), *Nature Structural & Molecular Biology* (1), *PNAS* (4) and *EMBO Journal* (1), and review journals such as *Annual Review in Plant Biology*, *Trends in Ecology & Evolution*, *Trends in Genetics*, *Trends in Microbiology*, *Trends in Biochemical Sciences*, *Trends in Plant Sciences*, and *Current Opinion in Plant Biology*.

Among the most cited papers published during the period under consideration, we can highlight the following original papers:

. the genome of *Laccaria bicolor* (*Nature* 2008, 185 citations) and the genome of truffle (2010, 48 citations)

. functional, strutural, and spectroscopic characterization of a glutathion-ligated [He-2S] cluster in poplar glutaredoxine C1 (PNAS 2007, 65 citations)

. redox sensitive GFP in *Arabidopsis thaliana* is a quantitative biosensor for the redox potential of cellular glutathion redox buffer (Plant Journal 2007, 60 citations)

. 454-pyrosequencing analyses of forest soils reveal an unexpectedly high fungal diversity (*New Phytologist* 2009, 57 citations)

. chloroplast monothiol glutaredoxins as scaffold proteins for ther assembly and delivery of [2Fe-2S] clusters (*EMBO* J 2008, 52 citations)

. transcript profiling of poplar leaves upon infection with compatible and incompatible strains of foliar rust *Melamspora larici-populina* (*Plant Physiology* 2007, 46 citations)

. PeroxiBase : the peroxidase database (*Phytochemistry* 2007, 43 citations)

and the following reviews :

. the mycorhiza helper bacteria (*New Phytologist* 2007, 83 citations)

. the role of glutathione in photosynthetic organisms (*Ann. Rev. Plant Biology* 2008, 82 citations)

. the fungal dimension of biological invasions (*Trends in Ecology & Evolution* 2007, 61 citations)

All the researchers and (assistant)-professors are publishing scientists according to AERES standards.

Assessment of the unit's integration into its environment:

Possible research applications translated into three patents and an ANR-OSEO award related to the first patent and supporting the creation of a company for innovative biotechnology (Trehalotech project 2008 "Biological diagnostic and quantification of trehalose"). Four regional awards were obtained and one for an innovative start-up creation (Trehalotech).

The members of the Unit are integrated into several communities and networks: national Inra network "EcoMic" (*Soil and Aquatic Microbial Ecology*), national networks "REID" (*Ecology od Sustainable Interactions*), "Effectomes", "R-Syst", "BML" (Molecular Biology of Trees), "Environmental Genomics" (CNRS-InEE), and GDRs CNRS "Redoxines" and "ComEvol" (Biotic interactions of Communities, Theory and Models). At the European level, they participated to Network of Excellence "EvolTree".

Three participations to national collective assessments: "Impact of global change on forests", "Adaptation to global change" and "Sustainable biomass production of the future", and about 50 participations to Science-Society debates.

They actively participate to the Poplar National Council (GIS "Peuplier"), and they published 16 papers in professional journals.

They contributed to a significant level of communications to the general public. For instance with respect the truffle genome project they advertised in several media such as radio, TV, newspapers, publications in national journals, and popular science publications. A wiki site about mycorrhiza and a blog on genomics and metagenomics were created and are maintained by members of the Unit.

Nine socio-economic partnerships: Agro-nutrition, INERIS, FCBA, Solvay, Suez Environnement-COFELY, SIAPP, ADEME, Région Paris Ile de France.

Their ability to obtain external funding seems very good with 15 projects funded by the ANR (French National Agency for Research), nine of them are coordinated by members of the Unit, 4 projects funded by EU (one as coordinator) and 4 genomics projects funded by the Joint Genome Institute (DOE, USA).

Assessment of the research unit's reputation and drawing power:

Several members of the UMR IAM have a high level of scientific recognition and some of them are considered as leading scientists in their respective field of research. The scientists of the Unit have been invited to give 72 oral contributions in international conferences. They have also organized 13 international conferences.

Members of the Unit participate to the editorial board of international journals: *Journal of Biological Chemistry*, *New Phytologist* (Section Ed.), *Fungal Ecology, Fungal Biology & Genetics* (Associate Ed.) and to the edition of special issues of journals such as *Advances in Botanical research*, *Photosynthetic Research*, *New Phytologist*, *Fungal Biology & Genetics*.

The members of the Unit received several distinctions and awards: the prestigious Gay Lussac–Alexander von Humboldt prize, the nomination of a senior (2007) and junior member (2009) of the "Institut Universitaire de France", a Gold Medal of the "Académie de l'Agriculture" (2010), a nomination as "Chevalier de l'Ordre du Mérite agricole", the "Suzanne Zivi" award from the "Académie de Stanislas" (2010), the "Chercheur de la Région Lorraine" (2007) prize, two "PhD thesis de la Région Lorraine" awards (2008 and 2010, and the "PhD thesis du PRES Lorrraine (2010)" prize.

They participate in a large number of national and international programs. For instance, members of the Unit coordinate the European project "EnergyPoplar" and the project "Plant-Microbes interactions" with the DOE Dpt (USA). They also coordinate or participate to five international consortia for the sequencing of fungal genomes.

Assessment of the unit's involvement in training:

Teaching and training activities of the Unit: in total 6630 hours (about 1310 per year) involving the assistant-professors (7) and professors (4), and also researchers for part of their time. The supervision of students is quite important (42 PhD thesis, 36 Master students). They contribute to the elaboration of 24 new teaching units and they coordinate two Masters.

The assistant-professors (7) and professors (4) are involved in the various university steering committees: head of IFR110 "EFABA" (*Forest Ecosystems*, *Agroresources*, *Bioprocesses and Food*), head of the Centre for Excellence of Science and Technology for Life and Environment (FABELOR), member of the executive board of the Department "Plant Biology, Genetics and Microbiology", members of the Council and the Teaching commission of the Biology sector of the Faculty of Science and Technology, members of the Scientific Council of the "A2F" pole (*Agronomy*, *Agrofood and Forest*).

During the last 5 years, 22 PhD thesis were defended, and 20 PhD thesis are ongoing. All PhD students are granted. Since 2009, they have a PhD monitoring committee (one or two meetings during the thesis). They are also strongly encouraged to participate in conferences (at least one international) and to follow external trainings. The average number of publications is 3.2 per PhD student (87 % as first or second author), and the average number of conferences is 3.4.

Thirty post-doctoral and contractual positions were employed with a mean period of 15 months. Six foreign scientists were invited with a mean period of 9 months.

Assessment of the unit's governance and life:

All the members of the Unit recognized during the meetings with the review committee the very important work done by the previous director and her deputy-director, especially considering the emphasis given to the human management based on collegial decisions and which was at the centre of the Unit's decision making life. They also made a very positive assessment of the Unit novel proposed structure including a better mutualisation of administrative tasks.

The functionning of the two platforms is unanimously appreciated, and the soon to come inaugural of the new building in Champenoux will offer new possibilities for the "Genomics", "Bioinformatics" and "Imaging" platforms.

All the members of the Unit also considered that the new organization in three teams for everyday life and in five themes for the scientific animation will improve the convergence of scientific objectives between teams, and especially between teams of the two sites (Champenoux vs Vandœuvre), through integrated and innovative approaches.

The next director being a professor must be discharged of the main part of his teaching activities to be present on the two sites on aregular basis.

The in-house scientific communication could be improved in order to increase the interactions between members of the two sites. This point seems to be crucial for the students.

Assessment of the strategy and 5-year project:

The Unit's scientific strategy for the coming period has been validated by the supervisory bodies. Indeed the University of Lorraine representative considers that the Unit plays a key role within the "A2F" pole (*Agronomy*, *Agrofood and Forest*), one the 10 "Poles" defined by the University of Lorraine In addition the Inra representatives have made clear that this defines, for them one of the most important in the field of "Forest Sciences" and certainly the most important one in "Forest Soil Microbiology", with an important and positive influence on the EFPA Dpt, and an active participation to the elaboration of the Inra "Meta-programs".

The scientific structuration into five themes can also be considered as a new strategy that encourages the emergence of innovative and integrated approaches potentially leading to the emergence of young scientific leaders.

The Unit has very good perspectives in allocation of means, as many contracts (regional, national and international) are ongoing.

The Labex "ARBRE" (*Advanced Research on the Biology of TRee and Forest Ecosystems*), coordinated by Inra (F. Martin) with the University of Lorraine and AgroPari'Tech as partners, was recently accepted (February, 2012). It will progressively integrate all the research activities dedicated to "tree" in Lorraine. This will be a very good scientific and financial opportunity for the Unit, especially if all the themes of the Unit are included in this Labex.

The detailed analysis of the 5-year project is given below theme by theme.

4 ● Project-by-project analysis

Project Theme 1: Stress response and redox regulation

Name of project leader: Mr Nicolas ROUHIER

Workforce

Workforce in Full-time Equivalents	06/30/2011	01/01/2013
FTE for professors or assistant professors	5.2	5.2
FTE for EPST and EPIC researchers		
FTE for engineers, technicians and administrative staff on a permanent position	1	1
FTE for engineers, technicians and administrative staff on a non-permanent position		
FTE for postdocs having spent at least 12 months in the unity	3	
FTE for doctoral students	9.5	
TOTAL	**18.7**	**6.2**

• Detailed assessments

This research project aims to understand the role of antioxidant and redox systems in poplar under environmental constraints and in the ligninolytic fungus *Phanerochaete chrysosporium*, by focusing on the molecular mechanisms and protein families involved in the regulation of carbon metabolism, of iron and redox homeostasis and of the oxidative stress response. The proposed research is with some reorientation and addition, due to new expertise (assistant-professor recruited in 2010, Chaire d'excellence INRA-UdL) and involvement in Theme 5 (0.6 FTE), in line with the previous research conducted at the international forefront on proteins, enzymes and metabolic pathways dealing with reactive oxygen species (ROS). In aerobic life, ROS are generated by various metabolic processes in different subcellular compartments. ROS are toxic and can cause destructive oxidation of DNA, proteins and lipids. Some ROS have signaling roles, but biotic and abiotic stresses can importantly increase the amount of ROS leading to oxidative stress at the cellular level. Since 2007, the group has focused on structure/function relationships of antioxidant enzymes of the thioredoxin, glutaredoxin, glutathione S-transferase, thiol peroxidase and methionine sulfoxide-reductase families, obtaining detailed insight at the molecular level of the catalytic mechanisms and mode of interactions.

Theme 1 is organized as three major tasks:
Task 1: Redox regulation of carbon metabolism enzymes by new plastidial thioredoxins (Trxs)
Task 2: The regulation of iron homeostasis by glutaredoxins (Grxs)
Task 3: Functional and structural characterization of glutathione S-transferases (GSTs)

Activities in Task 1 will be reduced during 2013-2017 due to the retirement of JP Jacquot likely at the end of the five-year period, while the arrival of the recently recruited assistant-professor increases activities in Task 3. Generally the methods and technologies required are available and benefit from established local, national and international collaborations. However, in particular for Tasks 2 and 3, physiological validation of the functional roles of proteins of interest will depend on successful development of genetic tools to obtain and analyze gene knockout or gene over-expression variants.

Task 1: Redox regulation of carbon metabolism enzymes by new plastidial thioredoxins (Trxs)

Focus will be on two atypical and poorly characterized Trx classes, Trx-like and Trx-lilium, and on two target enzymes, glucose-6-phosphate dehydrogenase (G6PDH) and sedoheptulose 1,7-bisphosphatase (SBPase). These excellent choices are highly relevant, thus G6PDH is regulated in the "opposite way" meaning active when oxidized and inactive when reduced; the redox regulation of the G6PDH P2 isoform remains to be identified and will be studied. Furthermore structural information is lacking and high yields obtained of the P2 isoform enable mutational analysis of functional roles of five cysteines, and crystal structures of oxidized and reduced forms will be determined (collaboration with Naples University). With regard to SBPase as a Trx target it is predicted to be redox regulated differently from the related fructose 1,6-bisphosphatase (FBPase) on the basis of structural differences. Previously only low amounts not suitable for crystallization have been obtained, but in a breakthrough last year during a 6 months visit to Bielefeld on the occasion of the Gay-Lussac-von Humboldt prize the SBPase was produced recombinantly in high yield making structure determination and mutational analysis of individual cysteine residues possible. The biochemical and enzymatic characterization of several Trx-like and Trx-lilium is underway and their activities with selected targets will be determined.

Comments/Conclusion:

Several reactions of Trx are still to be understood at the molecular level and the planned work on the structure, function and mechanisms of action of the poorly characterized Trx types and two very important Trx-target-enzymes addresses fundamental biochemical questions and extends previous research at the international forefront. In both Task 1 and Task 2, it will be of high interest to solve structures of covalent complexes of interacting proteins generated by the aid of site-directed mutagenesis. The various activities will undoubtedly lead to excellent publications and dissertations, and to invitations to conferences and institutions. The work involves both national and international collaborations. The originality and importance of the project should make it possible to get external funding. The leader of this task has an exceptional scientific profile being IUF member, receiving the Gay Lussac-von Humboldt prize and coauthoring a large number of publications in excellent journals for the field. He has also important international collaborations and invitations and has embarked on visionary unconventional studies, e.g. single molecule analysis by AFM with Fernandez at Columbia University (New York). The long-term continuation building on current and near future achievements is ensured by expertise available in the research group. Scientifically Task 1 activities are integrated with Tasks 2 and 3 and the fundamental insight obtained in Task 1 is relevant for research in three other themes (Themes 2, 3 and 5) of the Unit.

Task 2: The regulation of iron homeostasis by glutaredoxins (Grxs)

Iron is essential for the formation of different metalloproteins and in particular in plants. Very little is known about the regulation and reaction pathways involved in the biosynthesis of Fe-S cluster proteins essential for fundamental processes in phytosynthesis, respiration and nitrogen and sulfur assimilation. Guided by reports on glutaredoxin playing a role in Fe-S assemblies in yeast, evidence is emerging for plant Grxs having potential to serve as scaffold or carrier proteins, thus a plant Grx was shown to transfer its cluster to a recipient protein. This is groundbreaking and numerous facets of how this happens at the structural level and the regulatory mechanism driving it offer highly interesting questions to be addressed. A project will be developed to uncover the roles of plant Grxs in Fe-S cluster biogenesis or iron sensing and in oxidative stress caused by iron and ROS. To identify involved Grxs requires a multidisciplinary approach including genetics, physiology, cellular biology and biochemistry, because Grxs are found as large multigene families and iron and ROS are present in most subcellular compartments and as different assembly systems. Candidate Grxs will be produced and characterized and analysis of their ability to incorporate Fe-S clusters will be evaluated under different environmental conditions by gene knockdown and overexpression in Arabidopsis thaliana.

Comments/Conclusions:

Task 2 consists of novel multidisciplinary endeavors at the international forefront towards unraveling roles of Grxs in plants by gaining insights spanning from three-dimensional structures and mechanisms of protein interactions to genome-wide transcriptome analysis of plants having a macroscopic phenotype. This is truly relevant and very original research and the responsible for Task 2 is a young professor with an outstanding profile as an IUF member, which provides funding to the project. Also to be mentioned, this young professor is an editorial board member of the Journal of Biological Chemistry, and senior author on several publications in top journals for the field reflecting the excellent recognition by the international community of the young research leader of Task 2. The planned research involves both national and international collaborations and will undoubtedly lead to high-impact publications, including on new protein structures of poorly studied enzyme classes, several dissertations and invitations to conferences and institutions. Funding is in place for the coming years and there is due to the relevance, quality and originality of this transdisciplinary collaborative research, a strong potential for raising more grants. The current well established scientific and technical basis and the expertise available in the research group provides a fine frame ensuring achievements to be obtained as planned. Scientific activities in Task 2 are integrated with those in Tasks 1 and 3 and the work has relevance for research in Theme 5.

Task 3: Functional and structural characterization of glutathione S-transferases (GSTs)

GSTs constitute a protein superfamily showing important diversity with regard to functional roles and reaction mechanisms supported by phylogenomic analysis. Activity-based profiling and ligand-fishing will be applied in collaboration with synthetic chemists and biophysicists from LERMAB and Crm2 (University of Lorraine). This will aim at identifying and characterizing biochemical and structural properties of individual GSTs from plants and fungi typically containing 50-90 and 10-40 GSTs, respectively, categorized into seven classes, two of which are specific to plants and four to fungi. The aim is for poorly characterized fungal isoforms to uncover functional properties combined with *in vivo* gene overexpression or inhibition (collaboration with the University of Bristol). This pioneering work will facilitate assigning function to unknown GSTs and such functional mapping of GSTs may be important in relation to wood preservation using GST inhibitors and enabling fungicide development. Moreover GSTs may serve as biomarkers for the presence of xenobiotics or wood degradation stages. In plants, GSTs catalyze detoxification of herbicides and emerging insight draws attention to GST-catalysed glutathionylation of proteins, metabolites and xenobiotics. Certain GSTs in vitro show peroxidase activity and one most timely and very important goal is to unravel structure/function relationships of several GST types to assign functional properties and mode of action to the different GST classes. Validation in vivo will take place in external collaborations.

Comments/Conclusions:

There is a great need to ensure further advancement of the growing knowledge on biological roles and structure/function relationships of members of the GST protein superfamily. Three members involved in this Theme 1 hold strong expertise in *Phanerochaete chrysosporium* and plant GSTs and generation of ROS. One challenge despite the interaction with expertise at the University of Bristol is to get a sufficiently feasible basiodiomycetes transformation system. In collaboration within Theme 5, they address post-genomics analysis of plant-pathogen interactions for the poplar-poplar rust system as well as resistance proteins. Task 3 activities include various lines of novel emerging research with international and national collaborations, and will provide high-impact publications on poorly studied enzymes, dissertations and invitations to conferences and institutions. Funding is in place for coming years and there is strong potential for raising more grants for this transdisciplinary collaborative research. The available technologies and strong scientific background ensure future discoveries in biology and enzyme chemistry. Scientific activities in Task 3 have relevance for Tasks 1 and 2 and there is integrated activity with other themes of the Unit, in particular Theme 5.

Conclusion:

The research plans and researchers engaged in Theme 1 belong at the international forefront in a very demanding field and have good technology access, collaborations and funding, which altogether represent a truly important *Strength*.

The *Opportunities* are given by the multidisciplinary approach and the possibility to benefit from researchers with distinguished profiles and established international and national collaborations.

Weaknesses include lack of established routine access to systems for *in vivo* studies and validation, shortage of technical staff and few postdoctoral fellows.

Risks exist both in some of the ambitious scientific plans and in the continuation of funding also for infrastructure of the Unit, but the members of Theme 1 have an excellent scientific level suitable for addressing "high risk/high gain" research problems.

Recommendations: It is recommended to secure possibilities to pursue the structural biology leading to novel insight into how the various proteins are interacting and recognizing each other, to address the numerous open questions on the formation and regulation of iron-sulfur cluster proteins, including to attract young researchers, postdocs and PhD students more aggressively to increase the experimental activities, and to work towards assuring access to in vivo validation, perhaps by encouraging formalizing a facility for poplar transformation. It will moreover be important to provide special support to secure the seamless collaboration between proteins crystallographers at the University of Lorraine and Theme 1.

Project Theme 2: Molecular interactions between soil bacteria, fungi and trees

Name of project leader: Mr Francis MARTIN

Workforce

Workforce in Full-time Equivalents	06/30/2011	01/01/2013
FTE for professors or assistant professors	3	3.3
FTE for EPST and EPIC researchers	2.65	2.15
FTE for engineers, technicians and administrative staff on a permanent position	3.6	3.6
FTE for engineers, technicians and administrative staff on a non-permanent position		
FTE for postdocs having spent at least 12 months in the unity	7	
FTE for doctoral students	14	
TOTAL	**30.25**	**9.05**

- Detailed assessments

An advanced know-how on forest soil functioning is required to design integrated strategies for the preservation and/or sustainable exploitation of forest environments. A wide variety of abiotic and biotic factors modulate and impact on the productivity of forest soils. Biological research on this complex and difficult-to-access ecosystem is often limited to studies on individual species or single organism interactions. In contrast, Theme 2 presents comprehensive mechanistic approaches to decipher the molecular mechanisms involved in the complex network of interactions connecting tree roots to soil resources via mycorrhiza fungi and rhizospheric bacteria. The proposed research addresses specific questions, corresponding to four tasks. The complementary expertise combined with the critical mass of the project members have placed this Theme 2 in a unique and international leadership position to effectively and meaningfully carry on this ambitious project which aims at unravelling forest soil functioning on a systems level.

Theme 2 is organized as four major tasks:
Task 1: Genomics and genetics of mineral weathering bacteria
Task 2: Molecular mechanisms of fungal-bacterial interactions
Task 3: Comparative genomics of forest soil fungi
Task 4: Molecular networks controlling symbiosis development

Task 1: Genomics and genetics of mineral weathering bacteria

Among the forest soil 'prokaryomes', mineral weathering bacteria as well as mycorrhiza helper bacteria (MHB) are of central importance for soil dynamics and thus, for tree performance. Surprisingly, the scientific community studying these bacteria consists of few laboratories. Among these, the Champenoux group is leading as reflected by the number and quality of publications and invited reviews. They collaborate with international laboratories of related scientific interests in Europe and the USA; further expanding multidisciplinarity and thus strength. For the upcoming five years highly original and in itself streamlined research has been proposed: Task 1 seeks to functionally study mineral weathering genes. The first bacterial mutants are available that permit to assign functions to genes and to apply the latter to designing the first molecular forest soil fertility array.

Task 2: Molecular mechanisms of fungal-bacterial interactions

Task 2 aims at unravelling the function of molecular determinants in either organism of the plant-fungal interaction and extends beyond the discovery of the first crucial bacterial component, the type III secretion system.

Comments/Conclusion to tasks 1 and 2:

For both tasks the respective bacterial genetic material and characterization assays have been established, promising a rapid progress of each project. The swift advancement of the functional characterization of fungal genes will largely depend on the generation of mutants resulting from either random mutagenesis or targeted disruption of chemotropism genes. The expected results have the potential to be published in high-ranking journals that will increase the visibility of this exciting research field and will invite to expand its scope. In consequence, it can be expected that the opportunities for rising external funding and for proposing further innovative activities will follow.

Task 3: Comparative genomics of forest soil fungi

For a long time the leader of Theme 2 has been known for excellence in ectomycorrhizal research. Over the past years he has additionally become one of the world's leading genome biologists. The comparative genomics work proposed in Task 3 is a logical and immediate continuation of the on going massive sequencing activities of fungal genomes performed in conjunction with the Joint Genome Institute (USA) and large international consortia. Consequently, a large group of international researchers is involved in the generation as well as the mining of the data, which, in the past, has enabled numerous publications in high-ranking journals, including Nature. These efforts would not have been possible without the strong support by national and international funding agencies/ programs. The future resource will contain representative genomes of all fungal taxa and will serve the mycological research community worldwide. Embedded within these efforts is the sequencing of 25 ectomycorrhizal and several wood decaying fungal genomes that will enable to address questions of central relevance for forest soil productivity such as e.g. differences in the genetic make-up of ectomycorrhizal fungi exhibiting variable benefit on economically relevant trees or the continuum between saprophytic and symbiotic life-style.

Comments/Conclusions to task 3:

The expertise in genome biology, the leading role of the group leader in international genomics research networks, the strong support by national and international funding agencies/programs and the relevance of the scientific questions addressed guarantee that original and important results with high-ranking journals publication potential will be obtained and provided to the mycological research community world-wide. Through this task, the leading position of the Unit in mycorrhiza and tree biology will be reinforced.

Task4: Molecular networks controlling symbiosis development

The intimate relationship between plant and ectomycorrhizal fungi not only leads to a bidirectional exchange of nutrients but also to a striking modification of host root architecture that involves the plant hormone auxin. Members of Theme 2 have applied comparative genomics to computationally search for small-secreted proteins that potentially could serve the function of fungal effectors in reprogramming the host for symbiosis, including root architectural modulations via auxin signaling. They have identified a number of mycorrhizal induced small-secreted protein (MiSSP) from *Laccaria bicolor* and recently published the functional characterization of MiSSP7, the first effector from ectomycorrhizal fungi. In future, the possible crosstalk between MiSSP and auxin signaling pathways in poplar will be investigated as well as poplar MiSSP identified among the small-secreted proteins expressed during symbiosis with L. bicolor.

Comments/Conclusions to task 4:

Task 4 continues these successful activities and outlines an exciting future experimental concept that embraces functional studies in the fungus and the plant to unravel the molecular network in their principal ectomycorrhizal model organisms. The required tools such as mutagenesis on poplar and L. bicolor are in place in laboratories of the respective collaborators.

Conclusion:

Overall, the projected work is of excellent quality and originality, and is also realistically designed. The complementary expertise combined with the critical mass of the project members have placed this Theme 2 in a unique and international leadership position to effectively and meaningfully unravel forest soil functioning on a systems level.

Strengths and opportunities:

The expertise in genome biology, the leading role of the group within international research in mycorrhizae and more generally in mycological genomics, the strong support by national and international funding and the focus on model systems represent Strengths of outstanding importance The Opportunities are manifested in the identification of new genes and regulatory networks for deciphering the variability of mechanisms involved in mycorrhizal interactions through leading massive international sequencing programs, and by the proposal of a novel exciting experimental concept based on mycorrhizal induced small-secreted protein (MiSSP).

Weaknesses and risks:

The only weakness of this Theme identified by the panel is the lack of a poplar transformation platform on campus (see recommendations, below). Risks were judged as negligible.

Recommendations:

The panel has noticed that Task 4 of Theme 2 (and several tasks) would benefit from the availability of a poplar transformation platform on campus to facilitate and accelerate work related to functional and/or cellular analyses in this important model plant. This platform could serve the needs of a number of laboratories, and would additionally contribute to interactions across the members of the different themes and the two sites of the Unit. They also discussed the desire to see some action with respect to proteomics and metabolomics of ectomycorrhizal association as promised in the presentation by the leader of Theme 2.

Project Theme 3: Ecology and role of forest microbial communities

Name of project leader: Mr Marc BUÉE

Workforce

Workforce in Full-time Equivalents	06/30/2011	01/01/2013
FTE for professors or assistant professors	0.2	0.9
FTE for EPST and EPIC researchers	4.55	3.05
FTE for engineers, technicians and administrative staff on a permanent position	3.6	3.6
FTE for engineers, technicians and administrative staff on a non-permanent position		
FTE for postdocs having spent at least 12 months in the unity	7	
FTE for doctoral students	5.5	
TOTAL	**20.85**	**7.55**

- Detailed assessments

An advanced know-how on forest soil functioning is required to design integrated strategies for the preservation and/or sustainable exploitation of forest environments. Characterization of the functioning of an ecosystem relies to a large degree on knowledge about the identity of the abiotic and biotic determinants and the magnitude of their respective influence on ecosystems dynamics. Nutrient and carbon cycling is of central relevance in forest ecosystems and includes trees, saprophytic and mycorrhizal fungi.

Theme 3 is organized as four major tasks:
Task 1: Structure and functioning of the bacterial communities involved in mineral weathering
Task 2: Diversity of the fungal communities and role in C and N cycles
Task 3: Role of fungal-bacterial interactions in soil functioning
Task 4: Metagenomics of forest soils

Task 1: Structure and functioning of the bacterial communities involved in mineral weathering

Task 1 aims at studying the ecology of the bacterial communities involved in the mineral weathering process in forest soils by using cultivation-dependent and -independent technologies. Metagenomics is used as a diagnostic tool (linked with Task 4) and generates a signature of the microbial community for comparative approaches, such as e.g. in diverse ectomycorrhizospheres or in soils of varying characteristics (partly in collaboration with Research Unit BEF in Inra Champenoux Campus). Beyond diagnostics, determining the spatial distribution of mineral weathering bacteria in the soil by FISH will provide an important survey over bacterial species distribution as a function of the soil mineral composition.

Comments/Conclusion to task 1:

Together with Task 2 of Theme 1, this work revisits the geomicrobiology of the tree rhizosphere. The work is closely related to the identification of the functional genes involved in mineral weathering ability of bacteria that will make this research really original. Development of new tools as bioassay and collaboration with BEF are strengths of this program. It can be anticipated that metagenomics will yield an overview on the bacterial diversity of the ectomycorrhizosphere and therefore represents a "no-risk" approach. FISH on soil organisms is technically rather challenging but appears to have been established in the group. The suggested work therefore is feasible and should reveal a signature of the bacterial community in the respective ectomycorrhizosphere and moreover, the spatial distribution of selected bacterial species. It would have been desirable to include the identification of the functional genes involved in mineral weathering ability of bacteria, which would have linked this task to Task 1 of Theme 2.

Task 2: Diversity of the fungal communities and role in C and N cycles

The objective of this task is to characterize the mechanisms driving the structure of fungal communities in forest soils from micro- to macrogeographical scales. The effect of changes in tree phenology and forest managements on the shift of species assemblages through carbon allocation will be specifically investigated. Combining the determination of molecular DNA patterns with characteristic transcriptomic profiles will allow not only to monitor the presence but also the transcriptional activity of soil microbes in a specific environmental context, and therefore can be expected to generate important molecular markers for forest soil dynamics (complementing Theme 2, Task 1). Another powerful methodological combination applies isotope labeling with metatranscriptional analyses to clarify the carbon uptake capability of ectomycorrhizal fungi from decomposition of organic matter.

Comments/Conclusion to task 2:

Task 2 lies at the heart of Theme 3 as the proposed combination of metatranscriptomics and radioactive isotope labelling will provide information on forest soil "activity", and includes nutrient cycling, tree nutrition, or enzymes involved in wood decay. It outlines an exciting future experimental concept that embraces functional studies in the fungus and the plant to unravel the molecular network in their principal ectomycorrhizal and saprophytic model fungi. The required tools such as mutagenesis on poplar and *Laccaria bicolor* are in place in laboratories of the respective collaborators. The combination with microcosm experiments will permit to define individual parameters central to the functioning of forest soil dynamics.

Task 3: Role of fungal-bacterial interactions in soil functioning

This task aims at a better understanding of the in situ functioning of complex fungal-bacterial consortia in forest soils. Addressed are two reciprocal questions: how bacteria modulate the activity of the fungi and conversely how the fungi contribute to the structure and the activity of the bacterial communities. The group has settled on three fungal model systems, two ectomycorrhizal fungi, the ascomycete *Tuber melanosporum* and the basidiomycete *Laccaria bicolor* plus the wood decaying *Phanerochaete chrysosporium* to perform comparative studies, regarding the continuum from saprotrophism to mutualism as well as their preference to cooperate with specific strains of mycorrhiza-helper bacteria (MHP). In accordance with Theme 2/Task 2, the focus will be on signaling and trophic hypothesis.

Comments/Conclusions to task 3:

Investigation of bacterial diversity in the three model systems is a very interesting way to address the role of bacteria in their biotic interactions with fungi in soils. In this complex environment, determining the spatial distribution of bacteria by FISH would provide an important survey over bacterial species distribution and their respective comparative niches, namely mycorrhizosphere, fruiting bodies and decaying wood.

Task 4: Metagenomics of forest soils

This task is mainly devoted to technology development to explore the forest soil microbiome mainly by rDNA pyrosequencing and metatranscriptomics. The objective is to characterize prokaryotic and eukaryotic genes expressed in relation to environmental fluctuations or perturbations associated with nutrient cycling. It therefore will provide the needed genomics resources for Tasks 1, 2 and 3, to determine microbial species and the transcriptional activity from a variety of environments.

Comments/Conclusions to task 4:

Task 4 continues the successful genomics activities and the establishment of metatranscriptomics among the genomics toolbox represents an important addition. However, RNA-Seq approaches to forest soils are technically particularly challenging and the success of this project relies on the US collaborators to master this complex biological diversity. The leading contributor of this Task 4 will be confronted with a number of challenges due to his previous background in metal homeostasis and bioremediation.

Conclusion:

Strengths and opportunities:

The proposed work largely pioneers techniques for the documentation of forest soil properties. The combination of Task 2 and Task 4 promises to provide a valuable insight into forest soil functioning and to make major contributions to the field. Furthermore, the quality of the expected data is very original and addresses ecosystem activity in addition to composition. Furthermore, both tasks are well integrated into the activities of the Unit.

Weaknesses and risks:

In contrast, Task 1 was perceived as suboptimally matching the research subjects of Theme 3. Task 3 must be the priority of this Theme 3, because of its originality and its connection to Theme 2, which must be reinforced. The Task 3 focuses on studying MHP at defined niches (mycorrhizosphere, fruiting body and decaying wood) and on the signalling and trophic hypotheses. It would also have been desirable to include functional analyses into the planned work on these prokaryotic microbes to provide answers to more profound questions.

Overall the review committee is concerned about the leadership of Theme 3 since streamlining seems necessary to concentrate manpower on clearly defined research lines of central interest. In contrast to some of the other Themes, rather young scientists lead the tasks of Theme 3. Along the same line, it was rather surprising that Theme 3 was not presented by its group leader but by a colleague who only recently joined the unit.

Recommendations:

In general the panel suggests evolution of Theme 3 according to the concluding comments and possibly a change in management to coordinate compatible activities in a more cost and manpower effective fashion.

Project Theme 4: Ecology of forest diseases in a context of global change

Name of project leader: Mr Benoît MARÇAIS

Workforce

Workforce in Full-time Equivalents	06/30/2011	01/01/2013
FTE for professors or assistant professors		
FTE for EPST and EPIC researchers	1.7	2
FTE for engineers, technicians and administrative staff on a permanent position	2.7	2.7
FTE for engineers, technicians and administrative staff on a non-permanent position		
FTE for postdocs having spent at least 12 months in the unity		
FTE for doctoral students	5	
TOTAL	**9.4**	**4.7**

- Detailed assessments

Biosecurity has become a very popular research area, especially when linked to climate change. Theme 4 focuses on this topic through the investigation of the ecology of forest pathogens. Forest tree epidemics have great significance worldwide issue and thus have particular relevance in France in the agroforestry industry. Recent outbreaks of sudden oak death (*Phytophthora ramorum*), acute oak decline, horse chestnut-bleeding cancer, and established epidemics of dutch elm disease (*Ophiostoma ulmi*) and chestnut blight (*Cryphonectria parasitica*) have all impacted on European forests and commercial plantations. Pathogens such as sudden oak death have the potential to kill large numbers of trees and thus seriously to reduce the biodiversity and visual quality of our rural environments. The team comprises experts with a breadth of knowledge and the appropriate experience to tackle the questions they pose and thus make an impact on understanding and control of forest disease.

Theme 4 is organized as two major tasks:
Task 1: Determining the causes of forest tree disease emergence
Task 2: Measuring dispersal and evaluating its evolutionary consequences during disease spread

Task 1: Determining the causes of forest tree disease emergence

Disease incidence caused by *Sphaerosis sapinea* (*Diplodia pinea*) and *Dothiostroma* has increased significantly over the last 15 years, possibly due to climate change, whilst oak mildew (Erysiphe alphitoides) has long been widespread but is favoured by climate warming. *Phytophthora cinnamomi* and *Cryphonectria parasitica* are both widespread and well-documented diseases, which may also be exacerbated by global warming. All five chosen diseases are important pathogens within agroforestry and cause significant economic losses. The potential impact of these studies needs to be explored in relation to recommendations for control. The team will approach this task by using these 5 disease scenarios to understand the underlying mechanisms of disease emergence such that new models can be developed for future predictive use. A database approach will be used to define functional groups within the pathogen population and to study phenological synchrony between host and pathogen.

Task 2: Measuring dispersal and evaluating its evolutionary consequences during disease spread

Chalara fraxinea is a recently emerged disease of alders and little is known of its biology and epidemiology, thus justifying additional work on mechanisms of dispersal and life history. In contrast, *Melampsora larici-populina* (poplar rust) is well known, its genome is sequenced and many epidemiological studies have been conducted. This fungus is the subject of investigation in Theme 5 and this justifies its inclusion also in Theme 4. The team is well placed to use specific locations in France (e.g. Durance Valley) to study regular disease epidemics of poplar rust and model the disease spread and the evolutionary consequences of these patterns of dispersal. Collaboration with Avignon modellers will be an important aspect of the work.

It is worth noting that this research area is very important in relation to national policies and Inra's strategy, but it is not a subject area for ground breaking academic research. Plant disease epidemiology is a very practical subject and involved much routine collection of data and analysis before innovative conclusions can be drawn. Nevertheless, the amalgamation of younger personnel who are experienced in the molecular aspects of genome evolution into Theme 4 will bring the original theme members closer to the Unit's overall mission.

Conclusion:

Strengths/opportunities:

The two tasks represent two distinct and logical pieces of work. They are feasible, relevant to important issues of biosecurity and climate change, and will interface with other themes. The group is small and is the only theme where only one scientist contributes by more than 50%. The proposed project is well defined and should be feasible despite the small size of the group.

Theme 4 comprises a small team with skills in plant pathology, epidemiology, population genetics, molecular biology and climate change. The theme and its members are adequate to address their aims and contribute to the regional and national agenda. Relative to the other themes, this group are not so strong in relation to scientific outputs and reputation, but to some extent this is a consequence of the nature of the area of research. Overall this theme has an important albeit peripheral place within a Unit with an international lead in tree/microorganism interactions. They have a good relationship to Theme 5 and link to Theme 3, and good past history of experience in this area. Influx of additional modelling and molecular expertise via young researchers will complement the traditional skills well.

The tasks proposed within this theme are appropriate, bearing in mind comments on financial sustainability and small size of the Theme 4 group. The sharing of personnel between Themes 4, 3 and 5 will ensure a cross-fertilisation of ideas and expertise and will bring innovative practice into what was a fairly solid but traditional group.

Weaknesses/threats:

The small size of the team means that they will be particularly compromised if any members leave the group or are unable to contribute for a significant period of time. The topic area is a difficult one to obtain external funding, as it is not always seen as 'ground-breaking' research. This threatens long-term sustainability.

Recommendations:

Develop a contingency plan should future competitive funding not materialise. Ensure that the statistical analyses are supported by additional collaborative input. Encourage a more outward facing culture within the theme, to engage more with international activities and partnerships.

Project Theme 5: Mechanisms and evolution of the poplar-poplar rust interaction

Name of project leader: Mr Sébastien DUPLESSIS

Workforce

Workforce in Full-time Equivalents	06/30/2011	01/01/2013
FTE for professors or assistant professors		
FTE for EPST and EPIC researchers	1.7	2
FTE for engineers, technicians and administrative staff on a permanent position	2.7	2.7
FTE for engineers, technicians and administrative staff on a non-permanent position		
FTE for postdocs having spent at least 12 months in the unity		
FTE for doctoral students	2.5	
TOTAL	**6.9**	**4.7**

- Detailed assessments

The group involved in Theme 5 has been leading the first published genome project on plant pathogenic biotrophic rusts. The published track record of the group is very good. The research planned for this theme has contributions from the groups working on "Stress responses and redox regulation", "Ecogenomics of the interaction", and "Ecology of forest pathogens". For future research, the work will be organised under heading of "Mechanisms and evolution of the poplar-poplar rust interaction". The group has a clear vision of what to do and the choice of topics is highly relevant.

Theme 5 is organized as five major tasks:
Task 1: Molecular bases of the R-Avr interaction
Task 2: Post-genomic analysis of the poplar-poplar rust interaction
Task 3: Role of fungal-bacterial interactions in soil functioning
Task 4: Evolutionary implications of the breakdown of a qualitative resistance gene
Task 5: Evolutionary quantitative genetics of disease-associated traits

Task1: Molecular bases of the R-Avr interaction

The task will look for resistance genes from the host and virulence/avirulence genes of the pathogen. Genome resources for the host and pathogen are used to extract candidate genes for this. The host genes are selected from approx. 400 R-gene candidates. For the pathogen, 20 small-secreted proteins are selected from the rust for deeper sequencing and five selected for functional studies. Timing for expression of host and pathogen genes will serve as one base for selecting candidate genes.

Comment:

The choice of studies is logic based on the previous work. Of particular interest is the characterization of small secreted proteins that are identified in the *Melampsora larici-populina* genome and that are thought to possibly be acting as effectors of host immunity. By successfully leading a spearhead genome project on the rust fungus, the group is very well positioned to be able to generate novel information on the host-pathogen cross talk.

Task 2: Post-genomic analysis of the poplar-poplar rust interaction

Expression studies and genome analysis generate candidate genes for interaction characterization. In this task, genes not previously indicated as R/Avir genes will be in focus. State of the art protein characterisation and plant transformation will be performed partly in collaboration with other groups. An effector delivering screening system in *Arabidopsis* will be used in collaboration with a Canadian laboratory. Interesting candidates from the host already identified are a thaumatin-like protein and a major defence response gene shown to have strong effects on *Melampsora* development. Fungal genes of interest include small-secreted proteins under diversifying selection. Recombinant proteins will be studied *in planta*.

Comment:

The interaction studies are central to the understanding of poplar-rust interaction. A potential factor that might slow down some of the analyses of the fungal genes is that a functional transformation system for the fungus is not fully in place. This is also the case for the inter-American poplar hybrids; the initial transformation and expression tests should be encouraged.

Task 3: Study of resistance proteins

One major QTL for rust resistance has been identified, including a NB-LRR gene (rus) inherited from *Populus trichocarpa*. Another QTL including the gene R1 has been inherited from Populus deltoides. Gene product localisation will be investigated *in planta* using GFP fusions. 3D-structure and enzymatic activities will be studied. Interacting proteins from the fungus will be searched for using chromatographic approaches. Physical interactions will be studied using e.g. surface plasmon resonance.

Comment:

Detailed characterisation is key to the understanding of host-pathogen interaction.

Task 4: Evolutionary implications of the breakdown of a qualitative resistance gene

Recently the R7 resistance gene widely used in e.g. the widely planted poplar clone Beaupré has been overcome by M. *larici-populina* in the field. This task will take a population genomic approach to find loci under selection. About 90 000 SNPs are available for genotyping a set of fungal isolates originating before and after 1992, the year for breakdown of the host resistance. During the presentation of Task 4, we were informed that already 40 fungal strains have been completely sequenced.

Comments:

This is a highly valuable approach that should be able to identify genetic markers in linkage disequilibrium with the vir/avir 7 locus. In addition to the Avr 7 locus, it would be possible to also associate with other virulence genes provided that a careful phenotyping will be carried out.

Task 5: Evolutionary quantitative genetics of disease-associated traits

Quantitative measures of several steps in the rust life cycle in relation to host infection will be measured for natural populations of M. *larici-populina*. Then a genetic linkage map will be constructed, and QTLs will be mapped to the fungal genome. The linkage map is also useful in order to improve the genome assembly of M. *larici-populina*.

Comments:

Provided that large enough offspring can be obtained and analysed from the rust lines, the QTL approach can reveal strong indications of the genetic background for important stages in rust infection development on the host.

Conclusion:

The overall impression is that the group that is now constituted for the poplar and rust research had a very good period of research over the last five years. It has established a world leading position and will with the new organisation now be able to more clearly focus on the system.

Strengths/opportunities:

The team has a wide world leading expertise spanning from oxidative reactions and characterizing proteins over evolutionary and molecular population ecology to genomics of fungi and trees and into interaction biology. The proposed research programme for the upcoming time period is very ambitious and builds on these strengths to explore various aspects of the pathosystem. In particular the population genomic approach holds many promises. A particular opportunity lies also in the possibility to build a tight collaboration on characterizing processes and molecules important to host pathogen interaction. A very good basis for most of the proposed work is the availability of genome sequence information for both the pathogen and members of the host genus. A collection of fungal isolates representing various ecological and pathogenic lines is available.

Weaknesses/threats:

The downside of the broad expertise is the challenge in making different fields work together. This requires a build-up of team spirit; something that the site visit and presentations clearly showed is in place. Also the communication channels with tree breeders are necessary to establish/maintain in order to get the best impact of the research. For the interaction work to be fully successful, transformation systems are in need in order to firmly confirm findings.

Recommendations:

In order to lead the future development it is recommended that the team seek to find novel aspects of host pathogen interactions. The post-genomic analysis and the association mapping approach hold good promises for this. The proposed studies are highly relevant and can also generate important information for poplar management.

5 • Grading

Once the visits for the 2011-2012 evaluation campaign had been completed, the chairpersons of the expert committees, who met per disciplinary group, proceeded to attribute a score to the research units in their group (and, when necessary, for these units' in-house teams).

This score (A+, A, B, C) concerned each of the four criteria defined by the AERES and was given along with an overall assessment.

With respect to this score, the research unit concerned by this report received the overall assessment and the following grades:

Overall assessment of the unit **Tree-Microbe Interactions (IAM)** :

Excellente unité à tous points de vue.

Grading table:

C1 Scientific quality and production.	**C2** Reputation and drawing power, integration into the environment.	**C3** Laboratory life and governance.	**C4** Strategy and scientific project.
A+	**A+**	**A+**	**A+**

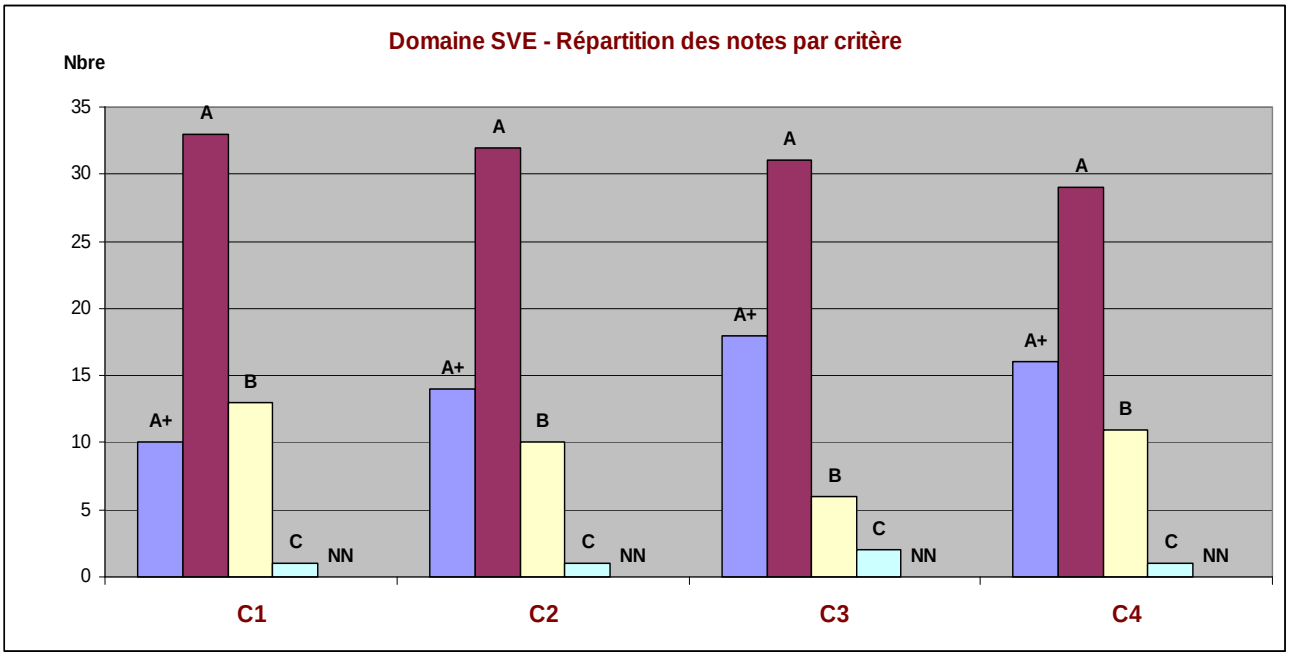
6 • Statistics per field

Notes

Critères	C1 Qualité scientifique et production	C2 Rayonnement et attractivité, intégration dans l'environnement	C3 Gouvernance et vie du laboratoire	C4 Stratégie et projet scientifique
A+	10	14	18	16
A	33	32	31	29
B	13	10	6	11
C	1	1	2	1
Non noté	-	-	-	-

Pourcentages

Critères	C1 Qualité scientifique et production	C2 Rayonnement et attractivité, intégration dans l'environnement	C3 Gouvernance et vie du laboratoire	C4 Stratégie et projet scientifique
A+	18%	25%	32%	28%
A	58%	56%	54%	51%
B	23%	18%	11%	19%
C	2%	2%	4%	2%
Non noté	-	-	-	-



7 • Supervising bodies' general comments

UNIVERSITÉ DE LORRAINE

Date 10/04/2012

L'Administrateur Provisoire
Jean-Pierre Finance

à

Monsieur Pierre GLORIEUX
Directeur de la section des unités de l'AERES
20 rue Vivienne
75002 PARIS

Objet : rapport d'évaluation de l'UMR IAM
Référence du document : C2013-EV-0542493S-S2PUR130004732-RT

Monsieur le Directeur,

Vous m'avez transmis le 7 mars dernier le rapport d'évaluation de l'UMR « Interactions Arbre-Microorganismes » et je vous en remercie.

Je vous prie de trouver ci-dessous les éléments de réponse de Madame P. Frey-Klett, directrice de l'unité, ainsi que celle de Monsieur E. Dreyer au titre de l'INRA, établissement cotutelle de cette structure.

En tant que tutelle du laboratoire nous apprécions les commentaires extrêmement positifs du Comité d'évaluation et n'avons pas de remarque particulière à émettre sur son rapport. Nous prenons bonne note de ses recommandations qui nous semblent tout à fait recevables à ce jour.

Je vous prie d'agréer, cher collègue, l'expression de mes sentiments distingués.

L'Administrateur Provisoire

Jean-Pierre Finance

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Observations de E. Dreyer, Directeur du Centre INRA de Nancy

Réponse générale

Les unités soutenues par l'INRA en Lorraine (qui emploie 200 permanents et 100 contractuels) participent activement aux deux axes de recherche du pôle Agronomie, AgroAlimentaire, Forêts (A2F) de l'Université de Lorraine:

1. Un projet "Forêt Bois Territoires" avec comme 3ème partenaire AgroParisTech-Nancy. Si on y rajoute des équipes propres de l'INRA, des UMR INRA-AgroParisTech, et une unité de l'UL (le LERMAB sur le Bois Matériau, qui sera sans doute labellisée par l'INRA lors du prochain contrat), ces unités couvrent l'ensemble des compétences nécessaires pour aborder les questions qui se posent pour l'avenir de la filière forêt-bois: adaptation des forêts aux changements climatiques et de gestion, ajustements de la production aux besoins croissants, en bois matériau et en bois pour l'énergie, vulnérabilité et résilience aux contraintes de l'environnement, économie de la filière, identification et évaluation des services écosystémiques, etc. Ces questions requièrent la mobilisation d'une large gamme de disciplines. Cette forte complémentarité entre unités et cette participation à un projet collectif font la force de ce domaine de recherche en Lorraine, et ont permis la construction et le succès du projet de Labex "ARBRE" retenu lors du second appel à projets des PAI en février 2012 (lors des visites des comités).

2. Un axe de recherches sur l'"Ingénierie et Sécurité des Aliments" qui regroupe également un nombre important d'unités sur des thématiques d'importance pour plusieurs départements de l'INRA.

Certaines des unités comme le LGM (Dynamic) ou le LAE contribuent aux deux axes de recherches. Les autres sont plus spécifiquement actives dans l'un des deux. Les avis de l'AERES et les réponses apportées par les directions des unités feront l'objet de présentation et de réactions des départements de recherche impliqués : "Ecologie des Forêts, Prairies et Milieux Aquatiques", "Microbiologie et Chaine Alimentaire", Environnement et Agronomie", "Physiologie Animale et Santé des Elevages", "Alimentation humaine" qui sont les tutelles scientifiques INRA pour ces unités, et qui se prononceront sur les aspects de stratégie scientifique. La réponse présentée ici s'attache plus spécifiquement aux dynamiques locales entre unités. Les commissions de visite ont perçu ces enjeux et ont souligné les contributions des unités au projet collectif. De plus, les avis portés sur les différentes unités sont dans l'ensemble très positifs et nous ne pouvons que nous en féliciter.

Eléments concernant l'UMR 1136 "Interactions Arbres-Micro-organismes"

Le comité a émis des avis très positifs sur cette unité en soulignant sa production exceptionnelle et sa position de leader dans son domaine, ainsi que son rôle clé dans la structuration des recherches dans A2F et dans la construction du Labex ARBRE. Deux suggestions ont plus particulièrement retenu l'attention de l'INRA-Nancy: celle de développer une plateforme de phénotypage consacrée à des caractérisations de la fonctionnalité des systèmes racinaires: un tel projet commun avec l'unité EEF est clairement d'importance pour le centre de Nancy. La seconde concerne les besoins de développer une facilité pour la transformation de peuplier nécessaire à la validation d'hypothèses sur les fonctions physiologiques des protéines étudiées: cette suggestion sera examinée avec attention.

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REPONSE DE L'UNITE AU RAPPORT D'EVALUATION DE L'UMR 1136 IAM

OBSERVATIONS DE L'EQUIPE DE DIRECTION SUR LE RAPPORT

1. Appréciation générale de l'unité

Nous souhaitons remercier le comité d'évaluation pour l'analyse approfondie qu'il a faite de notre unité. Celle-ci fait ressortir toutes les forces de notre collectif de recherche : qualité et haut niveau de la production scientifique, participation soutenue dans la formation, la diffusion de connaissance et la valorisation. Elle souligne aussi son rôle clé de leader à l'échelle internationale et son attractivité.

Nous apprécions l'évaluation positive que le comité a faite de la future organisation de l'unité en cinq thèmes pour la période 2013-2017 : *« The scientific structuration in five themes appears to be a strong motivation for all members of the unit... (it) can also be considered as a new strategy that encourages the emergence of innovative and integrated approaches potentially leading to the emergence of young scientific leaders ».* Nous retenons l'idée de mettre en place une évaluation interne à mi-parcours pour juger de l'intérêt de maintenir à terme une structuration mixte thème/équipe.

Le rapport fait ressortir à juste titre les difficultés que nous rencontrons dans la gestion et l'animation scientifique de l'unité située sur deux sites distants de 20km. Conscients des enjeux, nous poursuivrons nos efforts pour continuer à améliorer la communication interne dans l'unité, via l'utilisation d'intranet. Par ailleurs, notre unité a toujours été très dynamique en matière d'organisation de séminaires et va mettre tout en œuvre pour poursuivre dans cette voie. Etant donné l'étendue des champs disciplinaires portés par l'unité, la future direction s'efforcera de proposer également des séminaires moins spécialisés pouvant intéresser l'ensemble du personnel de l'unité.

Le rapport souligne les besoins importants de notre unité en terme de soutien technique, non seulement pour le groupe situé sur le campus de Vandoeuvre mais aussi plus globalement, puisque des départs passés et à venir risquent de conduire à des pertes de compétences techniques très dommageables pour l'unité. Etant donné la dynamique de croissance très positive qui caractérise notre unité du point de vue du personnel non permanent (doctorants, post-doctorants, CDD techniciens et ingénieurs), un enjeu majeur pour l'avenir de l'unité sera d'assurer la pérennité des compétences acquises, en lien notamment avec les très nombreux développements technologiques réalisés. Pour y parvenir, la future direction de l'unité aura effectivement besoin d'un soutien fort des tutelles en matière de recrutements de personnels techniques. Par ailleurs, comme évoqué par le comité, l'ensemble du collectif de recherche de l'unité compte bien continuer à se mobiliser pour attirer les meilleurs étudiants et chercheurs du domaine, que ce soit au niveau national et international, et l'acceptation récente du Labex ARBRE devrait être un atout supplémentaire pour renforcer l'attractivité de notre unité.

La future direction de l'unité retient la recommandation du comité de permettre un temps de discussion entre les doctorants et les membres de leur comité de thèse, en l'absence de leur directeur de thèse. Elle réfléchit aussi à mettre en place un système de référent interne à l'unité, pour tous les doctorants.

2. Appréciation détaillée des différents thèmes

THEME 1

Les membres du thème 1 ont apprécié les commentaires positifs du comité et la discussion qui a été engagée au cours de l'évaluation. Le comité a bien identifié les forces de ce thème ainsi que les facteurs pouvant potentiellement freiner l'avancée des recherches. En accord avec cette analyse, au cours des années à venir nous allons poursuivre nos recherches en biologie structurale en collaboration étroite avec l'unité CRM2 de l'Université de Lorraine. De plus, comme souligné par le comité pour d'autres thèmes, nous explorerons les possibilités de développer des approches de physiologie utilisant les outils de la transformation du peuplier et des champignons.

THEME 2

Nous remercions le comité pour son évaluation positive du thème 2 : '*Overall, the projected work is of excellent quality and originality, and is also realistically designed. The complementary expertise combined with the critical mass of the project members have placed this Theme 2 in a unique and international leadership position to effectively and meaningfully unravel forest soil functioning on a system level*.' Le comité fait remarquer à juste titre que la mise en place d'une plateforme de transformation du peuplier pourrait profiter à la tâche 4 du thème 2 (ainsi qu'à d'autres tâches) en permettant d'accélérer les analyses menées au niveau fonctionnel et cellulaire sur cet important arbre modèle. Nous allons étudier la possibilité de recueillir un soutien financier et humain de la part du Labex ARBRE récemment accepté, pour développer une telle plateforme en collaboration avec l'UMR EEF.

THEME 3

Dans son rapport, le comité s'interroge sur la place qu'occupe la tâche 1 dans le thème 3, tout en soulignant le leadership de l'unité sur cette thématique : *« Among the forest soil 'prokaryomes', mineral weathering bacteria as well as mycorrhiza helper bacteria (MHB) are of central importance for soil dynamics and thus, for tree performance. Surprisingly, the scientific community studying these bacteria consists of few laboratories. Among these, the Champenoux group is leading as reflected by the number and quality of publications and invited reviews».* Cette thématique est indissociable de celle portée par la tâche 2 car seul un couplage entre les tâches 1 et 2 permettra une compréhension intégrée du fonctionnement complexe des sols forestiers. Il est par ailleurs important de souligner que cette thématique joue un fort rôle structurant au niveau du centre INRA de Nancy et du département EFPA car elle est menée depuis l'origine en étroite collaboration avec l'unité BEF. Cette thématique continuera donc à s'inscrire dans les priorités de l'unité à l'avenir.

Dans son rapport, le comité relève à juste titre l'importance des tâches 2, 3, 4. Il précise en effet : (i) *« Task 2 lies at the heart of Theme 3 »,* (ii) *« The combination of Task 2 and Task 4 promises to provide a valuable insight into forest soil functioning and to make major contributions to the field. »* et (iii) *« Task 3 must be the priority of this Theme 3, because of its originality and its connection to Theme 2, which must be reinforced. ».* Nous remercions le comité d'avoir souligné l'importance de la tâche 3, son originalité ainsi que le leadership de l'unité sur cette thématique des interactions bactéries-champignons (cf rapport du thème 2 rappelé ci-dessus). La tâche 3 s'inscrit à l'interface entre les tâches 1 et 2. Elle a pour objectif d'intégrer d'un point de vue fonctionnel les recherches menées dans l'unité sur les communautés bactériennes et sur les communautés fongiques. C'est pourquoi elle n'a de sens que si elle est menée en complémentarité des tâches 1 et 2. Elle n'a pas vocation à se substituer à ces deux tâches.

Pour conclure, le thème 3 joue un rôle central pour l'unité car comme le souligne à juste titre le comité dans l'introduction du rapport du thème 2, « *An advanced know-how on forest soil functioning is required to design integrated strategies for the*

preservation and/or sustainable exploitation of forest environments ». C'est la raison pour laquelle au cours du prochain contrat, nous prévoyons de renforcer ce thème par le recrutement d'un nouveau scientifique (cf plan de recrutement proposé pour 2013-2017), et nous avons toute confiance dans le dynamisme des « jeunes » chercheurs qui vont animer ce thème : ils ont toutes les qualités pour construire un collectif de recherche solide, permettant de relever avec brio les forts enjeux écologiques qui fondent le thème 3.

THEME 4

Nous remercions le comité pour son appréciation positive du thème 4. Nous reconnaissons la petite taille du groupe impliqué dans ce thème et nous serons particulièrement attentifs à cet aspect au cours des cinq prochaines années. Il est cependant important de signaler qu'une partie des projets portés par le thème 4 (ex : évolution des populations au cours du processus de dispersion) sera menée en lien étroit avec le thème 5, ce qui permet de relativiser le problème de la petite taille du collectif de recherche en charge du thème 4.

THEME 5

Nous remercions le comité pour son appréciation concernant la maturité de ce projet transversal. Nous comprenons sa préoccupation quant au fait de réunir des chercheurs de disciplines différentes et les difficultés de communication que cela pourrait représenter. Un de nos objectifs majeurs sera d'avoir des réunions scientifiques et stratégiques régulières afin de maintenir la cohérence de nos objectifs scientifiques. Ceci nous aidera à envisager de nouvelles approches pour l'étude des interactions hôte - pathogène, tel que recommandé par le comité. Par ailleurs les échanges avec les généticiens des arbres devraient grandement étayer notre projet, et il y a actuellement une volonté, soutenue par le Département EFPA, de renforcer la relation avec l'Unité AGPF de l'INRA d'Orléans. La mise au point d'un système de transformation pour des études fonctionnelles sur le pathosystème peuplier - rouille est une de nos priorités et nous travaillerons de concert avec le thème 2 pour atteindre cet objectif.

Champenoux, le 23 mars 2012

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ANSWER OF THE UNIT TO THE EVALUATION REPORT OF THE UMR1136 IAM

OBSERVATIONS OF THE DIRECTORS ON THE EVALUATION REPORT

1. Global assessment of the unit

We would like to thank the evaluation committee for their in-depth analysis of our unit. Their review has highlighted our unit's collective research strengths: the production of high quality research, a commitment to teaching and training, a dedication to the dissemination of scientific discoveries to the public and the socio-economic world. The evaluation also underlines the leadership and attractiveness of our unit at the international level.

We appreciate the positive evaluation rendered by the committee concerning our unit's future research plans and the new organisation around five main themes for the 2013-2017 period: "*The scientific structuration in five themes appears to be a strong motivation for all members of the unit... (it) can also be considered as a new strategy that encourages the emergence of innovative and integrated approaches potentially leading to the emergence of young scientific leaders*". Further, we are in agreement with the evaluation committee's suggestion that we should conduct an interim internal evaluation to judge the added value of maintaining the mixed theme/team system.

The report properly highlights the main difficulties we face in the management and scientific leadership of a unit located on two sites 20km apart. Aware of the issues related to this physical separation, we will continue with our efforts to improve internal communication within the unit via the use of intranet and collective seminars. Our unit has always been very active in organizing seminars and will make every effort to pursue this. Given the breadth of disciplines within the unit, the future management will be devoted to also providing seminars that are of more general interest to attract more participation and interaction amongst the teams.

The report underlines the critical need of our unit for additional technical support. This need applies broadly, not just to the group on the campus of Vandoeuvre, as the past and upcoming retirement of a number of our technicians could lead to a loss of technical skills which would be very harmful to the operation of the unit. Given the positive momentum of growth that characterizes our unit in terms of non-permanent staff (PhD students, postdocs, technicians and engineers), a major challenge for the future of the unit will be to ensure the sustainability of previously acquired techniques/skills, particularly in connection with quickly evolving technologies. To achieve this, the future management of the unit will need the strong support of their parent institutions in hiring technical staff. Moreover, as discussed by the committee, the collective research unit plans to pro-actively attract top students and researchers, both from national and international sources. The recent acceptance of the Labex program ARBRE should be an added advantage in the pursuit of this goal.

The future management of the unit will follow the committee's recommendation to allow time for discussions between PhD students and members of their thesis committee in the absence of their supervisor. The management will also considering setting up an internal referral system for all doctoral students.

2. Detailled assessment of the different themes

THEME 1

The theme members have appreciated the positive comments and the discussion engaged in the course of this evaluation. The committee has properly identified both strengths and potential limiting factors of the research conducted in this theme. According to this analysis, we will pursue in the next years our activities in structural biology, trying to ensure our efficient collaboration with the Unit "CRM2" from the Lorraine University. In addition, as also noticed for the other tasks, we will explore the development of physiological approaches through poplar and fungal transformation.

THEME 2

The committee's main conclusion: "*Overall, the projected work is of excellent quality and originality, and is also realistically designed. The complementary expertise combined with the critical mass of the project members have placed this Theme 2 in a unique and international leadership position to effectively and meaningfully unravel forest soil functioning on a systems level*" was appreciated by the theme members. The committee has noticed that Task 4 of Theme 2 (and several other tasks) would benefit from the availability of a poplar transformation platform on campus to facilitate and accelerate work related to functional and/or cellular analyses in this important model plant. We will explore the opportunity to obtain funds and manpower from the recently awarded Labex program ARBRE to set up this platform in collaboration with the UMR "EEF".

THEME 3

In its report, the committee questions the place of task 1 in Theme 3, while stressing the strong leadership of our group on this issue: "*Among the forest soil 'prokaryomes', mineral weathering bacteria as well as mycorrhiza helper bacteria (MHB) are of central importance for soil dynamics and thus, for tree performance. Surprisingly, the scientific community studying these bacteria consists of few laboratories. Among these, the Champenoux group is leading as reflected by the number and quality of publications and invited reviews*". Task 1 is inseparable from Task 2, to obtain an integrated understanding of the complex functioning of forest soils. Task 1 also plays a pivotal role in structuring the research at the INRA center of Nancy and at the EFPA department, because since its inception, this thematic has led to a strong collaboration with the INRA Unit "BEF". Task 1 will thus keep being one of the research priority of the our unit in the future.

The committee also points out the importance of Tasks 2, 3, 4. The evaluation specifically states: (i) "*Task 2 lies at the heart of Theme 3*", (ii) "*The combination of Task 2 and Task 4 promises to provide a valuable insight into forest soil functioning and to make major contributions to the field* " and (iii) "*Task 3 must be the priority of this Theme 3, because of its originality and its connection to Theme 2, which must be reinforced* ". We would like to thank the committee for underlining the originality of Task 3 and the strength of the unit's leadership on this thematic concerning the interactions between bacteria and fungi (see Theme 2 report mentioned above). The objective of Task 3 is to be the interface between Tasks 1 and 2, not a subsitute nor a replacement thereof - it aims to lend a functional integrated perspective to the research of the unit concerning forest bacterial and fungal communities.

In conclusion, Theme 3 plays a central role in the unit because, as rightly pointed out the committee's report in the introduction of Theme 2, " *An advanced know-how on forest soil functioning is required to design integrated strategies for the preservation and/or sustainable exploitation of forest environments* ". This is why we plan, in the coming contract, to enhance this theme by the recruitment of a new scientist (see proposed recruitment plan for 2013-2017). We have confidence in the dynamism of "young" researchers who will lead this theme as they all have the qualities to build a strong research group and to successfully meet the strong ecological issues underlying the theme 3.

THEME 4

We would like to thank the committee for the positive comments concerning Theme 4. We acknowledge the small size of the group involved into this theme and will be particularly careful about this in the future 5-year-period. We would like, however, to point out that part of the work of Theme 4 (population evolution during dispersal) is in close connection with Theme 5 and will alleviate the problems associated with small group size within this theme.

THEME 5

We acknowledge the support from the committee on the maturity of this transversal project. We understand their concern about bringing researchers from different field together and the communication difficulties this might represent. This will be a major goal for us to have regular scientific and strategic meetings in order to maintain the coherence of our scientific objectives. This will clearly help to prospect for novel aspects of the host-pathogen interaction as recommended by the committee. Communication with tree breeders is indeed a crucial point for the outcomes of our research, and there is currently an effort made with the support of the EFPA Department to strengthen the relationship with the AGPF Unit at INRA Orléans. Setting a transformation system for functional studies with our poplar-poplar rust pathosystem is a priority and we will work together with Theme 2 to achieve this goal.

Champenoux, March the 23rd 2012

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