

Projects funded in 2009 (Summaries)

No	Full name
0900-001	ARCAD: Agropolis Resource Center for Crop Conservation, Adaptation and Diversity
0900-002 completed	Acquisition of competencies in soft matter rheology
0900-003 completed	Additional support for the realization of the congress AGRO2010 MONTPELLIER
0900-004 completed	The future of Agricultural Research for Development: A rendezvous for young researchers from the South and the North
0901-001	Has <i>Ceratonia siliqua</i> set up a joint venture with mycorrhizal and nitrogen fixing symbioses? Potential for early tree growth and orchards implantations
0901-002 completed	Agriculture sources of atmospheric biological ice nucleators in dryland cropping systems
0901-005	Coupling of C, N & P biogeochemical cycles in nodulated legume rhizosphere in agroecosystems of reference areas of the Mediterranean basin
0901-006	Development of a non-destructive near infrared spectroscopic phenotyping methodology for mandarin fruits as an aid to the study of phenotypic variability in response to water stress and to varietal selection
0901-007	Men and Fruit trees around the Mediterranean: from domestication to present varietal and genetic diversities, from local management practices over time to contemporary international trading
0901-009 completed	International Symposium "Innovation and Sustainable Development in Agriculture and Food" - Organization of a Mediterranean working session
0901-010 completed	Conference « reconsidering food nutritional quality from the plate to the field »
0901-013	Understanding land surface - atmosphere exchanges within a Tunisian hilly watershed devoted to agricultural activities : on the influence of upward and downward flows on energy and mass transfers
0901-016 completed	Food Security in Mediterranean Areas in 2030: qualitative and quantitative issues
0901-019	Organization of an international workshop on Mediterranean palms
0902-003 completed	International Workshop on Tree Stability Modelling
0902-007	Reconstruction of 3D geometric model of plant from laser scanner data
0902-008	Modelling of water and nutrients uptake by plant root systems: a mathematical and numerical approach with explicit account of root system architecture
0902-009	Population genetics and architectural-functional plant growth models. Application to <i>Mascarocoffea</i> (coffee trees natives from Madagascar) genetic resources preservation
0902-010	PHENOTyping by Modelisation of plant ENVironnement and Architecture
0902-011	A tool to conceive sustainable production systems - case of the peach brown rot couple

0902-012 completed	Third International Symposium in the series Plant Growth Modelling, Simulation, Visualization and Applications
0902-013 completed	Dynamics and evolution of life history traits in plant pathogens and pests
0902-015 completed	Organization of the Agropolis session within the 'TDWG- Biodiversity Information Standards' 2009 annual meeting, Montpellier, 9-13 November
0902-016	A thematic network to reinforce regional collaborative projects in virtual landscape and ecosystem visualization
0902-018	Coupling photon and proton imaging : towards a 3D functional imaging in plant

Keywords:

IPB-1 Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*

IPB-2 Integrative Plant Biology 2: *Plant pests and diseases, integrated crop protection, population ecology*

STDI-1 Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*

STDI-2 Socio-Technical Dynamics of Innovation 2: *Agrifood innovations, food and non-food use of plant crops*

STDI-3 Socio-Technical Dynamics of Innovation 3: *Innovation processes, social management of innovations*

Year of CfP: 2009

Project No 0900-001

Project title: ARCAD (Agropolis Resource Center for Crop Conservation, Adaptation and Diversity)

Units managing the project: AGAP (Genetic improvement and Plant adaptation) (CIRAD, INRA, Montpellier SupAgro), DIADE (Diversity, Adaptation and development of Plants) (IRD, UMII), LGDP (Plant genome and development laboratory) (CNRS, UPVD)

Project leader: Jean-Louis Pham [pham(a)agropolis.fr]

Countries involved in the project: Burkina Faso, Cote d'Ivoire, Guinea, Kenya, Madagascar, Mali, Niger, Nigeria, Morocco, Senegal, Uganda; Brazil, Chile, Ecuador, Peru, Trinidad, USA; Denmark, European Cooperative Programme for Plant Genetic Resources; FAO; CGIAR (Generation Challenge Programme, Bioversity International, ICRISAT)

Research units from the Foundation's scientific network involved: BGPI, GALF, GREEN, RPB

Sub-thematic axes: IPB-1 Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*; STDI-1 Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*; STDI-3 Socio-Technical Dynamics of Innovation 3: *Innovation processes, social management of innovations*

Objectives: ARCAD is aimed at setting up a new open multi-function (conservation, research and training) platform devoted to the assessment and better use of plant agrobiodiversity in Mediterranean and tropical regions. It will focus on the relationship between crop diversity and the processes of domestication and adaptation to the agricultural environment. The project involves:

- Advanced research on the history and process of domestication and crop adaptation as well as on key parameters for adaptation through studies of evolutionary genomics, population genetics and multi-disciplinary studies involving biology and social sciences;
- Better use of existing information on plant genomes and biological resources (e.g., sequencing and germplasm databases, national and international germplasm collections and associated databases, *in situ* agrobiodiversity inventories) to enhance the use, conservation and sustainable management of cultivated plants diversity in tropical and Mediterranean agriculture;
- Development of international visibility and attractiveness of the Montpellier scientific community in the field of plant agrobiodiversity and preservation;

This initiative is expected to:

- Improve scientific knowledge and encourage the creation of new tools and methods to study the diversity of cultivated plant genetic resources, to determine the adaptive response of plants to their environment, to understand the role of environmental and human factors in agrobiodiversity, and *in* and *ex-situ* conservation of plant biological resources;
- Develop training in the research fields including various tools and methods of the ARCAD project.
- Contribute in enhancing dialogue between the stakeholders involved in the preservation of agrobiodiversity; and serve as leverage in developing new partnerships and initiating new activities, and linkages between agrobiodiversity preservation and economic and social dynamics.

Total Agropolis Fondation funding: €3 000 000

Funding category(ies): Agropolis Fondation Grants for Scientific Platform; Post-doc Fellowships; Doctoral Fellowships; Support to prepare applications for national or international Calls for proposals; Support for publication and dissemination of results. Support for hosting pre-doctoral students

Project duration: 01 October 2009 – 30 September 2013

Keywords: agrobiodiversity – crop genetic resources – plant biological resources – conservation Mediterranean regions – tropical regions – domestication – adaptation – evolution – diversity – gene – genome – population – local knowledge – culture – farmers' practices – climate change – agroecosystems

Year of CfP: 2009

Project No 0900-002 Completed

Project title: Acquisition of competencies in soft matter rheology

Unit managing the project: UMR IATE, Agropolymer Engineering and Emerging Technologies [CIRAD, INRA, Montpellier SupAgro, Université Montpellier II]

Project leader: Paul Menut [Paul.menut(a)supagro.inra.fr]

Countries involved in the project: USA

Sub-thematic axes: STDI-2 Socio-Technical Dynamics of Innovation 2: *Agrifood innovations, food and non-food use of plant crops*

Objectives:

The objectives of the project are to develop new competencies within the IATE research unit in the area of rheology of soft matter.

Paul Menut is assistant-professor at Montpellier SupAgro, affiliated to the research group "Agropolymers structuring under stress" of IATE RU. The team investigates the structuring of food and non-food products under stresses (flow, pressure, temperature). Understanding how such factors affect the structure of products all along the technological processes is of high importance for the control of final quality. Additionally, it should also lead to the development of newly design materials thereof exhibiting original structure and properties.

Paul Menut especially works on protein-based materials, which are mainly prepared from wheat gluten or feather keratin. Those co-products of the food industry exhibited specific properties that can lead to the production of innovative and environmentally-friendly materials, generally considered as "soft" materials due to their mechanical properties. Up to now, the approach has been to describe the material mechanical and physico-chemical properties and to relate these to the process variables (shear, temperature...) involved during the material production. The ultimate objective is to be able to trigger the process variables in order to produce material with improved specific properties.

In this situation, becoming conversant with the rheology concepts and tools will offer Dr Menut the capability to explore in depth the material mechanical properties and to investigate finely its structure. As rheology is the study of the response of a product submitted to a deformation, it is also a convenient tool to characterize *in-situ* the structuring of a product under shear.

Whereas rheology appears as a key approach in the IATE RU application field nobody in the team has specific competencies on it. Thus, with the full support of the team, the objective is to spend one year in a lab that works in the area of soft matter rheology, focusing on research with a complete exemption of teaching.

Action carried-out and results obtained:

Microgels are soft particles composed of a cross-linked polymer network swollen in a solvent. They are deformable and can thus be packed to effective volume fractions greater than the random close packing limit for hard spheres. Moreover, their softness can be tuned by varying their cross-link density. Hence, they offer great potential to study the behavior of suspensions at high packing fraction, exploring phenomena such as the colloidal glass transition or aging in colloidal glasses. Microgels are also excellent model systems to mimic natural products like globular proteins, casein micelles, or swollen starch granules, thus helping to gain insights into the behavior of these complex materials. In this project, the particle-to-polymer transition in paste of microgel particles at high concentration was studied. In isotropic compression the transition is observed directly at

the onset of mechanical rigidity. In linear shear deformation however, non-affine motions shift the appearance of the transition to much higher compressions. Once yielded, the particulate nature of the material is refound even at very high compressions.

Three communications have been released in International Conferences (two in the US, one in Europe). Two publications are actually under redaction.

Prospects for the future:

Such results open new routes to analyze the rheological behavior of natural products like wheat gluten which exhibit exceptional viscoelastic properties but which structure (polymeric or colloidal-like) remain subject to hot debate. Indeed, they show that a macroscopic rheological behavior at low deformation exhibiting the traditional feature of polymeric system is not incompatible with a colloidal structure at a microscopic level. A PhD thesis will be launch in 2010 in UMR IATE in order to explore the structure of wheat gluten suspensions with the background acquired during the project.

Total Agropolis Fondation funding: €20,000

Funding category(ies): Release from teaching duties

Project duration: 01 March 2009 - 31 March 2010

Keywords: soft matter rheology – products - flow – pressure – temperature – structure – mechanical properties – soft materials – shear

Year of CfP: 2009

Project No 0900-003 Completed

Project title: Additional support for the realization of the congress AGRO2010 MONTPELLIER

Unit managing the project: UMR SYSTEM, Functioning and management of tropical and Mediterranean culture systems [Cirad, Inra, SupAgro]

Project leader: Jacques Wery [wery(a)supagro.inra.fr]

Countries involved in the project: Pays-Bas, Australia, CGIAR, Members of European Society for Agronomy, American Society of Agronomy, Australian Society of Agronomy

Research units from the Foundation's scientific network involved: LEPSE, ECO&SOLS, LAMETA, AGAP, AMAP, BGPI, CBGP, LISAH, LSTM, EMMAH, GREEN, INNOVATION, PSH.

Sub-thematic axes: STDI-1 Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*; STDI-3 Socio-Technical Dynamics of Innovation 3: *Innovation processes, social management of innovations*; IPB-1 Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*; IPB-2 Integrative Plant Biology 2: *Plant pests and diseases, integrated crop protection, population ecology*

Objectives:

The objective assigned to Agronomy by the society was to improve production on the basis of external input (fertilizers, pesticides, energy). During the past 20 years Agronomy came back progressively to its original concept with the integration of environmental impacts in the assessment or in the design of cropping systems. With the launching of the *Agence Nationale de Recherche* (ANR) Call "Systerra", the challenge is now to design agro-ecosystems with high production performance based on limited input and environmental impacts. This has to be conducted into a sustainable development context thereby adding socio-economic criteria to this multi-functional vision of agronomy. Although it remains deeply anchored in the biophysical functioning of the cultivated field, the science of agronomy is, today, a multi-scale and multi-criteria systemic approach.

This project will use the opportunity of the 11th Congress of the European Society for Agronomy (ESA) in 2010 in Montpellier to create a major international scientific event around Agronomy (Agro2010). This event includes a set of symposia and workshops covering (i) the scientific challenges for agronomic research in the context of sustainable development, (ii) the presentation and discussion of recent advances in the interfaces of agronomy and neighboring disciplines, and (iii) the major advances and research agenda for agronomy in Europe and in the developing world.

Specifics workshops will be organized for young scientists and students from developing countries, in order to help them to manage their research project and establish networks with the Agropolis Fondation scientists.

Action carried-out and results obtained:

The International Scientific Week Around Agronomy, Agro 2010 (Montpellier August 29 - September 3, 2010), has been co-organized by Agropolis International and the European Society for Agronomy (ESA) for its XIth congress, with the help of SupAgro, Inra and Cirad under the chair of Professor Jacques Wery (Executive Secretariat of ESA). The aim of this congress was to demonstrate the scientific grounds, the applied results and the ambitions of Agronomy to address the burning questions of the XXIst century for agriculture and its contribution to sustainable development. It was more specifically dealing with adaptation to climate change, ecological intensification of cropping systems, yield gap analysis and the design of productive and resilient

cropping systems with low use of pesticides, fertilizers and energy. The design of this scientific event allows to follow a large range of trails with specific combinations of the following elements:

- an International symposium "Agronomy for Sustainable Development" with high level contributions opening the dialogue between scientists and stakeholders on the major challenges for Agronomic Research in Europe and in the developing countries
- Three Parallel symposia on scientific advances and challenges of interdisciplinary research between Agronomy and other disciplines:
 - o Plant Biology and Genetics: Co-designing plants and cropping systems for new targets
 - o Ecology: Ecological intensification of cropping systems
 - o Economy and Social Sciences: Co-assessment and co-design of technological innovations and agro-environmental policies
- Three parallel symposia organized by the scientific division of ESA on the three pillars of modern agronomy:
 - o Plant System Biology: the cultivated plant in a field (ESA - Division 1),
 - o Field Scale Agroecology: the cultivated field as an ecosystem (ESA - Division 2),
 - o Cropping Systems at Farm, Regional and Global Scales: the Cropping System in its embedding systems (ESA - Division 2),
- A symposium for the dialog between researchers and extension services on "Decision-Aid in Agriculture: which type of research and how to better use it in extension" with specific sessions for Europe and Africa,
- Three field trips combining meetings with farmers, tasting of regional products and visits of monuments
- Two international master classes on crop modelling and integrated assessment of agricultural systems, given for young scientists with priority given to developing countries,
- Two seminars aimed to develop international collaborations on Adaptation of Agriculture to Global Changes in OECD countries and on Ecological Intensification of cropping systems in the tropics.
- This congress was opened by an evening show to open the discussion between scientists and the Montpellier inhabitants on agriculture and the role of research.

Agro2010 has gathered 590 participants, which is a record in ESA congresses history. 56 countries were represented, 75% from Europe and 25% from all over the world, Africa being represented by more than 30 participants

Across the first four days Agro2010 organized 29 scientific sessions of two hours each. 470 papers have been published in the proceedings from which 160 oral presentations have been selected for an oral presentation and 370 have been presented as posters. All these communications and a large set of films are available on the congress web site www.agropolis.fr/agro2010

Prospects for the future:

A specific brochure of 68 pages dedicated to the expertise in Agronomy of 13 Montpellier's research teams, and their partners, was especially edited in French and English by Agropolis International and distributed to all participants. It is available at <http://www.agropolis.org/publications/thematic-files-agropolis.php>

During Agro2010, and thanks to the involvement of Agropolis International, the European Society for Agronomy (<http://www.european-agronomy.org>) has established its headquarters in Montpellier and will continue on the international momentum of this congress.

Total Agropolis Fondation funding: €18,402

Funding category(ies): Small Grants - Support for the organization of high-level scientific events (conferences, seminars, workshops, etc.)

Project duration: 01 November 2009 - 31 December 2010

Keywords: Agro2010 – Agronomy – European Society of Agronomy

Year of CFP: 2009

Project No 0900-004 Completed

Project title: The future of Agricultural Research for Development: A rendez-vous for young researchers from the South and the North

Unit managing the project: French Initiative for International Agricultural Research (FI4IAR: a Joint venture of INRA and CIRAD) - IFRAI

Project leader: Trish Kammili [trish.kammili(a)cirad.fr]

Countries involved in the project: CGIAR centres, Africa, North America, South America, Europe and Asia, Young Professionals' Platform for Agricultural Research (YPARD)

Sub-thematic axes: IPB-2 (Integrative Plant Biology 2: *Plant pests and diseases, integrated crop protection, population ecology*); STDI-1 (Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*); STDI-2 (Socio-Technical Dynamics of Innovation 2: *Agri-food innovations, food and non-food use of plant crops*); STDI-3 (Socio-Technical Dynamics of Innovation 3: *Innovation processes, social management of innovations*)

Objectives:

This seminar targets young doctoral and post doctoral fellows. Its objectives are to provide an opportunity for young researchers from the North and the South to exchange on their research projects; to raise awareness about the stakes for agricultural research in the different regions of the world; to heighten understanding among the researchers of the North regarding the problems of the South; to identify synergies and complementarities together; and to build linkages. The overarching theme of the event is "innovation and integration".

The event will gather some 40 young researchers who will reflect on how innovation and integration are factored into their respective research work, what are the obstacles faced, what are the institutional and organizational prerequisites, etc.

Senior discussants, from different parts of the world, will also be involved during the seminar. They will provide their expert's opinion in terms of the innovative dimension of the research projects as well as linkages and cross-cutting issues between these projects. Some young professionals from the agricultural development sector will also be invited to express their point of view on the outputs of these research projects based on their personal experiences.

Follow-up events are envisioned to be organized where some previous participants will be invited to take part again over the course of the years. By then, the same young researcher at a different stage of his/her career would have interesting insights to share with new participants. Such is expected to contribute to building a dynamic community of young researchers from different parts of the world interacting with each other and jointly producing and sharing knowledge on important issues related to agricultural research.

Action carried-out and results obtained:

This Round Table brought together senior agricultural and rural development Ministry and development agency officials and specialists from northern and southern Mediterranean countries and international organisations. The experts discussed global and national policies that foster innovation for sustainable development in agriculture and food in the Mediterranean Region. Panelists drew on practical experience and lessons from successful cases from the OECD, Egypt, France and Morocco, and address the following three questions. First, what are the main drivers and spaces of agricultural and rural innovation for sustainable development at the national, regional and global levels? Second, what institutions have been successful in mediating and

promoting learning and innovation and what support do they need? Third, what governance frameworks are required to allocate resources and manage complexity effectively for innovation (e.g. participatory learning approaches, public policies, financing, and assessing impact)? The panel session concluded with some practical implications for better linking research and policy making processes and actors to foster innovation.

Prospects for the future:

The results of the round table were posted on the site of the « Global Donor Platform for Rural Development », were sent out through the AARINENA network and will be published as a book chapter within a book on ISDA which will be published by Quae-Wageningen Publishers and CTA in French and English.

We also hope that these reflexions will be carried on within the ArimNet, the Aarinena network, or at a next edition of the ISDA symposium.

Total Agropolis Fondation funding: € 60,000

Funding category(ies): Agropolis Foundation Small Grants to sponsor and support the organization of an international seminar on agricultural research for development for the future involving young researchers from the North and the South

Project duration: 15 July 2009 - 30 June 2010

Keywords: innovation, integration, young researchers, young professionals

Year of CfP: 2009

Project No 0901-001

Project title: Has <i>Ceratonia siliqua</i> set up a joint venture with mycorrhizal and nitrogen fixing symbioses? Potential for early tree growth and orchards implantations
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Unit managing the project: LSTM (Laboratory of Tropical and Mediterranean Symbioses) [CIRAD, INRA, IRD, Montpellier SupAgro, UMII]

Project leader: Yves Prin [prin(a)cirad.fr]

Countries involved in the project: Morocco

Research units from the Foundation's scientific network involved: BPMP

Sub-thematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*), STDI-1 (Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*)

Objectives:

According to the Moroccan forest ministry, 12.5% of the territory is occupied by forest stands, whereas 56% of the territory remains available to forest or agroforest implantation. Among native tree species carob tree (*Ceratonia siliqua*) is an emblematic species in Morocco particularly due to its multipurpose uses for farmers (human and forage uses, mixed agroforestry systems, ornamental ...) and at industrial levels (carob flour, gelification, cosmetics, pharmaceuticals, and food additive). *Ceratonia siliqua* thus constitutes one of the major cards in the diversification of productions and cash incomes for small farmers.

Ceratonia siliqua is non nodulated but depends on arbuscular mycorrhizal (AM) symbioses for its development. Some results suggest that in ancestral legumes nodulation would not occur, but a primitive form of nitrogen fixing association would result from AM infection as a "vector" of bacteria to the intercellular compartment. Additionally a number of studies have reported the natural occurrence within AM fungi of nitrogen fixing bacterial strains.

The overall objective of the project is to depict how these arbuscular mycorrhizal symbioses could be the hidden and obligatory vector of an un-described nitrogen fixing association, both associated partners optimizing the survival of young plants in orchards.

Total Agropolis Fondation funding: €30,000 (running costs, travel expenses)

Funding category(ies): Agropolis Fondation small grants (support for small exploratory, risky and innovative projects, « proof of concept », new frontier research..., and support to pre-doctoral students)

Project duration: 01 august 2009 - 31 December 2011

Keywords: mycorrhiza – fungi - nitrogen – symbioses – growth – tree – orchard – *Ceratonia siliqua*

Year of CfP: 2009

Project No 0901-002 Completed

Project title: Agriculture sources of atmospheric biological ice nucleators in dryland cropping systems (DryLand Biolce)

Unit managing the project: AVI-PATHO (Plant Pathology) [INRA]

Project leader: Cindy Morris [cindy.morris(a)avignon.inra.fr]

Countries involved in the project: USA, Syria (ICARDA)

Research units from the Foundation's scientific network involved: EMMAH

Sub-thematic axes: IPB-2 (Integrative Plant Biology 2: *Plant pests and diseases, integrated crop protection, population ecology*)

Objectives:

With the growing awareness of climate changes on our planet, interest in atmospheric processes that define climate has heightened and diversified. Due to the abundance of micro-organisms in the atmosphere and the wide range of properties that could foster their direct involvement in atmospheric processes, numerous hypotheses have recently emerged about their roles.

One of the roles of micro-organisms in atmospheric processes that are receiving considerable interest concerns their potential to enhance rainfall. This role would be facilitated by their ability to act as cloud condensation nuclei and as ice nuclei. Several plant-associated bacteria are among the most highly active ice nuclei naturally present in the atmosphere. It is currently suspected that one of the limiting factors for rainfall can be the abundance of active ice nucleators in clouds.

The major source of biological ice nucleators are plants. Most of the microbial ice nucleators are inhabitants of leaf, stem and fruit surfaces. Hence, land use and management practices have an important effect on the abundance and variety of microbes in the atmosphere. Furthermore, the nature of the landscape (spatial organization of plants and other features) and deployment of management practices have marked impacts on the microclimate causing variations in temperature, relative humidity, wind speed and turbulence near the plant canopy. These variations could be sufficient to cause changes in microbial growth on plants and their flux into the atmosphere.

The objective of this project is to identify agricultural sources of biological ice nuclei in the atmosphere, as well as agro-climatic conditions that favor emission of aerosols containing these biological ice nucleators in dryland cropping systems of the Mediterranean region. Particular focus will be on regions covered by the ICARDA regional programs, especially those in North Africa, West Asia and other parts of the Mediterranean basin. The data obtained will then be used to establish a project proposal on the interaction of cropping systems and rainfall patterns.

Action carried-out and results obtained:

The main actions consisted of training a Master's level student, Mr. J. Samsatly from the American University of Beirut, at INRA-Avignon (Sept. 2009). Via this experience, Mr. Samsatly then organized a sampling campaign for April 2010 to screen dry land crops for biological ice nucleators, and for bacteria in particular. The crops to be screened consisted of a broad range of the different species and cultivars at the Tel Hadya field station in Aleppo, Syria and wheat cultivated between Aleppo and the northern border of Syria with Turkey. In collaboration with the head of the ICARDA Seed Pathology laboratory (Dr. Siham Asaad) in which the work was conducted, he also made sure that all of the necessary equipment for the research was available. The project coordinator (C.E. Morris, INRA) and the MSU partner (D.C. Sands) participated in the

April 2010 field campaign to further re-enforce the training of Mr. Samsatly and to effectively transfer the needed competence for this work to the Seed Pathology laboratory of ICARDA. During the field campaign we also identified the strategy to secure a scholarship for Mr. Samsatly's doctoral training.

The achievements of this project were as follows.

1) The screening work in Syria revealed that there was not any plant species that was particularly stronger than any other in harboring naturally-occurring biological ice nucleators. This led us to decide that the future orientation of this work should be to develop techniques to assure an increased and constant abundance of biological ice nucleators on one of the dominant cultivated plant species in the region, wheat.

2) The preliminary work realized in this project allowed the Seed Pathology Lab at ICARDA in Aleppo to acquire all of the necessary technology to conduct this work. In addition, we have determined that the principal technique to assure abundance of biological ice nucleators on wheat will be via seed inoculation. The ICARDA partner has significant competence to assure this work. Furthermore, a student entering into a Master's program at the University of Aleppo (Mr. A. Mukahhal) was among the laboratory assistants for the April 2010 experiments. He became enamored with the subject and will be conducting his research on developing seed inoculation techniques for ice nucleation active bacteria onto wheat.

3) This work has led to the development of a long-term research project with ICARDA's Seed Pathology lab, INRA and MSU. The initial objective of the 'Seed the Skies' project is to demonstrate the effective transfer of biological ice nucleators from seed-coatings to the atmosphere. For this project we will use non pathogenic ice nucleation strains of *P. syringae*. Current work in the greenhouse deploys strains from France. Sampling of wild plants from the mountains near Latakia, Syria has led to the isolation of Syrian strains that are non pathogenic and ice nucleation active that are currently being characterized by the INRA partner to validate the absence of pathogenicity before field trials will be conducted.

4) Preliminary field observations in Syria, conducted during a period of intense attack of wheat by stem rust, suggested that wheat plants with symptoms of bacterial blight (*P. syringae*) had markedly lower intensities of attack by rust. This suggested that, in addition to exploring how rust spores could be vectors of dissemination of *P. syringae* as ice nucleators, we should also consider how this bacterium might have biological control action against rust.

5) Mr. Samsatly has submitted applications for two sources of funding to conduct his graduate studies at MSU. His Fulbright fellowship application was refused for reasons of geographic choice for his studies. His application for a scholarship from the MSU Molecular Bioscience Program is currently being evaluated.

Prospects for the future:

There are 2 main prospects for this work. Firstly, we will continue collaboration with the ICARDA Seed Pathology lab to develop and validate a technique to assure that wheat harbors surface populations of ice nucleation active bacteria that can become aerosols. This will involve the training of a Master's student at the University of Aleppo. The second prospect will depend on success of Mr. Samsatly in obtaining funding for his studies. If he is successful, this will allow pursuit of further collaborative work between ICARDA, INRA and MSU on establishing plant sources of ice nucleation active bacteria, formation of aerosols, and their interaction with atmospheric processes.

Total Agropolis Fondation funding: €22,576 (running costs, living and travel expenses)

Funding category(ies): Agropolis Fondation small grants (support for small exploratory, risky and innovative projects, « proof of concept », new frontier research..., and support to pre-doctoral students)

Project duration: 20 July 2009 - 30 November 2010

Keywords: ice nucleators – rainfall – microorganisms

Year of CfP: 2009

Project No 0901-005

Project title: Coupling of C, N & P biogeochemical cycles in nodulated legume rhizosphere in agroecosystems of reference areas of the Mediterranean basin (SeqLeg)

Unit managing the project: Eco&Sols (Soil and Rhizosphere Biogeochemistry) [INRA, IRD, Montpellier SupAgro]

Project leader: Jean-Jacques Drevon [drevonjj(a)yahoo.fr]

Countries involved in the project: Tunisia, Algeria, Syria (ICARDA) & India (ICRISAT)

Sub-thematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*), STDI-1 (Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*)

Objectives:

The interest of grain-legumes for Mediterranean agriculture is to decrease the dependency on imports of plant proteins and to increase the diversification of cereal cropping systems. Legumes contribute to food security and soil fertility in particular as a consequence of the symbiotic nitrogen fixation (SNF). But they face yield instability because of biotic and abiotic constraints, including low P availability in most soils of the Mediterranean basin.

The hypothesis to be tested is that C sequestration would increase in cultural systems with legumes that would contribute more than 50% of their N content from atmosphere thanks to their symbiotic capacity to fix N₂. This contrasts with the non N-fixing species that require addition of (energy costly) mineral N to fix more CO₂ through their photosynthesis, thus eliminating the benefit of C sequestration by counter-part emission of CO₂ for the production of N fertilizer. In conclusion legumes would increase the overall C sequestration by fixing N₂. However soil P may be limiting the N₂-dependent legume photosynthesis and growth. Therefore, it is necessary to investigate the interaction between atmospheric N₂ fixation and soil P availability.

Bean (*Phaseolus vulgaris*) recombinant inbred lines contrasting in P efficiency for SNF have been obtained in cooperation with CIAT (Colombia). The objective of this project is to analyze the interactions between the biogeochemical cycles of C, N and P in the rhizosphere of legumes, by comparing the C, N and P accumulation in these recombinant inbred lines of common bean and their rhizospheric soil in reference zones of the Mediterranean basin.

These data will be used with the MOMOS model to assess the contribution of the N₂-fixing rhizobial symbiosis to the carbon sequestration resulting from residues decomposition in the soils, and to the up-scaling at the regional scale.

Total Agropolis Fondation funding: €42,640 (running costs, travel expenses, organisation of a workshop)

Funding category(ies): Agropolis Fondation small grants (support for small exploratory, risky and innovative projects, « proof of concept », new frontier research...)

Project duration: 01 September 2009 - 31 December 2012

Keywords: rhizosphere – Mediterranean – agroecosystems- nodules – symbiotic nitrogen fixation

Year of CfP: 2009

Project No 0901-006

<p>Project title: Development of a non-destructive near infrared spectroscopic phenotyping methodology for mandarin fruits as an aid to the study of phenotypic variability in response to water stress and to varietal selection</p>
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Unit managing the project: Qualisud (Integrated food processing) [CIRAD, Montpellier SupAgro, UMI, UMII]

Project leader: Guy Self [guy.self(a)cirad.fr]

Countries involved in the project: Morocco

Sub-thematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*), STDI-1 (Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*), STDI-2 (Socio-Technical Dynamics of Innovation 2: *Agrifood innovations, food and non-food use of plant crops*)

Objectives:

Improving management of water resources, while increasing product quality to support a sustainable agriculture is one challenge currently facing the Mediterranean basin. Of tropical and subtropical origin, citrus, the region's principal fruit crop provides an excellent model to study this challenge as it requires both water and heat to produce quality fruit. With water resources in the Mediterranean basin becoming more scarce, in part due to global climate change, their judicious management will be key in producing citrus in the future. For instance, it has been shown that water stress applied at precise times during fruit development resulted in better quality mandarin fruit. Progress in breeding can also improve water-use efficiency. Increases in productivity, plant vigour, harvest index and photosynthetic efficiency should all lead to substantial economies in water use. Recent work has shown that triploidy increases tolerance to salt stress and water deficit. Most current varieties are diploid, self-incompatible and produce quality fruits without seeds. However, their pollen and ovules are viable and produce seeds by cross pollination with other citrus varieties. This creates an important commercial problem, because consumers tend not to accept seedy mandarins. Triploids are sterile and usually do not produce seeds. We have started a triploid breeding program and have now created more than 3000 triploid hybrids. In addition to fruit quality monitoring, it is necessary to evaluate the water use efficiency of those new hybrids. At the same time, it is vital to maintain or even improve fruit quality to sustain performance in highly competitive markets.

The speed and ease with which quality criteria can be evaluated is essential in order to accelerate gains in water resource management whether by genetic improvement or innovative production methods. Near infrared spectroscopy (NIRS) is a proven technology for the non-destructive quality evaluation of agro-food products, including citrus fruits. Portable NIR spectrometers have been used in the field to evaluate mango fruit quality, but progress has been limited by the performance, portability and ease of use of available equipment.

The objective of this project is to develop NIRS for the rapid evaluation of citrus fruit quality in the field. This phenotyping method can be applied to improve water management and to select high quality mandarin hybrids. This is expected to allow for the investigation of water use efficiency of the better selected hybrids as well as the effect of a more limited irrigation on the fruit quality of those hybrids.

Total Agropolis Fondation funding: €31,200 (equipment, travel expenses, running costs)

Funding category(ies): Agropolis Fondation small grants (support for small exploratory, risky and innovative projects, « proof of concept », new frontier research...)

Project duration: 01 September 2009 - 31 December 2012

Keywords: spectroscopy – mandarin fruit – selection – water stress – phenotype

Year of CfP: 2009

Project No 0901-007

Project title: Men and Fruit trees around the Mediterranean: from domestication to present varietal and genetic diversities, from local management practices over time to contemporary international trading (FruitMed)

Unit managing the project: AGAP (Genetic improvement and Plant adaptation) (CIRAD, INRA, Montpellier SupAgro)

Project leaders: Bouchaib KHADARI (AGAP) [khadari(a)supagro.inra.fr] and Hélène JOLY (CEFE) [helene.joly(a)cirad.fr]

Research units from the Foundation's scientific network involved: GALF, MOISA

Sub-thematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*) and STDI-2 (STDI-2 (Socio-Technical Dynamics of Innovation 2: *Agrifood innovations, food and non-food use of plant crops*))

Objectives:

The objectives of the project are (1) to understand the social and biological processes that have led to the present distribution and importance, for Mediterranean societies, of the diversity of almond and olive ; (2) to understand the role of interactions between tree species biology, human practices and social representations in shaping intra-specific genetic diversity ; (3) to understand how social, cultural and economic values and uses pertaining to tree agro diversity relate to changes and development of local rural societies and (4) to analyze how contemporary evolution of rural societies and globalization of markets affect the distribution and use of varieties in order to evaluate risks of genetic erosion.

The implementation of this project is expected to shed light on the following:

1- Environmental issues:

- The preservation of wild relatives of cultivated species in Mediterranean countries where evolution of rural societies and urbanization or forest progression put wild relatives and old varieties at risks ;
- The development of almond varieties that take into account cross pollination of species in order to prevent diffusion of alleles to landraces and wild relatives ;

2- Climatic change: Development and selection of new olive and almond drought resistant varieties.

Total Agropolis Fondation funding: €87,200 (allocations for a doctoral fellow, pre-doctoral students and senior scientist, travel expenses, running costs)

Funding category(ies): Agropolis Fondation small grants (support for small exploratory, risky and innovative projects, « proof of concept », new frontier research; support to pre-doctoral students; support to prepare applications for national or international calls for proposal (e.g. ANR and EU FPs), Support for publication and dissemination of research results, Visiting scientist fellowship for short period of stay, Support for the organization of high-level scientific events (conferences, seminars, workshops, etc))

Project duration: 01 September 2009 - 31 January 2013

Keywords: Domestication – diffusion – management practices – diversity – genetic – Mediterranean

Year of CfP: 2009

Project No 0901-009 Completed

Project title: International Symposium "Innovation and Sustainable Development in Agriculture and Food" - Organization of a Mediterranean working session (ISDA 2010-MED)
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Unit managing the project: INNOVATION, Innovation and development in agriculture and the agrifood sector [CIRAD, INRA, and Montpellier SupAgro]

Project leader: Hubert Devautour [hubert.devautour(a)cirad.fr]

Countries involved in the project: International (ArimNet and AARINENA)

Research units from the Foundation's scientific network involved: DIADE, GREEN, MOISA

Subthematic axes: STDI-1 (Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*), STDI-2 (Socio-Technical Dynamics of Innovation 2: *Agrifood innovations, food and non-food use of plant crops*), STDI-3 (Socio-Technical Dynamics of Innovation 3: *Innovation processes, social management of innovations*)

Objectives:

In the face of global threats such as climate change, the scarcity or degradation of resources, and population growth, agriculture and the food sector have moved right to the top of many political agendas. These are crucial sectors because they fulfill vital economic and social needs by mobilizing fragile environmental resources. To achieve development that enables environmental aspects to be better taken into account and wealth to be shared more equitably, it is important to critically evaluate current innovation systems.

While innovation was formerly limited to technical and industrial disciplines, today cognitive, social, and political fields also contribute as knowledge processes and are increasingly taken into account. Multidisciplinary approaches are developed, dialogue between science and society to better face uncertainties and risk in a sustainable perspective are encouraged. Parallel to this evolution of scientific approaches, Innovation Systems are increasingly considered at a regional level, as different innovation networks and forums emerge. In the Mediterranean region, different reports agree that climate change, degradations of resources as water, urbanization will involve important agricultural and food production systems changes, and that a regional innovation system is still lacking.

The objective of the ISDA (Innovation and Sustainable Development in Agriculture and Food) Symposium is to bring together different communities to make a global review of the current situation and see how to improve innovation systems to contribute to sustainability. To facilitate exchange, the symposium will encourage dialogue between researchers of Northern and Southern countries develop linkages between life sciences, technical sciences and social sciences, create an interface between science and society to get different actors involved in the scientific debate.

This proposal aims to encourage participation of Mediterranean researchers in the ISDA Symposium (see www.isda2010.net) and organize a working session on the Mediterranean within the overall symposium.

Action carried-out and results obtained:

This Round Table brought together senior agricultural and rural development Ministry and development agency officials and specialists from northern and southern Mediterranean countries and international organizations. The experts discussed global and national policies that foster innovation for sustainable development in agriculture and food in the Mediterranean Region. Panelists drew on practical experience and lessons from successful cases from the OECD, Egypt,

France and Morocco, and address the following three questions. First, what are the main drivers and spaces of agricultural and rural innovation for sustainable development at the national, regional and global levels? Second, what institutions have been successful in mediating and promoting learning and innovation and what support do they need? Third, what governance frameworks are required to allocate resources and manage complexity effectively for innovation (e.g. participatory learning approaches, public policies, financing, and assessing impact)? The panel session concluded with some practical implications for better linking research and policy making processes and actors to foster innovation.

Prospects for the future:

The results of the round table were posted on the site of the « Global Donor Platform for Rural Development », were sent out through the AARINENA network and will be published as a book chapter within a book on ISDA which will be published by Quae-Wageningen Publishers and CTA in French and English.

We also hope that these reflexions will be carried on within the ArimNet, the Aarinena network, or at a next edition of the ISDA symposium.

Total Agropolis Fondation funding: €19,481 (travel expenses, registration fees for experts, young scientists and PhD students)

Funding category(ies): Agropolis Fondation small grants (support for the organization of high-level scientific events (conferences, seminars))

Project duration: 01 January 2010 - 31 December 2010

Keywords: innovation - sustainable development – agriculture – food – Mediterranean – workshop – symposium

Year of CfP: 2009

Project No 0901-010 Completed

Project title: Conference « reconsidering food nutritional quality from the plate to the field »

Unit managing the project: MOISA, Markets, Organisation, Institutions and Operators' strategies [CIRAD, INRA, IRD, Montpellier SupAgro, Ciheam-IAMM]

Project leader: Martine Padilla [padilla(a)iamm.fr]

Countries involved in the project: Lebanon

Research units from the Foundation's scientific network involved: IATE, QUALISUD, SYSTEM

Sub-thematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*), STDI-1 (Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*), STDI-2 (Socio-Technical Dynamics of Innovation 2: *Agrifood innovations, food and non-food use of plant crops*), STDI-3 (Socio-Technical Dynamics of Innovation 3: *Innovation processes, social management of innovations*)

Objectives:

All over, from the gene to the field and then from the field to the plate, a very large and diverse set of disciplines are involved, with very limited integration. When integrated, they never link from plate to field, and seldom from field to gene, e.g. breeders usually produce high yielding varieties, less often varieties specifically adapted for one given agricultural system, and even less for one given diet. As diets become a major global issue, the mode of thinking has to be turned around, to see how nutritional needs can influence upstream research in original and new integrative approaches. For 40 years plant breeding focused on crop production and adaptation to stress, but recent studies showed breeding can also be based on crop diversity for micronutrients. Agricultural systems and practices, postharvest technologies can also impact on food quality. Social changes, north and south of the Mediterranean Sea, have also affected diets.

The objectives of the conference « reconsidering food nutritional quality from the plate to the field» are:

- to have the different stakeholders present the different opportunities in their specific field
- to organize a debate between them and the scientists attending on new possible collaborative multidisciplinary projects in which the nutritional quality drives upstream research

Action carried-out and results obtained:

This meeting was organized by the society of Biology in partnership with Agropolis International, Agropolis Foundation, the activity structure of research and strategic thinking "citrus" (Assembly of research groups on the Use of Micronutrients and their effects health) and the cluster Q@liMediterranean.

The nutritional quality of food is an important issue in every society, north, south and east Mediterranean Sea. We can relate in many ways, a particular point of the food chain, from plant to plate. Research has never looked at it in its entirety. The requirement of food quality can and must be informed at every stage, from research in plant diversity in search of quality as a result of agricultural practices, management of quality in food during processing, transport and distribution, management of power quality at the consumer's plate.

We have organised a multidisciplinary confrontation on the issue: plant sciences, agricultural sciences, food technology, economics, sociology, nutrition, medicine. Scientists, technologists and representatives of the commercial all participated in the discussions. These interactions are very innovative and have led to interesting insights for future research. 160 people registered for the event.

Prospects for the future:

The next meeting is scheduled for 2010 around the question of the relationship between nutrition and development of cancer-prevention-and-nutrition diet on cancer and treatment options-at the regional or international level-Mediterranean countries. Common reflexion AGRUMES members to participate in a project "area of knowledge" in FP7

Total Agropolis Fondation funding: €1,066 (travel expenses for 3 speakers)

Funding category(ies): Agropolis Fondation small grants (support for the organisation of high-level scientific events (conferences, seminars)

Project duration: 01 August 2009 - 31 January 2010

Keywords: field – plate – integration – genes – diet – nutritional needs – micronutrients – food quality – nutritional quality

Year of CfP: 2009

Project No 0901-013

Project title: Understanding land surface - atmosphere exchanges within a Tunisian hilly watershed devoted to agricultural activities: on the influence of upward and downward flows on energy and mass transfers

Unit managing the project: LISAH (Laboratory for studies of Interactions between Soils, Agrosystems, Hydrosystems) [INRA, IRD, Montpellier SupAgro]

Project leader: Frédéric Jacob [frederic.jacob(a)supagro.inra.fr]

Countries involved in the project: Tunisia

Subthematic axes: STDI-1 (Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*)

Objectives:

Within Mediterranean agricultural regions, decision making tools for water management, devoted to resource protection (quantity and quality) or use optimization (crop water needs and irrigation), require the development of modelling platforms that include the whole set of water fluxes and involved processes. In this context, characterizing energy and mass exchanges between land surfaces and atmosphere are of prime interest, since evapotranspiration corresponds to more than two-thirds of the hydrological budget within semi-arid regions.

Although agricultural watersheds are common within the Mediterranean Basin, energy and mass exchanges within hilly structures have been hardly studied, because of the complexities induced by the coupling between topography and external wind. Observing and modelling tools have been mainly used under mountainous conditions, but they have hardly been implemented over the typical hilly structures that characterize Mediterranean watersheds.

The current proposal aims at:

- promote original results recently obtained about uncommon behaviours that have never been reported such as opposite influences of upward and downward flows on flux magnitudes, by 50% in relative
- tentatively increase the genericity of modelling tools by investigating the linkages between fluxes and state variables such as surface temperature, and by including the coupling between wind direction and topography into the parameterisation of turbulent exchanges

Total Agropolis Fondation funding: €38,865 (running costs, travel expenses, congress participation fees)

Funding category(ies): Agropolis Fondation small grants (support for publication and dissemination of results, support for small exploratory, risky and innovative projects, « proof of concept », new frontier research...)

Project duration: 01 November 2009 - 31 December 2012

Keywords: hilly watersheds - agriculture - land surface energy fluxes - observing and modelling

Year of CfP: 2009

Project No 0901-016 Completed

Project title: Food Security in Mediterranean Areas in 2030: qualitative and quantitative issues (SAMAQQ 2030)

Unit managing the project: MOISA, Markets, Organisation, Institutions and Operators' strategies [CIRAD, INRA, IRD, Montpellier SupAgro, Ciheam-IAMM]

Project leader: Martine Padilla [padilla(a)iamm.fr]

Countries involved in the project: Egypt, Morocco, Tunisia, Turkey, Lebanon, Spain

Research units from the Foundation's scientific network involved: IATE, SYSTEM, MOISA, DIADE, AGAP

Sub-thematic axes: IPB-2 (Integrative Plant Biology 2: *Plant pests and diseases, integrated crop protection, population ecology*), STDI-2 (Socio-Technical Dynamics of Innovation 2: *Agrifood innovations, food and non-food use of plant crops*), STDI-3 (Socio-Technical Dynamics of Innovation 3: *Innovation processes, social management of innovations*)

Objectives:

A lot of scientific studies are available on the Mediterranean area, including foresight analysis; they deal notably with food production, environment quality and evolution, anthropic pressures (FAO, Blue Plan, IUCN, GFCM...), but very limited literature is available on the link between the possible evolutions of the main expected trends and the priorities for research and education. Currently the main foresight analysis, such as MEA (2006) IAASTD (2008), Agrimonde (2009) and even Mediterra (2008) precisely identify the key issues related with mega-trends but they do not detail recommendations for the frontier research fields to be open or supported. Pluridisciplinarity in science is always magnified but no consistent partnerships are identified or even suggested.

The Scientific and Technical Committee of Agropolis International brings together representatives of the main partners of this institution. This committee has the capacity to launch studies on issues which had been considered by the majority of members as key problems to be explored or analysed with a specific task force. The final goal is to give to the regional scientific community involved in agriculture and fisheries a better view of the priorities for R&D and academic programmes in the global field of agriculture, environment, feed and biodiversity.

Objectives: to build upon existing foresight studies with the view:

- To adapt the studies to the specificity of the Mediterranean area
- To complete the studies in mobilizing wider expertise (e.g.: expected climatic impact on agricultural production)
- To select recommendations in terms of new research fields and skills, notably in academic and education programmes, projects to develop in the coming years and strategic alliances to set up with that view
- To explore economic partnerships supported by technology innovation

This study will integrate the ideas of various experts from several different areas including some from the south-eastern Mediterranean area, with the aim of producing through a common foresight analysis several recommendations to be shared and put to use in practical applications.

Action carried-out and results obtained:

The project was completed in 19 months (September 2009-March 2011) according to the following activities:

- Partnership organization, solicitation of Mediterranean experts based on the network of CIHEAM-IAMM, Business Planning
- Organization of an educational module for engineering students of SupAgro in the Master-APIMET SEPMET 2009-10 (an entire module, EU-8, was devoted to this activity).
- International Meeting and discussion on future scenarios of Mediterra 2008 (1) A Mediterranean without belief (2) A Mediterranean under stress (3) A Mediterranean exploded but reactive (4) A Euro-Mediterranean confident. General recommendations on two types of climate scenario. Participation of local experts, foreign experts and SupAgro students in this debate
- Presentation of the study and its results to the GCARD, Montpellier
- Presentation of progress to the CST Agropolis
- Second International Workshop with experts from the Mediterranean area to discuss the scenarios and decide on priorities for research- Final report writing and editing a book on "Food Security in the Mediterranean in 2030: qualitative and quantitative aspects", published at Agropolis International
- Valuation of work in the framework of the INRA-CIRAD Dualine on foresight of food and agriculture (Montpellier and Paris)

Results obtained:

The prospective study SAMAOQ, food security across the Mediterranean: a quantitative and qualitative forecast to 2030, is based on 4 scenarios identified in the CIHEAM report Mediterra 2008, the future of Agricultural and Food in Mediterranean Countries. These scenarios describe possible futures of the region towards 2030. In the SAMAOQ study, two different evolutions of climate change (slow or fast) are integrated. The main objective of the SAMAOQ study aims at providing recommendations in terms of proposals for research, training and partnership for improving food security in the Mediterranean. The study focuses on ten fields: water, ecosystem and biodiversity, genetic resources and breeding, production systems, animal and plant pathologies, food technologies, nutrition and health, land management, training and, governance. For every fields and each scenario, economists, agronomists and health experts from various Mediterranean countries have submitted a number of proposals for research. Finally, this study identifies three global proposals which allow integrated research programs: periurban agriculture, endangered by a fast town expansion, modeling in economics and climate change in order to prevent risks, information and guidance of decision-makers, and finally, research on indicators and procedures for a better regulation of food trade, a stronger involvement of stakeholders in the efforts to be given and a more efficient protection for a better environment.

Prospects for the future:

All research proposals developed in SAMAOQ trying to build access roads to improve food security by 2030. The future is already gearing up in the Mediterranean in this burgeoning potential. May this study help to inform decision makers for research in the vital area of food security in the Mediterranean countries by allowing this to go from one suffered present to a chosen future? Each partner must apply to disseminate the results near the stakeholders in food security.

Total Agropolis Fondation funding: €28,982 (travel expenses, publication costs)

Funding category(ies): Agropolis Fondation small grants (support for small exploratory, risky and innovative projects, « proof of concept », new frontier research...)

Project duration: 01 September 2009 - 31 December 2010

Keywords: food security – Mediterranean area – foresight studies

Year of CfP: 2009

Project No 0901-019

Project title: Organization of an international workshop on Mediterranean palms (MEDI-PALMS 2010)
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Unit managing the project: DIADE (Diversity, Adaptation and development of Plants) (IRD, UMII)

Project leader: James Tregear [james.tregear(a)ird.fr]

Countries involved in the project: Tunisia

Research units from the Foundation's scientific network involved: AGAP

Subthematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*), IPB-2 (Integrative Plant Biology 2: *Plant pests and diseases, integrated crop protection, population ecology*)

Objectives:

The palms occupy a prominent position, not only in many natural ecosystems, but also in the economies of many tropical and sub-tropical countries. An understanding of their biology is critical to both the preservation of their biodiversity and the sustainable exploitation of their agronomic and ethnobotanic potential for the needs of human beings. A 3 day world conference entitled "Palms 2010: An International Symposium on the Biology of the Palm Family » is currently being organised by IRD and CIRAD researchers for 5-7 May 2010. The aim of this symposium is to bring together researchers from a wide range of disciplines carrying out research on the biology of palms (palm taxonomy, evolution, reproductive biology, genetics and genomics, palm biogeography, ethnobotany), so as to encourage the exchange of new knowledge and the development of multidisciplinary approaches.

Parallel sessions will be organised so as to accommodate a wide group of researchers. Within this framework, we wish to promote the participation of palm scientists from Southern Mediterranean countries and organise a workshop specifically covering palm species of Mediterranean regions.

Total Agropolis Fondation funding: €15,000 (travel expenses, room renting)

Funding category(ies): Agropolis Fondation small grants (support for the organisation of high-level scientific events (conferences, seminars))

Project duration: 15 July 2009 – 30 June 2011

Keywords: International – workshop – Mediterranean – palm

Year of CfP: 2009

Project No 0902-003 Completed

Project title: International Workshop on Tree Stability Modelling
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Unit managing the project: AMAP (Botany and computational plant architecture) [CIRAD, INRA, IRD, UMII, CNRS]

Project leaders: Thierry Fourcaud [thierry.fourcaud(a)cirad.fr] (AMAP) and Tancrede Almeras (LMGC)

Countries involved in the project: United Kingdom, Canada, Finland

Subthematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*)

Objectives:

Tree stability to high winds is a major socio-economic and environmental question because of the increased frequency of extreme weather events (storms, hurricanes, etc.) related to climate change. Research conducted over many years in this area was so far limited to particularly sensitive areas (North of the UK, Scandinavia, Canada). However, the damage caused by storms in recent years, particularly in Europe, has generated renewed interest in these issues by extending the international scientific community working on the stability of forest stands. An international group of researchers involved in studies on tree wind firmness was formed in 2008 with the first organization of a workshop on "tree pulling", which was held on 22 to 24 October 2008 in Edinburgh, Scotland (<http://www.forestresearch.gov.uk/fr/INFD-7DPDGA>). The goal of this first workshop was to present both different methods for testing the strength of trees *in situ* and analysis tools, and then to define standard experimental approaches to address specific problems.

UMR AMAP is now organizing the second workshop on tree stability in Montpellier (October 21-23, 2009). This is not an open event and participants (about 30) will be invited by a scientific board. This meeting aims in encouraging open discussions on standardization and genericity of tree stability models and methods of investigation, as well as in presenting software, models, and mathematical libraries during working sessions.

It will be decided about the future animation of the tree stability group (establishment of a European COST project and definition of collaborative projects). This workshop has an international character with participants from Europe (mainly France, Germany, UK, Finland, Sweden and Netherland), Canada, USA, Japan, China, Australia and New Zealand. It is complementary to more formal conferences organized on the subject, in particular the *Wind Effects on Trees* conference that will be held 13-16 October 2009 (one week before), in Freiburg, Germany.

Action carried-out and results obtained:

This workshop aimed in: (i) presenting the actual models, methods and computing tools that are available for tree stability investigations and prediction at the tree and stand scales; (ii) discussing about standardisation and integration of these methods and tools in decision support systems; (iii) deciding how to strengthen and make permanent the animation of this tree stability research network, and how to enhance and support international collaborations on this topic.

The workshop hosted 32 participants, including 3 invited speakers, from 9 different countries (Brazil, Canada, Finland, France, Germany, Italy, Japan, New Zealand, and United Kingdom). Presentations took the form of short talks (18) and software demonstrations (5). A large place was devoted to open discussions. The program was split into three main sections devoted to (i)

mechanical models of tree/stand stability; (ii) making the connexion between tree/stand growth and tree stability models; (iii) computer platforms that can host these models.

In addition, an introduction to the concepts and models of tree architecture has been presented at the beginning of the workshop. How to describing and model tree architecture, i.e. the dynamical evolution of tree topology and geometry, have been widely investigated in AMAP (the research unit which host this workshop), and we think that these concepts will help in improving approaches and models to study tree mechanical stability. An example of collaborative software development and sources sharing was also presented. At the end of these three days, a round table was organized in order to conclude this workshop and to decide about the future of this tree stability group.

Prospects for the future:

It was first decided to continue organizing regular workshops (1 per year) on the topic of wind hazards in forest. The next one will be devoted to tree acclimation and adaptation to wind and will take place in UMR PIAF, Clermont-Ferrand (France).

The group also proposed to make an European COST action that could help in animating the network and encouraging collaboration projects.

Last, we building the foundations for the development of a software platform dedicated to the simulation of wind risks in forest. This project should be further discussed within the group.

Total Agropolis Fondation funding: €4,805

Funding category(ies): Agropolis Fondation small grants (support for the organisation of high-level scientific events (conferences, seminars))

Project duration: 07 July 2009 - 31 December 2009

Keywords: workshop – international – tree stability – modelling – wind

Year of CfP: 2009

Project No 0902-007

Project title: Reconstruction of 3D geometric model of plant from laser scanner data (PlantScan3D)

Unit managing the project: AGAP (Genetic improvement and Plant adaptation) (CIRAD, INRA, Montpellier SupAgro)

Project leaders: Frédéric Boudon (AGAP) [frederic.boudon(a)cirad.fr] and Pierre-Eric Lauri (AGAP) [lauri(a)supagro.inra.fr]

Countries involved in the project: Finland

Research units from the Foundation's scientific network involved: LEPSE

Sub-thematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*)

Objectives:

Automatic acquisition of plant phenotypes, and in particular of architecture phenotypes, constitutes a major bottleneck of the construction of quantitative models of plant development. This issue needs to be addressed now to bridge the gap toward predictive agronomic applications, by building and assessing accurate virtual plant models. Most of actual measurement methodologies are manual and extremely time consuming. This is a major issue at both national and international scales.

Recently, 3D Laser Scanners (SL3D) have made it possible to acquire 3D images on which each pixel has an associated depth corresponding to distance between camera and the pinpointed surface of the object. They are used in industrial applications (e.g. design of car) and medicine (e.g. prosthesis) where surfaces are usually continuous and regular. Their applications to the description of plants show however some additional difficulties due to their irregular geometric nature.

The objective of this project is to develop the use of laser scanner for plant geometry reconstruction. For this, we will develop methodologies and tools for the automation of numerical 3D acquisition of vegetal structures of different sizes, and develop new methods for the reconstruction of parsimonious geometrical and structural models usable in agronomical and biological contexts. Our work should provide to the plant modelling community a set of open source software for the automatic reconstruction of plant structure and geometry from laser scanner data.

Total Agropolis Fondation funding: €30,000 (travel expenses, small equipment)

Funding category(ies): Agropolis Fondation small grants (support for small exploratory, risky and innovative projects, « proof of concept », new frontier research), support to prepare applications for national or international calls for proposals (e.g. ANR and EU FPs))

Project duration: 01 September 2009 - 31 December 2011

Keywords: 3D model – plant – laser scanner – phenotype – automatic acquisition

Year of CfP: 2009

Project No 0902-008

Project title: Modelling of water and nutrients uptake by plant root systems: a mathematical and numerical approach with explicit account of root system architecture
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Units managing the project: EMMAH (Mediterranean environment and modelling of agri-hydrosystems) [INRA]

Project leaders: Claude Doussan (EMMAH) [[doussan\(a\)avignon.inra.fr](mailto:doussan(a)avignon.inra.fr)] and Myriam Comte [[comte\(a\)ann.jussieu.fr](mailto:comte(a)ann.jussieu.fr)]

Research units from the Foundation's scientific network involved: PSH

Subthematic axes: STDI-1 (Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*)

Objectives:

Among mineral nutrients, nitrogen (N) and phosphorus (P) are key elements for plant growth. Intense use of N and P as fertilizers input in modern agriculture has led to the current high productivity of crops but at the expense of the alteration of water resources or greenhouse gases emission. From another point of view, the availability of P might be limited in the future for agriculture because of the exhaustion of P-ores. As an answer to these problems, low-input agriculture shall be devised by optimizing the use of fertilizers (or soil natural resources) and water by plant roots in the soil.

The aim of this proposal is to better understand the interactive effects between root system architecture (geometry, growth) and P / water uptake, in relation with the soil spatial variability of resources. This will be undertaken by numerical modelling and mathematical optimization with different levels of details in the description of the root system. This should result in a modelling coupling soil water/nutrient transfer and uptake by a root system architecture, including retro-actions between aerial and subterranean parts of the plant.

Total Agropolis Fondation funding: €42,514 (running costs, participation to a meeting, salary for 4 months for a software coding student, support for 3 pre-doctoral students)

Funding category (ies): Agropolis Fondation small grants (support for small exploratory, risky and innovative projects, « proof of concept », new frontier research; support to pre-doctoral students)

Project duration: 01 November 2009 - 31 October 2012

Keywords: modelling – water – nutrients – root – architecture – nitrogen - phosphorus

Year of CfP: 2009

Project No 0902-009

Project title: Population genetics and architectural-functional plant growth models. Application to *Mascarocoffea* (coffee trees natives from Madagascar) genetic resources preservation (MaGenA)

Unit managing the project: AMAP, Botany and computational plant architecture [IRAD, INRA, IRD, UMII, CNRS] & DIADE (Diversity, Adaptation and development of Plants) (IRD, UMII)

Project leaders: Sylvie Sabatier [sylvie-annabel.sabatier(a)cirad.fr] (AMAP), and Philippe de Reffye [philippe.de_reffye(a)cirad.fr] (AMAP)

Countries involved in the project: Madagascar

Subthematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*), STDI-1 (Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*)

Objectives:

In the context of rapid environmental changes better data, particularly about species phenotypic plasticity, are needed on factors causing the extinction or persistence of small populations in species distribution modelling. The growth potential of plants in their natural environment depends on the adaptive genetic diversity and the phenotypic plasticity which enables plants to adjust to spatial and temporal heterogeneity, thus minimizing stress effects. The plant response to environmental constraints is characterized by both architectural and functional plasticity in woody plant. One major difficulty lies in the complex interactions between genotype and environment. The functional-structural model GreenLab is a dynamic model taking into account architectural plasticity of the plants and biomass allocation to organ level.

The *Coffea* genus includes 103 species with 53 endemic to Madagascar (namely *Mascarocoffea*), which thus possesses the highest *Coffea* diversity. In this island however deforestation and human activities have led to strong forest fragmentation and modified ecosystems. Therefore, some forest species including *Mascarocoffea* could be threatened with extinction. Conservation strategies based on scientific data are needed and become urgent in terms of biodiversity preservation and sustainable development. Contrary to African *Coffea*, few studies have focused on *Mascarocoffea* at the molecular genetics and genomics levels. The size of *Mascarocoffea* genomes remains still unknown and none molecular genetic diversity study is reported until now.

The aim of this project is to:

- Analyze the phenotypic plasticity and adaptive capacity at the individual level within *Coffea* populations. Phenotypic plasticity is studied as the response in terms of architecture (which retrospectively provides growth data of individual trees at different developmental stages in their life) and assimilates production/biomass allocation (GreenLab model). We assess adaptive capacity by two complementary methods: the genetic diversity using molecular markers (genomic- and/or EST microsatellites) and the variability of adaptive traits between populations with different ecological niches
- Propose guidelines for *Coffea* genetic resources conservation

Total Agropolis Fondation funding: €92,102 (allocation for a doctoral student for 16 months, travel expenses, running costs, organisation of a meeting)

Funding category(ies): Agropolis Fondation doctoral fellowship

Project duration: 01 September 2009 - 31 December 2012

Key words: Genetics - architecture - growth - plants - coffee - Madagascar - phenotypic - plasticity - ability to adapt

Year of CfP: 2009

Project No 0902-010

Project title: PHENOTyping by Modelisation of plant ENvironnement and Architecture (PHENOMENA)

Unit managing the project: EMMAH (Mediterranean environment and modelling of agri-hydrosystems) [INRA]

Project leaders: Benoît de Solan (EMMAH) [benoit.desolan@avignon.inra.fr] and Christophe Pradal (DAP) [christophe.pradal(a)cirad.fr]

Research units from the Foundation's scientific network involved: DIADE

Subthematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*), STDI-1 (Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*)

Objectives:

Agriculture is facing huge challenges: it must combine both a high productivity to balance the increasing food demand and a limited environmental footprint to make the system sustainable. Further, climatic changes impose very strong constraints, particularly in the Mediterranean regions that will be particularly affected. Plant breeding has always been a major component in the past for production increase. It will be also a major tool in the adaptation of agriculture systems to face the above challenges. The success of the selection depends on our capacity to identify and quantify traits that are favorable such as improved resistance to pests and stresses or better use of nitrogen. New techniques allowing to access specific traits of cultivars have to be developed based on non destructive and rapid measurements such as offered by close range remote sensing known as "proxidetection". This technique allows the characterization of some of the main canopy variables that intervene in canopy functioning. However, the interpretation of such measurements is complex and relies on the way canopy architecture is modelled and linked to plant functioning.

The objective of this project is to combine a 4D plant model with a functioning model as a support to improve field high throughput phenotyping with remote sensors. This work will be based on two existing models, the SIRIUS crop functioning model and the ADEL-Wheat architectural model. Implementation will use the modelling platform OpenAlea, dedicated to functional structural modelling of plants.

The coupled model will then be used to simulate reflectance and gap fraction with a radiative transfer model.

Total Agropolis Fondation funding: €96,832 (allocation for a post-doctoral fellow, travel expenses, participation to 2 conferences)

Funding category(ies): Agropolis Fondation postdoctoral fellowship

Project duration: 01 January 2010 - 31 July 2012

Keywords: structural functional model - OpenAlea platform – canopy – proxidetection – remote sensors – phenotyping – modellisation -

Year of CfP: 2009

Project No 0902-011

Project title: A tool to conceive sustainable production systems - case of the peachbrown rot couple (PRIMo)

Unit managing the project: GAFL, Genetic Improvement of Fruits and Vegetables [INRA]

Project leaders: Bénédicte Quilot-Turion (GAFL) [quilot(a)avignon.inra.fr], Mohamed Mahmoud Ould Sidi (PSH) [mmouldsidi(a)avignon.inra.fr], Nadine Hilgert (ASB) [nadine.hilgert(a)supagro.inra.fr]

Sub-thematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*), IPB-2 (Integrative Plant Biology 2: *Plant pests and diseases, integrated crop protection, population ecology*)

Objectives:

Monilinia laxa causes brown rot in peach fruits and can provoke as much as 30 to 40% of crop losses. No other alternative than chemical treatment is available so fungicide applications are generalized and occur till pre-harvest. *M. laxa* conidial infection has been described occurring through wounds only, so cuticular cracks are likely to play a major role for fungal infection. Consequently, the probability of infection of a fruit depends on both inoculum density and cuticular cracks surface.

The cuticular crack density was shown to mainly vary with the intensity of the fruit growth, itself varying with the fruit crop load and irrigation regimes. Cuticular cracks can represent more than 10% of the fruit surface area. These cracks are not only large opportunities for fungal infection, but also contribute to fruit transpiratory losses that influence fruit growth and quality build-up. Sensitivity of cuticle to cracks may be controlled by the genome.

Practices can modulate infection probability, at the inoculum level as well as at the fruit level. Irrigation regimes and fruit thinning largely influence fruit growth and cracks appearance. Moreover, irrigation increases humidity that may favor fungus sporulation and germination. The peach-brown rot couple is thus a complex system under the triple influence of the genotype (fungus and host), the environment and cultural practices. Studying this system could lead to a reduction of fungicide use and thus to ecological, economical and health benefits. An integrated approach via modelling appears to be the best way to handle this complex system and propose a tool for decision making.

The aim of this project is to build a tool to conceive innovative management strategies that optimize genotype x environment x practices interactions to limit peach fruit contamination by brown rot in the orchard. For this, an existing process-based model (virtual fruit) describing growth and quality elaboration of peach fruits will be improved. The improved model will be used to conceive and evaluate production systems combining innovative practices and cultivars according to their cuticular and qualitative characteristics. This will be realised using efficient multiobjective optimisation algorithms and reliable evaluation methods. The genotype x environment x practices interactions will be optimized and the production systems proposed will be evaluated according to various criteria: feasibility (working time), economic profitability (yield, fruit size, turnover), environmental impact (number of pesticides, period relative to harvest, water consumption) and production quality (gustative and conservation potential).

Total Agropolis Fondation funding: €99,254 (salary for a post-doctoral fellow, travel expenses, computers)

Funding category(ies): Agropolis Fondation post-doctoral fellowship

Project duration: 01 January 2010 - 31 march 2012

Keywords: peach – fungi – brown rot – *Monilinia laxa* – modelling – genotype – practices – optimisation.

Year of CfP: 2009

Project No 0902-012 Completed

Project title: Third International Symposium in the series Plant Growth Modelling, Simulation, Visualization and Applications
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Unit managing the project: AMAP, Botany and computational plant architecture [CIRAD, INRA, IRD, UMII, CNRS]

Project leaders: Marc Jaeger (AMAP) [marcjaeg(a)gmail.com] and Jérémie Lecoœur (LEPSE) [lecoeur(a)supagro.inra.fr]

Countries involved in the project: Chine, Netherlands

Research units from the Foundation's scientific network involved: AGAP, PSH

Sub-thematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*)

Objectives:

PMA09 is the third International Symposium in the series Plant Growth Modelling, Simulation, Visualization and Applications after PMA03 and PMA06 both held in Beijing, China, in 2003 and 2006. PMA09 addresses Plant Biologists, Mathematicians and Computer Scientists with an interest in Plant Growth Modelling, Simulation, Visualization and their Applications in Plant and Crop Sciences, Forestry, Agriculture, Environmental Sciences, Ecology and Virtual Reality.

This international event provides an excellent opportunity to foster scientific and technical exchanges in a multidisciplinary subject area, and will also allow the building of bridges between different scientific communities. PMA09 is organized by Chinese and French Institutions and is open to international scientists and students interested in Plant Growth Modelling, Simulation, Visualization and Applications. The event is supported by an International Scientific Committee (PMA09 took place in Beijing, China, November 09-13, 2009)

Action carried-out and results obtained:

This third event of the series (after PMA03 and PMA06) took place in Beijing from 2009, November 9th to 13rd. Under PMA09 board (CAU and CIRAD), the international scientific committee selected 42 oral contributions and 18 poster contributions. The board also invited 4 key note speakers. Presentations were of high quality. They show that FSPM become mature. Most of the contributions present applications in which FSPM provide the background support for experiments model coupling and focused specialized researches. Proceedings are edited by IEEE CPS. Selected papers were edited (or are currently edited) in the following journals: Annals of Botany, Journal of Computer Sciences and Technology, International Journal of Computer Sciences.

The event was organized by the China Agricultural University (CAU), involving nearly 100 participants. Tutorial day attendees were a dozen. The symposium received the support from the following French and Chinese institutions: CIRAD, INRIA, Agropolis Fondation, French Embassy in China, LIAMA, CAU, 863 Program, NSFC, CAF, CASIA, WSCT, CSIG, Nercita.

More information available on: <http://pma.cirad.fr>

Prospects for the future:

The event series is now definitively settle in the scientific community and welcome from international researcher seniors. The next event PMA012 is already on track.

Total Agropolis Fondation funding: €20,051 (travel expenses, registration and lodging costs, publication costs)

Funding category(ies): Agropolis Fondation small grants (support for the organisation of high-level scientific events (conferences, seminars))

Project duration: 08 July 2009 - 31 January 2011

Keywords: Symposium – international – plant growth – modelling – simulation

Year of CfP: 2009

Project No 0902-013 Completed

Project title: Dynamics and evolution of life history traits in plant pathogens and pests
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Unit managing the project: BGPI, Biology and Genetics of plant/pathogen Interactions [CIRAD, INRA, Montpellier SupAgro]

Project leaders: Virginie Ravigné (BGPI) [Virginie.Ravigne(a)cirad.fr] and Frédéric Grogard (INRIA) [Frederic.Grogard@sophia.inria.fr]

Subthematic axes: IPB-2 (Integrative Plant Biology 2: *Plant pests and diseases, integrated crop protection, population ecology*), STDI-1 (Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*)

Objectives:

The development of a more sustainable agriculture is at the core of current ecological and societal concerns. Facing this scientific challenge we have to pave the way to a more durable use of ecologically-acceptable management strategies of plant pathogens and pests such as e.g. the use of resistant plant varieties, biocontrol agents or new generation pesticides. So far most theoretical developments concerning the durability of crop management strategies have focused on controlling pest and pathogen population dynamics. In this project, we alternatively argue that the long-term sustainable regulation of plant pathogens and pests may critically depend on the evolution of their life histories, what is rarely taken into account. Life history theory deals with the strategic decisions of organisms along their life-time. In particular it is concerned with the timing of reproduction, the way organisms exploit hosts or forage resources, and how they manage their growth schedule. For plant pathogens and pests, all these traits have a strong influence on the damage they cause to agricultural crops and how they disseminate in the environment, but they have never been properly modelled.

Our objectives are thus twofold:

- to develop a comprehensive theory of life history trait evolution of pests and pathogens based on optimal control modelling
- to embed these predictions in an adaptive dynamics framework which enables both evolutionary history and population dynamics of pests and pathogens to be assessed under various environmental scenarios

Because of the determinant influence of seasonality on life-history evolution, special attention will be devoted to contrast results for non-seasonal (tropical) and seasonal (temperate) environments.

Experiments will be carried out in parallel to challenge the theoretical predictions on some model species (temperate and tropical plant pathogen fungi of major crops). Group meetings will be organized, since we consider essential that mathematicians and biologists work in close collaboration, and a final seminar will be held for sharing and discussion of results.

Action carried-out and results obtained:

This project has allowed triggering extensive collaborations between 5 young researchers in phytopathology, theoretical evolutionary ecology and mathematics, their associated students and post-docs and more generally their respective teams.

To date, we have set the bases of a comprehensive theory of life history trait evolution of pests and pathogens based on optimal control modelling. For instance, we have shown that having a latent period, during which all resources extracted from host are allocated to within-host

colonisation, is optimal under a wide variety of conditions. We also show that pathogens that have different access to host resources should differ in their host exploitation strategy. Pathogens that rely on a finite amount of resource that is progressively consumed (e.g. necrotrophic foliar fungal pathogens) should first colonise host tissues and then dedicate fully to spore production, letting their within-host exploitation structure decay until the end of infection. In contrast, pathogens that benefit from a constant nutrient flow from their host (e.g. biotrophic fungal pathogen, aphids...) should rather continue ensuring the maintenance of their within-host exploitation structure after the onset of sporulation. Both strategies dramatically differ in the dynamics of spore production. One may therefore expect that they will have different epidemiological impacts. These models have been successfully validated by experiments carried out on two fungal pathogens of huge agronomical impact: the *ascomycete Magnaporthe oryzae* that is responsible for rice blast and the basidiomycete *Melampsora larici-populina* that causes poplar rust. To end with, these models allow envisaging how management tactics affecting different aspects of host-pathogen interactions will affect the selective pressures on host infection strategies.

A second line of the project was to embed these predictions in an adaptive dynamics framework, which enables both evolutionary history and population dynamics of pests and pathogens to be assessed under various environmental scenarios. To date, we focused on models of evolution of infection strategies in a temperate environment (i.e., under annual seasonality formalised through semi-discrete models). As an example of the results obtained, we show, by analysing a seasonal consumer-resource system (e.g., herbivorous insects on plants), that the optimal foraging strategy, which could be qualified as a cooperative and sustainable use of resources, although stable in a population dynamics acceptance, is not evolutionarily stable in the long run. This strategy is indeed not immune to invasion by a more selfish strategy. The unbeatable (a necessary condition to evolutionarily stability) foraging strategy tends to overexploit the resources to prevent deviants' invasion; as a consequence it is un-sustainable in the long term. Such a result is an example of the well-known "tragedy of the commons" and may offer a better understanding of explosive and devastating pullulations outbreaks of pests.

Prospects for the future:

The project is only halfway. The months to come will see the PhD defense of Audrey Andanson on "Evolution of aggressiveness in fungal plant pathogen: combining theoretical and empirical approaches", the publication of several papers and the hiring of Magda Castel (a former pre-doc student of this project) as a PhD student on the evolution of reproduction strategies in plant pathogens. The richness of the results obtained has largely convinced us that much attention should be devoted to the evolution of pathogen and pests life histories in response to management tactics. We therefore plan to continue the integration of models of life history evolution and epidemiological models with special interest in plant pathogens and pests. As an acknowledgement of these works and advances we received recently the financial support from the INRA to pursue the project over the next two years.

Total Agropolis Fondation funding: €29,952 (small equipment, travel expenses, organisation of 3 meetings)

Funding category(ies): Agropolis Fondation small grants (support for small exploratory, risky and innovative projects, « proof of concept », new frontier research...)

Project duration: 06 July 2009 - 31 December 2010

Keywords: plant – pathogens – pests – evolution – adaptive dynamics framework – life history traits

Year of CfP: 2009

Project No 0902-015 Completed

Project title: Organization of the Agropolis session within the 'TDWG- Biodiversity Information Standards' 2009 annual meeting, Montpellier, 9-13 November

Unit managing the project: AMAP, Botany and computational plant architecture [CIRAD, INRA, IRD, UMII, CNRS]

Project leaders: Daniel Barthélémy (AMAP) [[daniel.barthelemy\(a\)cirad.fr](mailto:daniel.barthelemy@cirad.fr)] and Jean-Louis Pham (DIAPC) [[jean-louis.pham\(a\)ird.fr](mailto:jean-louis.pham@ird.fr)]

Countries involved in the project: USA, Italy

Subthematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*), IPB-2 (Integrative Plant Biology 2: *Plant pests and diseases, integrated crop protection, population ecology*), STDI-1 (Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*), STDI-3 (Socio-Technical Dynamics of Innovation 3: *Innovation processes, social management of innovations*)

Objectives:

The international Biodiversity Information Standards body called TDWG is a non-profit and educational association affiliated with the International Union of Biological Sciences. It builds with members the communities of practice that develop and validate informatics standards and tools to link biological information resources. TDWG was formed to establish international collaboration among biological database projects, and to promote the wider and more effective dissemination of information about the World's heritage of biological organisms for the benefit of the world at large.

All biodiversity research projects include a work package on information and informatics technologies that enables sharing the knowledge generated by scientists and the transfer towards developing countries or policy makers. This area is rapidly evolving and the scientists need to adapt their communication and product delivery strategy accordingly. To keep the research community up to speed, regular contacts with the international community are necessary. The TDWG annual meetings offer perfect platforms for experts to meet, exchange views and technologies with their peers. From this group, internationally validated information standards are produced and promoted worldwide.

Action carried-out and results obtained:

The 2009 TDWG meeting, held in November in Montpellier was the principal follow-up meeting of the important coming 'e-biosphere' conference in London (1-3 June 2009) that will set the roadmap for the biodiversity information and informatics standards for the next decade.

By organizing a session of this meeting, Agropolis International and Bioversity international aim at gathering worldwide experts in Biodiversity Informatics in the French Centre for Agronomic research. It also provides an excellent opportunity to increase the international awareness on Agrobiodiversity Informatics activities and particularly, on Agropolis and Bioversity flagship projects which are included as strong components in that area. Speakers will be invited to talk (i) on 'PI@ntNet' project – a Plant Computational Identification and Collaborative Information System, (ii) on the bioinformatics components of the ARCAD flagship programme, and (iii) on 'The Global Information System on Crop Genetic Resources' of Bioversity International. By combining all necessary expertise, the Agropolis session of this meeting aims at identifying challenges for enabling a strong connection of the locale initiatives (PI@ntNet, ARCAD, etc.) with international standards used worldwide, and a major visibility of their originalities.

Prospects for the future:

A group of experts will work at developing and adapting international information and informatics standards on the important current topics relevant to agronomy and biodiversity information.

Total Agropolis Fondation funding: €18,619 (publication costs, participation to venue renting, students registration to the meeting, travel expenses of speakers)

Funding category(ies): Agropolis Fondation support award for international training courses

Project duration: 10 June 2009 - 30 June 2010

Keywords: Agropolis – meeting – biodiversity – bioinformatics – TDWG – standards

Year of CfP: 2009

Project No 0902-016

Project title: A thematic network to reinforce regional collaborative projects in virtual landscape and ecosystem visualization (VLS-LRC)
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Unit managing the project: AMAP, Botany and computational plant architecture [CIRAD, INRA, IRD, UMII, CNRS]

Project leaders: Marc Jaeger (AMAP) [marcjaeg(a)gmail.com] and Pierre Bourdin [bourdin(a)imerir.com]

Countries involved in the project: Spain

Research units from the Foundation's scientific network involved: LISAH, GREEN

Subthematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*), IPB-2 (Integrative Plant Biology 2: *Plant pests and diseases, integrated crop protection, population ecology*), STDI-1 (Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*), STDI-3 (Socio-Technical Dynamics of Innovation 3: *Innovation processes, social management of innovations*)

Objectives:

Computer graphics and especially virtual reality seems to be a well mastered technique, especially thanks to entertainment, video games in particular. This reality sounds different however when it deals with professional uses related to sustainable environment, land-use and so on. Deciders are not yet familiar with visualisation or perception of dynamics and evolutions at various space and time scales, and the technology itself is still far from needs. The fact is that consistent dynamics is still an open problem, while complex system visualisation also is.

Several research teams work on various aspects and approaches of landscape dynamics and visualisation in Languedoc Roussillon and Catalonia. And, in several cases, thanks to existing approaches and tools (some industrial), virtual reality can already be used to contribute to a better understanding of this growing demographic area and its changes.

The idea of this proposal thus relies on local and complementary strengths, aiming at the development of virtual reality tools and their application to environment sustainability on local, concrete projects.

This project aims at midterm to:

- Build a regional thematic network on 3D real time landscape visualisation and its applications,
- Reinforce initiatives and projects related to landscape simulations, including virtual reality techniques,
- Strongly involve regional research teams in regional and local projects,
- Enhance dialog between research, industry, authority and public communities on land use strategy and plans.

Building a network of competences on the subject, sharing teaching supports, working together on current and new project will help to organize the community, identify the needs and the means, aiming to point out the key technologies for tomorrow sustainability communication, leading to new industrial developments and employments.

Total Agropolis Fondation funding: €12,924 (travel expenses, salary for an engineer for 3 months, organisation of a seminar)

Funding category(ies): Agropolis Fondation small grants (support to prepare applications for national or international calls for proposals (e.g. ANR and EU FPs))

Project duration: 15 August 2009 - 30 June 2011

Keywords: landscape – visualisation – virtual reality - network - sustainability

Year of CfP: 2009

Project No 0902-018

Project title: Coupling photon and proton imaging: towards a 3D functional imaging in plant (Green Imaging)
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Unit managing the project: AGAP (Genetic improvement and Plant adaptation) (CIRAD, INRA, Montpellier SupAgro)

Project leaders: Jean-Luc Verdeil (AGAP) [verdeil(a)cirad.fr] and Geneviève Conejero [conejero(a)supagro.inra.fr]

Subthematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*)

Objectives:

The success of reductionist approaches to study plant adaptation to abiotic stress conditions in plant research has yielded an unprecedented knowledge at the molecular level. However plant adaptation to environments with sub-optimal growing conditions is multi-level concept and researchers now face the challenge of integrating this knowledge into a complete understanding of whole systems. This is a crucial task for the understanding of the abiotic stress tolerance and for knowledge-based breeding plant for the future.

Advanced imaging techniques offer an important stepping stone to integrate these disparate approaches. Multiphoton microscopy and Magnetic resonance imaging (NMR) address different properties of the sample and operate on different geometrical scales. Magnetic resonance micro-imaging (NMR) addresses molecular properties (nuclear spin) related to the atomic composition and to specific chemical groups. It has a great potential for physiological studies of plant abiotic stress. On the other hand, Multiphoton imaging stimulates the auto-fluorescence of bio-molecules such as pigments or secondary metabolites. It also allows to image in 3D, fusion proteins with a fluorescent tag allowing localising proteins involved in water and cation (i.e. sodium) transport. By contrast with microNMR, multiphoton microscopy has a higher resolution allowing cell visualisation.

The objective of this project is the coupling of NMR micro-imaging to multiphoton imaging. All the necessary conditions are now in place to successfully meet this important challenge.

Success in combining these two complementary non invasive life imaging techniques will pave the way to coherently trace accumulation and transport process from the level of the whole plant organ and organism down to single cells. Coupling these two complementary imaging techniques will allow developing a synoptic view of plant adaptation to abiotic stress from gene to the whole plant body.

Total Agropolis Fondation funding: €100,464 (allocations for post-doctoral fellow and pre-doctoral students, travel expenses, running costs)

Funding category(ies): Agropolis Fondation post-doctoral fellowship, Agropolis Fondation small grants (support for small exploratory, risky and innovative projects, « proof of concept », new frontier research; support to pre-doctoral students; support to prepare applications for national or international calls for proposal (e.g. ANR and EU FPs))

Project duration: 01 January 2010 - 30 June 2013

Keywords: NMR – mutiphoton imaging – abiotic stress