Research evaluation

EVALUATION REPORT OF THE UNIT

BIOGER - BIOlogie et GEstion des Risques en agriculture

UNDER THE SUPERVISION OF THE FOLLOWING ESTABLISHMENTS AND ORGANISMS:

Institut national de recherche pour l'agriculture, l'alimentation et l'environnement - INRAE

EVALUATION CAMPAIGN 2024-2025
GROUP E

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High Council for evaluation of research and hignter education

In the name of the expert committee:

Monica Höfte, chairwoman of the committee

For the Hcéres:

Stéphane Le Bouler, acting president

In accordance with articles R. 114-15 and R. 114-10 of the Research Code, the evaluation reports drawn up by the expert committees are signed by the chairmen of these committees and countersigned by the president of Hcéres.

To make the document easier to read, the names used in this report to designate functions, professions or responsibilities (expert, researcher, teacher-researcher, professor, lecturer, engineer, technician, director, doctoral student, etc.) are used in a generic sense and have a neutral value.

This report is the result of the unit's evaluation by the expert committee, the composition of which is specified below. The appreciations it contains are the expression of the independent and collegial deliberation of this committee. The numbers in this report are the certified exact data extracted from the deposited files by the supervising body on behalf of the unit.

MEMBERS OF THE EXPERT COMMITTEE

Chairperson:	Ms Monica Höfte, Ghent University, Belgium
Experts:	Ms Wafa Achouak, CNRS, Saint-Paul-lez-Durance (representative of CSS INRAE) Mr Vincent Calcagno, INRAE, Sophia Antipolis Mr Frédéric Choulet, INRAE, Clermont-Ferrand (supporting personnel) Ms Natalia Requena, Karlsruhe Institute of Technology, Germany

HCÉRES REPRESENTATIVE

Mr Christophe D'Hulst

REPRESENTATIVE OF SUPERVISING INSTITUTIONS AND BODIES

Ms Marie-Hélène Ogliastro, SPE, INRAE

CHARACTERISATION OF THE UNIT

- Name: BIOlogie et GEstion des Risques en agriculture
- Acronym: BIOGER
- Label and number: UR 1290
- Composition of the executive team: Ms Sabine Fillinger, director of BIOGER (2020-2025) & Mr Thierry Rouxel, deputy director of BIOGER (2020-2023)

SCIENTIFIC PANELS OF THE UNIT

SVE2: Plan and Animal Production (Agronomy), Plant and Animal Biology, Biotechnology and Biosystems Engineering

SVE1: Basic and Applied Environmental Biology, Evolution

SVE3: Living Molecules, Integrative Biology (From Genes and Genomes to Systems), Cell and Development Biology for Animal Science

THEMES OF THE UNIT

The main focus of BIOGER is the investigation of fungal diseases affecting crops important for the French and European agriculture. Since BIOGER creation, this focus relies on the research from the field to the lab and vice versa to monitor, predict and redeem fungal diseases with an emphasis in developing sustainable management practices. The main scientific models addressed at BIOGER are fungal diseases affecting wheat and rapeseed, but also grapevine. These diseases are studied and fought from different angles, including epidemiological studies, molecular, biochemical and cell biology studies, phenotypic and diagnostic studies, as well as with the use of mathematical modelling. Further, they approach these diseases not only at the small scale in studies in the laboratory and greenhouse, but also at the field level helping to transfer the technology developed in the laboratory to the agricultural field. In particular three topics are the focus of the research at BIOGER: 1) the molecular mechanisms of the interactions between the plants and the fungi; 2) the mechanisms and dynamics of adaptation in a spatio-temporal manner; and 3) the development of strategies towards the management of the fungal diseases.

During the evaluation period, the BIOGER was composed of 5 research teams, supported by common services and internal technical platforms that helped to run and manage everything necessary to fulfill the aims of the institution from personal and financial management to greenhouse facilities. Only the very symbiotic interaction among the different unit teams, platforms and shared services allows running efficiently such a unit. During the evaluation period, the unit completed the movement to a new location (Campus AgroParis-Saclay) with significant impacts on many aspects related to science, personnel and management. This finally resulted in a new organisation chart that still addresses the same research topics but with a different organisation in terms of groups and supporting platforms.

HISTORIC AND GEOGRAPHICAL LOCATION OF THE UNIT

The BIOGER was created in 2007 by merging four research groups/units, all leading projects on fungal crop pathogens. It was located on the AgroParisTech (APT) campus of Grignon since 2009 and moved to the new campus Agro Paris-Saclay in Palaiseau in October 2022. The move was initially planned to occur in 2020, but it has been delayed for two years due to COVID-19 crisis. This move had a strong impact on BIOGER activities during the evaluated period. In addition, BIOGER completely stopped and disrupted the ongoing experiments in 2020 for three months due to COVID-19 lockdown.

INRAE is currently the only supervisory institution of BIOGER. AgroParisTech was a secondary supervisory institution from 2015 to 2021 with three permanent employees affiliated to BIOGER. The departure of these employees in 2019-20 led AgroParisTech to withdraw its enrollment during the evaluation period.

The organization of BIOGER into research teams and platforms was subject to important changes during the evaluation period, especially to adapt to major evolution of permanent staff. BIOGER is now composed of five research teams, three being newly created by restructuration during the period. They are supported by three technical platforms and common services. At reporting time, there are 59 employees: 44 permanent staff, nine PhD students, two postdocs, four non-permanent engineers. There are nineteen DR/CR/IR staff members while they were twenty at the beginning of the period. Eventually, one Professor of University Paris-Saclay joined BIOGER in 2024.

RESEARCH ENVIRONMENT OF THE UNIT

BIOGER was affiliated with INRAE and AgroParisTech until 2021, following the merger of four research units based in the Île-de-France region: Paris, Thiverval-Grignon, and Versailles. A key moment in BIOGER's history was its relocation from Grignon to the new Agro campus at Paris-Saclay in Palaiseau. This move, initially announced

before BIOGER's transition to Grignon in 2009, gained momentum around 2013–2014 with the development of the INRAE-AgroParisTech Saclay project. Although the relocation was originally planned for 2020, it was ultimately completed by the end of 2022 in a state-of-the-art facility.

Following the departure of AgroParisTech members in 2021, BIOGER became the sole research unit on the Agro Paris-Saclay campus affiliated exclusively with INRAE. Its staff are administratively and hierarchically linked to the University of Paris-Saclay, except for students and employees directly associated with the university. BIOGER is fully integrated into INRAE's "Plant Health & Environment" division.

BIOGER's technical support is structured around four platforms: (i) a fungal bioinformatics platform staffed by two engineers, (ii) a cytology platform with one assistant engineer, (iii) a molecular biology platform with three technicians and one assistant engineer, and (iv) a microbiology technician supporting three teams (plans for a dedicated microbiology platform were abandoned by late 2023).

At the beginning of the evaluation period, BIOGER comprised five teams: AMAR, EGIP, Epidev, EPLM, and ECCP. EGIP was dissolved in February 2021, followed by Epidev in June 2022. The self-evaluation focuses on AMAR, EPLM, ECCP, Epidev and two independent researchers from the former team EGIP. Moving forward, BIOGER has restructured into five newly organized teams, following a thorough internal review and external support.

UNIT WORKFORCE: in physical persons at 31/12/2023

Catégories de personnel	Effectifs
Professeurs et assimilés	0
Maîtres de conférences et assimilés	0
Directeurs de recherche et assimilés	7
Chargés de recherche et assimilés	7
Personnels d'appui à la recherche	30
Sous-total personnels permanents en activité	**44**
Enseignants-chercheurs et chercheurs non permanents et assimilés	1
Personnels d'appui non permanents	4
Post-doctorants	2
Doctorants	8
Sous-total personnels non permanents en activité	**15**
Total personnels	**59**

DISTRIBUTION OF THE UNIT'S PERMANENTS BY EMPLOYER: in physical persons at 31/12/2023. Non-tutorship employers are grouped under the heading "others".

Nom de l'employeur	EC	C	PAR
INRAE	0	14	30
AgroParisTech	1	0	0
Autres	1	0	0
Total personnels	**0**	**14**	**30**

GLOBAL ASSESSMENT

BIOGER has a unique focus on fungal pathogens of major agricultural crops including wheat (*Zymoseptoria tritici*, rust fungi) and oilseed rape (*Leptosphaeria maculans*) which are studied from the cellular to the landscape level using a multidisciplinary approach. Two additional fungal models, *Colletotrichum higginsianum* and *Botrytis cinerea* are used to elucidate the role of secondary metabolites as chemical effectors, the genomic determinants of host specialization and the role of fungal extracellular vesicles in plant infection.

BIOGER stands out by the way they combine basic and applied research and have organized the research in all their teams across three transversal themes: 1) the molecular mechanisms of the interactions between the plants and the fungi; 2) the mechanisms and dynamics of adaptation in a spatio-temporal manner; and 3) the development of strategies towards the management of fungal diseases.

Highlights for transversal theme 1 are the development of a heterologous expression platform to express cryptic biosynthetic gene clusters encoding fungal specialized metabolites, the identification of new fungal avirulence genes and their cognate resistance genes in *Leptosphaeria maculans* and *Zymoseptoria tritici*, and the identification of a conserved structural family of effectors in *L. maculans*, the LARS family. The identification of resistance proteins that are able to recognize LARS effectors may allow the development of broad-spectrum disease resistance.

Highlights for transversal theme 2 are the use of experimental evolution to discover new mechanisms of adaptation to fungicides in *Zymoseptoria tritici*, and the monitoring of virulence to cultivars and resistance to fungicides using innovative technologies and collaborative field networks.

Highlights in transversal theme 3 are the identification of agricultural determinants that drive fungal adaptation and the prediction of this adaptation using experimental field assays and modelling approaches. Based on this knowledge novel management strategies were developed.

Research at BIOGER is of high relevance to society and the unit puts a lot of effort in technology transfer to stakeholders and in the implementation of the management strategies identified. This is done by organizing training and events, participating in public bodies and professional organisations, and by the establishment of networks such as R4P.

BIOGER has become a French and European reference centre for research on fungal pathogens of wheat and oilseed rape with an excellent international reputation.

Since the move to the Agro Paris-Saclay campus, research facilities at BIOGER are excellent with state-of-the-art laboratories, growth chambers and greenhouses and a large L2 confinement area with all facilities to carry out research with L2 and L3 fungal pathogens including a cytological platform. Facilities have the potential to become outstanding, but their functioning is compromised by technical issues and high energy costs. The organisational problems to deal with these issues need to be overcome. The move to Agro Paris-Saclay also facilitates the interaction with other research units creating a conducive environment for top research. Access to experimental fields has declined by the move to Agro Paris-Saclay but this is compensated for by collaborating with the INRAE site in Versailles and by access to field trial networks such as the "Club Phoma" network.

BIOGER went through a turbulent period in the last years with the move from Grignon to Agro Paris-Saclay campus, the loss of technical support, and relational problems in two of the research teams. This has resulted in a rearrangement of the unit in two existing and three new research teams. The new research organization was considered as the best compromise between human well-being and scientific soundness. The unit should take care, however, that the new research teams avoid potential conflicts due to thematic overlaps.

The current director will step down at the end of 2025 and it is urgent and essential to identify a successor inside or external to the unit. The incoming director should be provided administrative support to make the position more attractive and manageable.

Attractiveness of the unit to foreign researchers could be further enhanced by continuing efforts to integrate the English language at the work floor. International visibility could be further increased by applying for international projects, and organizing international conferences. In addition, given the excellent research carried out by the unit, increasing the number of publications in the broad spectrum of high-ranking journals could further enhance the international visibility and reputation of the unit.

The global assessment of the research unit is excellent.

DETAILED EVALUATION OF THE UNIT

A - CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

The previous report highlighted risks associated with the move to Saclay, including loss of expertise, loss of access to fields, increased administrative burden and reduced scientific output. The unit indicates that the first risk has been well contained, thanks to the hiring of new personnel, which is expected to continue in the coming years. The second aspect was compensated for by using the fields at INRAE Versailles (20 km away). Fieldwork is conducted by the latter unit, but BIOGER personnel is involved in the steering committee and formulates experimental designs. Although access is more limited and the fields available are smaller, this seems to be a good adaptation strategy. Increased administrative burden did occur, but interestingly, this is not apparent from the self-assessment of the teams's agents involvement in administration tasks. Similarly, scientific productivity (as measured by the number of articles published), showed no indication of dropping during this period.

Other aspects raised by the previous report was the need to better use English as a language for internal communication, so as to attract and favor the integration of international staff/students. The Unit has developed a balanced strategy with respect to this point, with seminars using slides in English and internal emails being in both languages. During the interview, however, it was reported that these stated rules are not always well enforced: efforts should be maintained to promote English in scientific discussions.

As a response to the previous report, internal PhD mentorship has been introduced at BIOGER in 2022. This is a good initiative, and the PhD students declared to be happy with the mentorship system.

The suggested development of pathogenomics as a research theme appears to have been implemented, as the works reported in the first features of the Portfolio clearly pertain to "pathogenomics."

Finally, the previous report expressed worries regarding the fate of the small team EGIP. The unit says this problem has been solved with the new organization, even though one new team (BioSysCo) still seems pretty small (3 CR, 1 TR, plus three other technicians/engineers who are in shared activity only).

B - EVALUATION AREAS

EVALUATION AREA 1: PROFILE, RESOURCES AND ORGANISATION OF THE UNIT

Assessment on the scientific objectives of the unit

BIOGER's research projects are excellent and highly relevant since they focus on fungal diseases of great importance in France and Western Europe on major crops including wheat and oilseed rape. These fungal diseases are investigated using a multidisciplinary and multiscale approach. Research conducted addresses a major societal challenge: assuring global food security without increasing the area under cultivation while reducing chemical inputs and fit within the scientific orientation and scientific objectives of INRAE. BIOGER has become a French and European reference centre for research on fungal pathogens of wheat and oilseed rape with an excellent international reputation.

Assessment on the unit's resources

The unit has a yearly income of ca. 600 k€, mostly from competitive national/international projects. A significant part is from private contracts and service providing (ca. 150 k€/year). The unit has a policy of sharing equipment and staff (3 platforms and 1 shared technician) and budget as well (a common financial pool covers common lab equipment and facilities, and helps teams with no research grant to conduct projects). The unit has a very recent building and modern research facilities, with ample confinement zones. Access to fields is more restricted since the move to Saclay; the unit compensates for that by collaborating with the INRAE site in Versailles. The unit's resources can be regarded as excellent.

Assessment on the functioning of the unit

Management activities regarding safety, ethics, environment, and protection of the scientific heritage are excellent. Both COVID crisis and the move to Saclay had a strong impact and a major reorganization was undertaken during the period. Two teams were dissolved and three new teams were created. Thus, the organization established at the beginning of the contract was not fully successful. Human resource management is assessed as very good. Solutions should be found in order to ensure automated data backup. The protection of scientific data is good.

1/ The unit has set itself relevant scientific objectives.

Strengths and possibilities linked to the context

BIOGER is a French reference center internationally recognized for its research on major fungal diseases of European field crops with a focus on wheat and oilseed rape. These fungal diseases are investigated using a multidisciplinary and multiscale approach. Research in BIOGER is organized in three strongly interconnected research themes: (1) Understanding the molecular mechanisms involved in interactions with the ecosystem of the diseased plant; (2) Characterization of mechanisms and spatio-temporal dynamics of adaptation in phytopathogenic fungi; (3) Development, evaluation and transfer of sustainable strategies for the management of fungal diseases.

Research conducted addresses a major societal challenge: assuring global food security without increasing the area under cultivation while reducing chemical inputs. This research fits within scientific orientation SO 2 of INRAE. Research objectives are in line with the major scientific objectives of department SPE within INRAE including GOS-1: plant immunity; GOS-2: Biological regulation and GOS-4: Risks. Their research projects also contribute to the two cross-functional objectives: OT-1: accelerated transitions and OT-2: a global approach to health.

To conduct this research, BIOGER was organized in five research teams: EPLM, ECCP, AMAR, EGIP and EPIDEV and also hosted the phytopathology laboratory of ARVALIS, the technical institute for cereals. Technical support was provided by three platforms dealing with bioinformatics, cytology and molecular biology.

Weaknesses and risks linked to the context

Relational problems in the EGIP and EPIDEV teams led to their dissolution in 2021 and 2022, respectively. In addition, ARVALIS has chosen not to move to the new Saclay campus. In the past years, BIOGER has lost technical support, since various technicians did not move to the new Saclay campus.

2/ The unit has resources that are suited to its activity profile and research environment and mobilises them.

Strengths and possibilities linked to the context

BIOGER possesses modern research facilities, including an L2 confinement zone with the possibility to upgrade to L3 level, allowing for all types of laboratory approaches relevant to the unit theme of plant pathology. The move to a new building in 2022 should ensure perennial facilities and possibly reduced functioning costs. The Unit invests to maintain/improve the functioning of facilities (e.g. the installation of a cytology platform in the confinement zone). The unit has access to experimental fields through the neighboring INRAE Versailles unit.

A significant fraction (about 30%) of the unit income is allocated to a common pool, used to purchase and maintain laboratory equipment, to hire temporary staff for common services, and to supply "lab shops" (mutualistic pools of chemicals and reactants). Part of the common pool is also used for staff training.

Weaknesses and risks linked to the context

Access to experimental fields is indirect (though a companion unit), more limited than it was before the change of location, and remoter (20 km away). The sustainability of this functioning and its capacity to be sufficient is not guaranteed. The important common financial pool of the unit (ca. 300 k€/year) does not seem to be used to fund emerging projects between different teams, which could be a plus. A non-negligible share of it is allocated to "other current fees" which are not detailed and have much increased over the past year. The unit has expressed worries about the high energy cost and numerous structural defects in the new building. Structural defects such as electric breakdown pose risks for the loss of precious biological material such as culture collections and plant material. These issues appear to be serious, and yet to be resolved.

3/ The unit's practices comply with the rules and directives laid down by its supervisory bodies in terms of human resources management, safety, environment, ethical protocols and protection of data and scientific heritage.

Strengths and possibilities linked to the context

There is one person with 30% time dedicated to human resource management. Collective training sessions are organized to reinforce team and unit cohesion. Remote working was facilitated with clear rules establish to maintain interactions. Impressive efforts for environmental footprints reduction were boosted by the creation of a sustainability working group. In particular, collection of lab plastics and constrained traveling policies with short (equivalent 4h train) flights forbidden. Storage of precious biological material is secured and duplicated at two different locations. This represents strategic material that makes BIOGER a French reference research center for fungal diseases of crops wheat and rapeseed mainly, and grapevine to a lesser extent.

Weaknesses and risks linked to the context

If mutualization of technical support categories may be an asset, it may also raise problems due to weak engagement of staff in projects. This appears especially true for the molecular biology and bioinformatics platforms. Nevertheless, discussions during the visit of the committee showed that this is not an issue. There is no centralized and automated procedure for informatics data backup on secured NAS or Cloud solutions. Without data management plan clearly defined and a secured budget for data backup, there is a risk of data loss. There is no gender parity neither at the unit level (75% of women) nor at the level of team leaders (4/5) although the committee recognizes there is no gender discrimination. Remote working may be overused (3 days per week is a lot) and thus may lead, step by step, to an environment that is not suited for research activities that require social interactions and unplanned exchanges.

Although the Institute has strong scientific appeal, salary levels for both permanent and temporary positions fall below the regional standards in Paris. The current unit director will step down by the end of 2025 at the latest, and as of now, no successor has been identified or appointed. Several teams face ongoing challenges in securing technical support, and rising energy costs present a significant threat to BIOGER's operations.

EVALUATION AREA 2: ATTRACTIVENESS

Assessment on the attractiveness of the unit

The unit's overall attractiveness is very good to excellent, reflected in its success in securing national funding for research initiatives. Its appeal is further enhanced by its affiliation with Saclay Plant Sciences and the collaborative management and funding of its platforms, which benefit the entire community. While members are highly engaged in training numerous PhD students, there is room for improvement in recruiting postdocs and visiting researchers. A wider use of English on the workflow and in seminars could make the unit more attractive for foreign researchers. Additionally, the unit's members contribute valuable expertise and actively promote knowledge transfer to the socio-economic sector.

1/ The unit has an attractive scientific reputation and is part of the European research area.

2/ The unit is attractive because for the quality of its staff support policy.

3/ The unit is attractive through its success in competitive calls for projects.

4/ The unit is attractive for the quality of its major equipment and technical skills.

Strengths and possibilities linked to the context for the four references above

The unit is recognized for its research-dissemination efforts, demonstrated through participation in numerous national and international conferences. This includes 30 invited presentations at Annual Meeting of the Phytopathological Society of Japan (2019, Tokyo, Japan), Plant Health 2019 (APS, Cleveland, USA), and the Fungal Genetics Conference (2019, Asilomar, CA). The unit also takes an active role in organizing sessions at international events, such as leading specialized sessions at the 12th International Congress on Plant Pathology (ICPP, 2023, Lyon, France) and the 14th European Conference on Fungal Genetics (ECFG, 2018, Haifa, Israel).

BIOGER organized two webinars with global experts, titled "Fungal Pathogens through the Looking Glass" and "Transposable Elements vs. Fungal Genomes".

BIOGER is also highly successful in securing external research funding, actively obtaining grants through international, national, local, and INRAE calls. BIOGER teams and researchers consistently participate in competitive funding opportunities, including H2020 projects, where they serve as work-package leaders and contributors.

Additionally, BIOGER contributed to significant projects, including twelve ANR projects, two individual research initiatives, as well as participation in flagship projects like "Beneficials & Specialized Metabolites" in collaboration with other SPS institutes. Additional involvement included the PEPR "Agroecology & Digital" projects, "Cobreeding and AgroDiv", and the PPR "Cultivating and Protecting Differently" projects MOBIDIV, VITAE, DeepImpact, and FAST.

BIOGER's technical platforms, especially in bioinformatics and cytology, offer extensive support for research activities. The cytology platform, located within a containment zone, enables real-time imaging of type 2 pathogenic organisms and GMOs and is managed by a dedicated full-time engineer. These platforms provide comprehensive support to all research teams, enhancing the quality and scope of their projects.

BIOGER's genomic resources supported by the specialized infrastructure of the bioinformatics platform (BioinfoBIOGER), ensure efficient storage, accessibility, and utilization for the broader scientific community.

The application of GWAS and QTL methodologies on host organisms has strengthened collaborations with prominent institutions, including the unit GDEC (Génétique diversité écophysiologie des céréales, UMR INRAE Clermont-Ferrand) and NIAB (National Institute of Agricultural Botany, Cambridge).

During the evaluated period, two scientists specializing in modeling and two with expertise in biochemistry were hired. Plans for 2024 include hiring an additional scientist with a background in cell biology and an engineer skilled in biochemistry.

BIOGER hosted six international PhD students and six visiting scientists from Germany, Spain, Italy, Ireland, the United Kingdom, Denmark, Australia, and Japan for short-term research stays.

BIOGER is a full member of the Saclay Plant Sciences (SPS) Graduate School of Research, which funded 3 PhD positions during the period, covered 50% of most Master-2 internships and supported two flagship projects. BIOGER is also part of a network of 58 research teams specializing in plant sciences, with its scientists actively participating in all levels of SPS activities, including steering committee. This involvement has enhanced BIOGER's attractiveness, by fostering greater interaction with other institutes in the Versailles-Saclay area (e.g. IJPB, IPS2), and increasing its global recognition in the field of plant research.

Weaknesses and risks linked to the context for the four references above

There is a clear need to diversify their funding streams by exploring the possibility of leveraging their European and international networks to target Horizon Europe funding.

Leading ANR-type projects by members of the unit should be encouraged. BIOGER's teams contributed as participants in twelve ANR-funded projects.

Although the platforms play a crucial role in supporting the various teams within the unit and currently operate in a highly collaborative manner, their long-term sustainability requires careful assessment.

Offering bioinformatics or experimental analysis services to external parties, such as industrial or academic institutions, could provide a sustainable source of funding to support the platforms' future operational and maintenance costs.

Safety instructions and equipment manuals are often only available in French. Scientific seminars are also often held in French. This makes it more difficult for foreign scientists to integrate in the unit and may even pose safety issues.

EVALUATION AREA 3: SCIENTIFIC PRODUCTION

Assessment on the scientific production of the unit

BIOGER scientific production is excellent because it is recognized for its high-quality and collaborative scientific output across three main themes towards understanding the molecular interactions between fungal pathogens and their hosts, mechanisms of pathogen adaptation, and developing sustainable disease management. They have developed and implemented in their research novel technologies such as GWAS, chromatin studies or structural analyses during the evaluation period, advancing their portfolio and methodologies to combat disease with sustainable disease management strategies. This has been carried out in close collaboration with socio-economical actors contributing to a smooth transfer of technology to the agricultural sector.

1/ The scientific production of the unit meets quality criteria.

2/ The unit's scientific production is proportionate to its research potential and properly shared out between its personnel.

3/ The scientific production of the unit complies with the principles of research integrity, ethics and open science. It complies with the directives applicable in this field.

Strengths and possibilities linked to the context for the three references above

To highlight how the scientific production meets the quality criteria, the unit has described its scientific production along with the three main themes. Thus, the evaluation will follow this order.

1) Molecular mechanisms of the interactions

One of the key aspects BIOGER is focused on is the identification of fungal effector proteins and their targets in planta. Research in this area will help to identify putative resistance mechanisms and susceptibility genes that can be managed to produce plants more resistant to these pathogenic fungi in close collaboration with plant breeders. Among the significant findings of their scientific production in this area can be mentioned the following:

- Identification of new fungal Avr genes and their cognate resistance genes using GWAS and quantitative genetic approaches. This feature is highlighted in their **portfolio feature 2** because it incorporates new technology that has accelerated the discovery of new targets that can be employed by breeders.
- Discovery of unconventional interactions between Avr genes and their cognate R partners, including epistatic interactions between Avr genes or the requirement of neighbour Avr genes to trigger recognition.
- Use of structural biology and prediction tools approaches to identify the family of effectors that do not share sequence similarity, thus helping to elucidate mechanisms of action. **Feature 3 of the portfolio**
- Role of secondary metabolites at manipulating plant defense system, with the development of technology for recombinant secondary metabolite production in yeast, a highlight in **portfolio Feature 4**
- Development of markers to follow the role of extracellular vesicles in the translocation of fungal effectors into the plant
- Identification of regulatory mechanisms controlling the expression of secondary metabolites and protein effectors towards identification of the mode of action and putative antifungal compounds impeding their production during infection. This was highlighted in the **Feature 5** of the portfolio because this area of research carried out in two research teams has not only helped to advance basic science but also allowed the collaboration with the private sector to develop antifungal compounds. Further, this subject has brought international recognition to the teams, helping to expand and disseminate research achievements.

2) Mechanisms and dynamics of adaptation

In this theme the focus was on using molecular methods for the analysis of adaptation to different biotic and abiotic stresses, as well as the influence of the plant host or non-host in the pathogen population. Major outputs in this area were:

- Implementation of transcriptomic studies to analyze temperature adaptation mechanisms that identified regions with repetitive elements as hot spots of differential expression
- Development of a public database of AvrLm alleles to be able to monitor pathogen populations through molecular analyses as well as technical developments for monitoring mutations to fungicide resistance. This feature is highlighted in the **portfolio Feature 7** because it allows understanding the factors that drive the evolution towards resistance to fungicides and therefore virulence dynamics in cultivars as demonstrated in key publications.
- Signs of pathogen evolution towards host specialisation identification by using genomic analyses.
- Mechanisms of adaptation to fungicides either by target mutation or by activation of detoxification mechanisms. Here an interesting approach using experimental evolution was highlighted in the **portfolio feature 6**, which resulted in the development of a new area highlighted by excellent publications.
- Unexpected correlation between pathogen aggressiveness and fungicide sensitivity in specific cultivars/fungicide combinations
- Identification of operational drivers of selection by studies on the dynamics of adaptation in agricultural conditions, such as regional uses of fungicides or presence of crop residues in the soil, highlighted in **Portfolio Feature 8**. In this context factors such as adaptation to temperature, host cultivars or fungicides were investigated.

3) Sustainable strategies for disease management

To now, most of the disease management is achieved by studying plant resistance genes and fungicides. To develop methods that are able more durable in time and thus sustainable this theme was developed, and the most remarkable findings were:

- Also highlighted in **Features 6 and 10**, management strategies such as adjusting fungicide doses or alternations of fungicides strategies were studied from an evolutionary perspective to increase durability of resistance. These efforts have resulted in novel management strategies of antifungal treatments, using them in alternating form rather than pyramiding, or in the use of binary wheat cultivar mixtures. As a result, a novel funding opportunity has emerged.
- Towards early application of management strategies, prediction of pathogens behaviour in response to control measurements was evaluated comparing experimental and field data, resulting in the identification of major drivers of this trait, such as use of varieties with multidisease resistance and fungicide doses, highlighted in **Feature 9**.
- For the transfer of technology to stakeholders and implementation of the management strategies identified, BIOGER has collaborated with several humanities departments, to collect and analyze sociological data and finally to give recommendations on fungicides, resistant cultivars to public bodies, professional organisations and other stakeholders, as well as to disseminate the scientific achievements through popular activities. This was highlighted in **Feature 11** of the portfolio.
- Furthermore, knowledge dissemination also took place through teaching activities, hosting of young researchers (from schools to doctorate), and social media content as well as with some other remarkable activities such as the "Phytopathological strolls". **Feature 12**.

In addition, the unit has worked in emerging areas which are likely to be further developed in the next period such as for instance the study of the microbiome associated to the diseased plants in focus of BIOGER.

The publications of the BIOGER unit are in highly reputed journals well known to the plant sciences researchers, such as New Phytologist, PLOS Pathogens, BMC Biology, Microb. Ecology, or Mol. Plant Pathology as examples, and even in broad audience journals such as Nature Communications, Metabolic Engineering or eLife. It is also appreciated that they published in a large variety of journals that range from those where more applied or technical results find their niche to those where the basic science behind the molecular mechanisms investigated is at the forefront. Thus, besides the journals mentioned above that are mainly reporting basic science, others such Pest Management. Sci., J. Agr. Food Chem., J. Nat. Products, or Plant Breeding are among the journals where BIOGER members disseminated their knowledge and findings in more applied areas. It is remarkable the high degree of collaborations reflected in the publications both among members of BIOGER but also with other national and international researchers. In addition, the scientific productivity in terms of PhD

students that have received their degree in this period is very high and supports the dissemination activities of the whole unit.

To assess whether the scientific production is shared equally among the different teams is a difficult task, because several of the manuscripts provided to substantiate the productivity are shared among several units, where the members of the manuscript belong to. This is actually a very good sign as it demonstrates collaborations among the teams but makes it difficult to evaluate whether the production is truly proportional to the resources of each team. Furthermore, several manuscripts are ascribed to more than one feature in the portfolio, also complicating this task.

The unit is committed to an open science policy publishing preprints and data sets in repositories such as BioRxiv or Zenodo and by choosing Peer Community Journals. As far as we can judge, the unit complies with integrity and ethics values of publication (i.e. the committee does not have knowledge of misconduct or plagiarism that has been reported to this unit, or papers that have been retracted).

Weaknesses and risks linked to the context for the three references above

The unit has not specified how they comply with the principles of research integrity and ethics, whether they use anti-plagiarism software, or have electronic books or laboratory books that stay in the unit, etc. This could be a recommendation to improve this area. Also, the increasing use of AI in Science should be somewhat monitored for compliance to the rules of ethical behaviour, and it would be useful that the unit would define protocols to accomplish this in the future period.

EVALUATION AREA 4: CONTRIBUTION OF RESEARCH ACTIVITIES TO SOCIETY

Assessment on the inclusion of the unit's research in society

BIOGER is in strong interaction with breeders and non-academic partners, especially through its engagement in developing new strategies for crop disease management. The unit has close relationships with socio-economic partners such as ARVALIS, De Sangosse, or the "Union Française des Semences," with which the unit established the "Club Phoma." These interactions gave rise to seven Cifre contracts. The unit has played a vital role in the establishment of a fungicide resistance database at the national level (R4P) and European level (EPPO database on fungicide resistance). Its inclusion in society is excellent. This is true at different levels. For instance, several members of the unit contributed to a reference textbook in Phytopathology, published in 2023, or communicated science to school children through the "Des Plantes et des Hommes" program.

1/ The unit stands out for the quality and the amount of its interactions with the non-academic world.

2/ The unit develops products for the cultural, economic and social world.

3/ The unit shares its knowledge with the general public and takes part in debates in society.

Strengths and possibilities linked to the context for the three references above

There were seven Cifre contracts for PhD students in the past period which is much higher than what could be observed in similar-sized research units. They involved different partners: ANRT, Syngenta, Corteva, Bayer, Arvalis, Innolea, and Euralis. This demonstrates the importance of the research led by BIOGER to tackle key questions for the socio-economic world. There were strong interactions with ARVALIS, at least until 2021 since one team of ARVALIS was hosted at BIOGER. There were major contributions to expert groups (CTPS "Comité Technique Permanent de la Sélection" ANSES, for instance) that have an impact on public policy making. The effort of communication oriented towards knowledge transfer and popularization of science is noteworthy: training sessions for practitioners through the engagement in the R4P network (experts of resistance to pesticides), publications of many articles in French reviews Phytoma, "Perspectives Agricoles," "Innovations Agronomiques" for instance.

Weaknesses and risks linked to the context for the three references above

Interactions with ARVALIS may be lower than it has been in the past, since the departure in 2021 of the team hosted previously. This may weaken the interactions of BIOGER with the non-academic sector. There may be a risk of dependence to private funding which could lower the potential of developing original fundamental research projects. There is a need to continue applying to public calls for proposals to diversify sources of funding. Actions of communication towards school classes and journalists are mentioned in the SAD but it is unclear whether it is a major contribution to the social debate, the general public information, or rather a minor contribution.

ANALYSIS OF THE UNIT'S TRAJECTORY

- The unit has intensively worked on establishing and maintaining transversal themes of work and at increasing the scales of their research.
- Through their work in this period, they have established a collection of species and isolates with different properties, pathogens of their major plant hosts that are now also augmented with other microbes accompanying infected plants.
- This has created a series of resources, technologies and knowledge that are intended to be used in the next period.
- A structural reorganisation of the unit following the movement to the new premises has created central platforms that will benefit all teams and allow an even closer interaction among the teams, facilitating scientific exchange and dissemination of knowledge.
- Their former three main research projects have been augmented to four with the inclusion of the study dedicated to the study of the biology and lifestyles of the fungal pathogens. The other subjects, mechanisms of interactions, adaptation in phytopathogenic fungi and sustainable management of fungal diseases remain.
- Several personal problems still exist and need to be addressed in the next period by recruiting more scientific/technical staff to some teams that would benefit of increasing their portfolio and thus their international visibility. But also, by recruiting staff to facilitate the disentangling of the director position duties, which should be more clearly delineated.

RECOMMENDATIONS TO THE UNIT

Recommendations regarding the Evaluation Area 1: Profile, Resources and Organisation of the Unit

It is urgent and essential to identify a successor for the current unit director by initiating an external call for applications and establishing a solution to provide the incoming director with administrative support.

To drive the development, expansion, and optimized utilization of the platforms, it is recommended to implement a comprehensive, sustainable long-term economic model. Offering select platforms as research services to the academic and private sectors could generate additional funding, increase visibility, and enhance their overall appeal.

BIOGER researchers should respond to Horizon Europe-type calls for proposals to help cover building operating expenses.

The unit should explore solutions to mitigate premature and unexpected departures of personnel looking to relocate outside the Île-de-France region.

BIOGER should prioritize topics for which it has established international leadership and recognition.

Recommendations regarding the Evaluation Area 2: Attractiveness

The unit has a very good to excellent reputation and is well integrated in a national and international network of collaborations. Its attractiveness could be enhanced even further by continuing efforts to integrate the English language in the everyday life of the lab. The unit is very active in terms of teaching and outreach in France. It could increase its international visibility, by building additional international collaborations and projects, for instance, with developing countries facing similar challenges in combatting cereal diseases. Part of the common financial pool could perhaps be used to encourage the unit's members who are willing to try and obtain international projects such as ERC grants.

Although the unit often participates in the organization of pathology-related international conferences in other cities, it could maybe take responsibility in organizing one on its own site, which usually brings a big boost to a unit's visibility. Science outreach and transfer could also be made more international. For instance, the book "Phytopathologie" is a very valuable contribution, but it is published by the French Society for Phytopathology, and appears not to have been translated into English. Such a translation could be a worthy objective to make Feature 12 of the Portfolio even stronger.

Recommendations regarding Evaluation Area 3: Scientific Production

The scientific production of the unit is excellent. If at all, it would be recommended increasing the number of publications, if possible, in broad spectrum high-ranking journals to increase the visibility of the unit. We understand that publishing in such journals implies long revision and publication times, but this should be less critical in a research unit such as BIOGER given that they have staff with permanent positions and that they regularly pre-publish in repositories such as BioRxiv. One additional aspect that has not been explicitly addressed in their report and that should be considered is the use of specific technology and protocols to prevent and detect possible cases of plagiarism or non-ethical use of results.

Recommendations regarding Evaluation Area 4: Contribution of Research Activities to Society

There were strong and fruitful collaborations with socio-economic partners, especially through the funding of Cifre contracts and collaborative projects. This should be sustained. However, it is important not to become too dependent on private funding (FSOV "Fonds de Soutien à l'Obtention Végétale," for instance) to maintain a high level of production of original fundamental knowledge. The position as experts, as a reference to understand the dynamics of pathogenic fungal populations, is strategic and should be maintained.

TEAM-BY-TEAM ASSESSMENT

Team 1: AMAR: antifungals: mode of action and resistance

Name of the supervisor: Ms Anne-Sophie Walker

THEMES OF THE TEAM

The aim of the AMAR (Antifungals: mode of action and resistance) team is to provide knowledge for the management of fungicide resistance in the context of agroecology. The team has developed three research lines in the last period: (1) Pathogen adaptation: Which are the adaptive processes underlying pathogen adaptation to antifungals? (2) Sustainability: How to improve fungicide sustainability in the context of agroecology? (3) Management implementation: How to implement resistance management?

In recent years the team has extended its field of investigation to include natural antifungal compounds and biocontrol agents.

Research is focused on the fungal wheat pathogen *Zymoseptoria tritici*. Occasionally, other fungal models are used such as *Fusarium graminearum, Cercospora beticola* and *Puccinia striiformis*.

CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

The AMAR team implemented the recommendations from the previous report whenever feasible.

AMAR concentrated on understanding the mechanisms behind pathogen adaptation to fungicides and the development of sustainable resistance management strategies. Using a spatial modeling framework, they analyzed how different spatiotemporal treatment allocations influence the sustainability of the mosaic strategy. This analysis compared the mosaic approach to more commonly studied strategies, such as mixing and alternation, while also examining the impact of the targeted pathogen population composition. Additionally, the study ranked the effective lifespans of various strategies.

Despite the team's intentions, one researcher and three technicians have left, who were replaced by only two new technicians providing partial support.
They collaborated with ECCP team on host specialization in *B. cinerea*

AMR team continues to collaborate with agricultural and chemical industries, partnering with national and international organizations in the field of anti-resistance management. Notable collaborations include efforts with CNRS I2BC, Corteva (USA), and Sumitomo (Japan) to enhance fungicide sustainability within the framework of agroecology.

WORKFORCE OF THE TEAM: in physical persons at 31/12/2023

Catégories de personnel	Effectifs
Professeurs et assimilés	0
Maîtres de conférences et assimilés	0
Directeurs de recherche et assimilés	1
Chargés de recherche et assimilés	1
Personnels d'appui à la recherche	3
Sous-total personnels permanents en activité	**5**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels d'appui non permanents	0
Post-doctorants	0
Doctorants	3
Sous-total personnels non permanents en activité	**3**
Total personnels	**8**

EVALUATION

Overall assessment of the team

AMAR team conducts original research focused on uncovering the molecular mechanisms behind pathogen adaptation to antifungals, enhancing fungicide sustainability in agroecology, and implementing strategies for resistance management. The scientific quality of the work is very good to excellent and is of an international standard. Their work is well funded through national grants and industry partnerships, supporting a very good to excellent publication record.

AMAR's contributions to society are significant, demonstrated by collaborative efforts with leading industry partners, including Bayer Crop Science, Syngenta, and BASF and by the pivotal role the unit played in the establishment of national and international fungicide resistance databases.

Strengths and possibilities linked to the context

The team is conducting basic and applied research on antifungal resistance and is studying this topic in a comprehensive way from the molecular to the field level. The team uses an interdisciplinary approach in almost all its project and the scientists of AMAR cover disciplines such as agronomy, microbiology, biochemistry, molecular genetics, population genetics, phytopathology and biomathematics. This has resulted in a rich collection of resistant fungal populations and original diagnostic tools. Team members are considered leaders in their field. This is reflected by six invitations to speak at international conferences such as the Plant Health 2019 conference organized by the American Phytopathologica Society in Cleveland and the Fungal Genetics Conference 2019 in Asilomar, Canada and seven memberships of scientific committees for (inter)national conferences, including the 12th International Congress on Plant Pathology (ICPP, Lyon, France).

The team has done pioneering work on non-target site resistance mechanisms and identified bypass resistance mechanisms and alternative types of multidrug resistance such as increased efflux due transporters other than MFS1. Research on non-target site resistance mechanisms has become a signature of the AMAR team.

The team coordinates with Arvalis the Performance network in France. This is a database unique in Europe, which records the annual resistance status in *Z. tritici* populations at around 70 sites in France and provides recommendations for resistance management to stakeholders via an annual note. A comprehensive statistical analysis of the database allowed the identification of fungicide resistance evolution at large spatio-temporal scales. An application was developed to visualize the state of resistance on a map of France and to forecast their evolution.

The team is using a unique experimental evolution approach to investigate how *Z. tritici* adapts to fungicides. This approach, not commonly used in fungi, allows predicting putative resistance mechanisms against novel synthetic or natural antifungal compounds.

In terms of scientific output, the team has published 23 research articles of which 3 on BioRxiv. The others are published in their field of specialisation such as Environmental Microbiology, Pest Management Science and Phytopathology, with four papers published in more general journals (New Phytologist, Plos Pathogens, Communications Biology, Food Chemistry) with high international visibility.

The team is devoting a considerable amount of time in knowledge transfer to stakeholders. The team leader of AMAR is also the team leader of the Reflection and Research Network on Pesticide Resistance (R4P). The website of R4P provides information on pesticide resistance and hosts a database that records informed cases of pesticide resistance in France. This database initiated a European database on pesticide resistance hosted by the European Plant Protection Organisation (EPPO). Team members participate in professional organisations (Végéphyt) and expert committees (ANSES, ECOPHYTO, Certificats d'Economie des Produits Phytosanitaires [CEPP], EPPO) and are strongly involved in science communication. In the evaluation period, the team has written 8 transfer articles in French, mainly in Phytoma la Défense des Végétaux (6).

During the period, the team has trained 9 PhD students, which is a high number given the size of the group.

Weaknesses and risks linked to the context

The AMAR team with its focus on resistance to antifungal encounters increasing difficulties to secure public funding for its research.

The team has lost most of its permanent engineers and technical staff due to retirement and is without technical support in microbiology and molecular biology.

One member of the team is also director of BIOGER and is thus heavily involved in administrative duties.

Analysis of the team's trajectory

The entire AMAR team together with two former members of the EPIDEV team have established a new team, called GAIA (Guiding management and anticipation for fungal pathogen adaptation) in January 2024. The permanent staff of the GAIA team is composed of 1 DR, 1 CR, 3 IR and 1 TR. The non-permanent staff is composed of 3 PhD students and 1 temporary technical staff member. The team has 2 HDR holders and is affiliated with two doctoral schools: SEVE (Ecole Doctorale Sciences du Végétal) and ABIES (Ecole Doctorale Agriculture, alimentation, biologie, environnement et santé). The future trajectory aims to understand, anticipate and manage the adaptation of wheat pathogens in the context of agroecology. Fungal models that will be studied are *Zymoseptoria tritici* and *Puccinia triticina*. The trajectory is organized around 4 complementary questions from fundamental to applied research. The objective of Topic 1 (**Selection**: what constraints do control methods exert on fungi?) is to understand the interaction between antifungals (particularly biocontrol antifungals) and fungi at the molecular and cellular scales, leading to individual selection. In addition, public databases and dedicated trials will be used to describe how selection pressures are unevenly distributed over time and space in fungal populations. Topic 2 (**Adaptation**: Which are the processes underlying adaptation to cultivars and antifungals in fungi?) builds on the key expertise of the previous AMAR team and has as objective to understand the genetic and genomic determinism of adaptation to antifungals in *Z. tritici* with a focus on natural compounds and non-target site resistance. At the population and landscape scale, the aim is to understand how the joint selection from multiple control measures and the global fungal environment impacts the frequency of adapted variants and epidemics over time and space. A population geneticist will be hired to help with this topic. The aim of Topic 3 (**Sustainability**: How to improve the sustainability of control measures in the context of agroecology) is to improve the sustainability of control measures. Evolution experiments will be used to predict the resistance mechanisms that may be selected by antifungal compounds. A modelling approach will be employed to anticipate resistance evolution in populations. In Topic 4 (**Transfer**: How to implement adaptation management?) the use of relevant strategies will be promoted among farmers and advisors. Collaboration with social science colleagues will help to understand the technical and organisational issues that limit their implementation. In addition, the team will continue its activities in science communication and knowledge transfer via the R4P network and by giving recommendations to stakeholders and will also guide public policies by being active in relevant institutions. It is clear that the approach of the GAIA team will be more holistic than the AMAR team by not only looking at chemical antifungals, but also at biocontrol antifungals and cultivar resistance.

RECOMMENDATIONS TO THE TEAM

It is recommended that the team where possible target publications in highly respected multidisciplinary journals to increase the citations and visibility of their research work.

The team could strive to attract more applicants for postdoctoral fellowships and visiting professors.

It is recommended that the team attempts to recruit additional researchers, and postdocs, to enhance its potential future sustainability.

The team should enhance technical support in microbiology and molecular biology by recruiting additional skilled technicians.

Team 2: EPIDEV : Epidemiology and evolution of fungal wheat diseases

Name of the supervisors: Mr Frédéric Suffert

THEMES OF THE TEAM

Team EPIDEV conducted research in plant epidemiology, focusing on three fungal pathogens of wheat: *Puccinia triticina* (leaf rust), *Puccinia striiformis f. sp. tritici* (stripe rust), and *Zymoseptoria tritici* (Septoria leaf blotch). The team studied the impact of the pathogen genotype, the plant genotype and the environment, on the development and spread of the disease at different spatio-temporal scales (e.g. with the epidemic period versus between epidemic period). The team used a broad range of methods from plant pathology, population and quantitative genetics, ecology, biophysics and modelling.

CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

Recommendations of the previous report regarding scientific production have been well considered by the team and there was no decrease of the scientific production level despite the move to Saclay and the associated difficulties in maintaining field and greenhouse experiments. Importance of studies at the landscape scale was very well-considered while investigating sustainable solutions for disease management techniques. Studies at the molecular level, regarding gene-by-gene interactions, were carried out with great success and the team published important results on identifying novel virulence genes in Z. tritici.

WORKFORCE OF THE TEAM: in physical persons at 31/12/2023

Catégories de personnel	Effectifs
Professeurs et assimilés	1
Maîtres de conférences et assimilés	1
Directeurs de recherche et assimilés	0
Chargés de recherche et assimilés	2
Personnels d'appui à la recherche	6
Sous-total personnels permanents en activité	**10**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels d'appui non permanents	1
Post-doctorants	1
Doctorants	2
Sous-total personnels non permanents en activité	**4**
Total personnels	**14**

EVALUATION

Overall assessment of the team

The team activity is excellent. The team is well recognized for its expertise on a selected set of wheat pathogens and has a long history of monitoring them in the fields over the years. These activities are supported by good connections with and support from the agricultural sector (GIE Blé Dur, Arvalis...). This accumulation of data combined with expertise in genetic analyses (QTL mapping, GWAS) were successful, a conclusion supported by a sustained scientific production, in journals such as Plant Pathology, Phytopathology or PLoS Pathogens, and the participation in many national and international collaborative projects.

Strengths and possibilities linked to the context

An important strength of the team is its close connection with the agricultural sector and the long-term monitoring of pathogen epidemics and variants in the field, combined with state-of-the-art laboratory experiments and genetic analyses. This position is a major asset for the team and allows recurring funding opportunities, significant applied contributions, as well as innovative scientific inquiries. The research of the team is central to INRAE and as such is sometimes showcased; for instance, studies of wheat microbiome were presented at the "Salon National de l'Agriculture" in 2019, as an INRAE highlight.

Weaknesses and risks linked to the context

The team did not survive the combination of the COVID-19 pandemics and the relocation to Saclay, with the occurrence of serious inner tensions between members and its ultimate dissolution in 2022. It is not easy to determine what was contingent and what was preventable, but perhaps the large size of the team and the variety of its projects was a factor of risk. The team no longer exists and so most elements of risk or weaknesses are no longer relevant. One weakness mentioned by the team might be ongoing, however: it is the difficulty to finance postdoc researchers in the French ecosystem. Given the team's activity, finding a way to attract more postdocs would indeed be desirable.

Analysis of the team's trajectory

EPIDEV team was dissolved in 2022 and a substantial reorganization led to the creation of two novel teams, ADEP and BioSysCo, while some members joint a third new team GAIA. The trajectories of ADEP and BioSysCo are analyzed here.

ADEP was officially created in January 2024. It is co-led by 1 CR and 1 IR who used to collaborate efficiently in EPIDEV and who recently co-published important results associating quantitative genetics and genomics of fungal pathogens to identify effectors. A professor of University Paris-Saclay also joint the ADEP team, with an area of expertise in wheat-pathogen molecular interactions although on a different pathosystem. The team has thus strong leadership and management capabilities with (soon) 3 HDR holders. There are also 1 permanent TR, 2 PhD students, 1 postdoc, and 1 non-permanent engineer, to support the project. The project is overall excellent and in line with what has been successful previously. The association of the epidemiological view at the population scale, and the high-throughput genomics/transcriptomics to decipher molecular mechanisms of plant-pathogen dialog, is highly relevant. The scientific questions are raised clearly and the means to address them are sound, e.g. dual transcriptomics. It is unclear whether objectives were prioritized but it appears that objectives 1 and 2 are the main ones for the coming years. One key aspect for success and a risk is the capability to perform bioinformatics analyses for the projects. The support of the Bioinformatics platform will be critical, and one can wonder if the bioinformatics staff is sufficient to ensure service to all projects of the unit.

Objective 3 is well suited and raise the interesting question of the contribution of sexual reproduction of the pathogen on its adaptation. The pathosystem remains the same, wheat-STB, so this objective looks quite complementary and interconnected with what will be done in the previous objectives.

Objective 4 is newly launched and on another system, wheat rust (*P. graminis*). Given the split of the teams and the decrease in staff, one may wonder if the human resources are adequate to tackle this objective. However, it is mentioned that the aim is to develop the project within the 5 coming years, based on recent attractive initiatives and it is probably worth trying to set it as an objective. Finally, it is not clear how the professor who joins the team will contribute, with another pathosystem or not, to one or several of these objectives.

BioSysCo was founded in January 2024. The team associates 3 CR staff with 2 being co-leaders. It is a multidisciplinary team. The trajectory is in the direct continuity of the ongoing projects led by co-leaders. First axis wants to get better insights into leaf rust epidemiology (pluriannual dynamics), pathogen population dynamics, impact of cultivars on this dynamic, in order to enhance resistance management. Second axis is focused on another pathogen, *Zymoseptoria tritici,* and is more related to evolutionary genomics to decipher the genetic basis of pathogenicity. It also raises the question of genome adaptation to abiotic factors through experimental evolution. Finally, the team wants to integrate both axes in the near future. The need to build an integrated project appears crucial to benefit from the multidisciplinarity. BioSysCo is the only BIOGER team to be associated with other research units, through the IDEEV federation. The durability and significance of this is uncertain.

RECOMMENDATIONS TO THE TEAM

A recommendation to both new teams is, of course, to consolidate their project and inner cohesion, especially given the difficult relational issues their members have gone through. Obviously, potential conflicts related to thematic overlaps between the teams should be anticipated and avoided as much as possible. Those two teams are now much smaller than the original EPIDEV team (4–5 permanent staff each). Their projects should thus be tailored to this smaller size. This probably concerns more team ADEP, whose project is quite in line with

the earlier project and even projects to add a new axis. The team should be vigilant not to overload its actual work capacity.

Team BioSysCo is comprised of three scientists originating from three previous different teams and, for some of them, still at an early stage of their career. The project proposed is multidisciplinary and all three scientists act as co-leaders. The common project does not appear completely clear, even though the potential for building up on the diverse skills is noteworthy. More efforts should be devoted to building the project, especially the integration of theoretical and genomic approaches. This could be achieved in a more systematic manner, e.g. by organizing brainstorming retreats, with a couple of external advisors.

Team 3:	ECCP: Effectors of cellular communication at the fungal-plant interface
Name of the supervisors:	Ms Muriel Viaud and Mr Jean-Félix Dallery

THEMES OF THE TEAM

The ECCP (Effectors of cellular communication at the fungal-plant interface) team investigates the infection processes of two fungal models with distinct feeding strategies and host ranges: *Colletotrichum higginsianum*, a hemibiotrophic pathogen infecting *Arabidopsis thaliana* and other *Brassicaceae*, and *Botrytis cinerea*, a necrotrophic, polyphagous pathogen. Their research aims to elucidate the roles of secondary metabolites, identify genomic factors contributing to partial host specialization in polyphagous pathogens, and examine the function of extracellular vesicles in interkingdom communication.

CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

Previous recommendations were that international collaborations are crucial and that studies on secondary metabolites may lead to new intellectual property and links to industry.

In the period under evaluation, there has been a strong international collaboration about the role of extracellular vesicles in fungal-plant communication via the ERA-CAPS project "Exosomes" (2018–2022) that involved top plant scientists from Indiana University, Donald Danforth Plant Science Center and Copenhagen University. A key study showing that the secondary metabolite Higginsianin B acts as an effector and suppresses jasmonic acid mediated plant defenses was a collaboration with the Leibniz Institute for Plant Biochemistry and the Max Planck Institute for Plant Breeding Research in Germany and the University of Athens in Greece. In the coming years, international collaboration with Indiana University in the field of fungal extracellular vesicles will be continued.

So far, research of the ECCP team has not led to intellectual property or industrial collaborations, but this is planned in the trajectory in the framework of a European Doctoral Network which will look at the potential of fungal secondary metabolites in agriculture, health, food and cosmetic products.

WORKFORCE OF THE TEAM: in physical persons at 31/12/2023

Catégories de personnel	Effectifs
Professeurs et assimilés	0
Maîtres de conférences et assimilés	0
Directeurs de recherche et assimilés	2
Chargés de recherche et assimilés	2
Personnels d'appui à la recherche	4
Sous-total personnels permanents en activité	**8**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels d'appui non permanents	0
Post-doctorants	0
Doctorants	1
Sous-total personnels non permanents en activité	**1**
Total personnels	**9**

EVALUATION

Overall assessment of the team

The team conducts excellent and innovative research on infection mechanisms in two pathogenic fungal models with distinct feeding strategies and host ranges, employing multidisciplinary approaches. This work enhances their visibility and fosters strong collaborations with other BIOGER teams, as well as with national (ANR collaborative projects) and international (ERA-CAPS projects) partners. Their scientific output is very good, featuring excellent contributions in specialty journals, including a collaborative article in the Journal of Extracellular Vesicles. The team has successfully funded their research through international, national and non-academic/private sources.

Strengths and possibilities linked to the context

The team's interdisciplinary approach is evident in the wide array of journals where their work appears.

The collaborative nature of their research is highlighted by frequent co-authorship with international teams.

Their responsiveness to societal needs is demonstrated through partnerships with socio-economic stakeholders, such as De Sangosse (ANR HerbiFun).

Scientifically, the team is well established in their field, participating in numerous research projects with robust funding at local, national, and international levels.

Recruiting a new researcher specializing in extracellular vesicles (EVs) will enhance the team's position in this highly competitive international field.

Weaknesses and risks linked to the context

The team should work to increase the share of publications where they hold lead authorship.

Analysis of the team's trajectory

The proposed trajectory of the ECCP team is in line with the previous period and mainly falls in the theme II of BIOGER: molecular fungal-plant interactions. Four research topics are proposed. (1) Fungal secondary metabolites acting as chemical effectors; (2) Genomic determinants of host specialization; (3) Fungal extracellular vesicles: unravelling their roles in plant infection; (4) Which plant signals reprogram fungal gene expression? Topics 1 and 3 will be prioritized. Execution of topics 2 and 4 will depend on funding and the possibility of recruitment.

Topic 1 will focus on the identification and functional characterization of secondary metabolites in *Colletotrichum higginsianum* and *Botrytis cinerea*. The topic is technically demanding and will benefit from recently developed technical tools in the ECCP team such as the yeast factory and knockout tools. In addition, a new class of secondary metabolites will be investigated, the dikaritins. Interactions between fungal secondary metabolites and plant proteins will be investigated using heterologous expression. In addition, more attention will be paid to applications by valorizing the biotechnological potential fungal secondary metabolites.

In Topic 2 the hypothesis that host specialization in Botrytis cinerea is determined by retrotransposons and their derived siRNAs will be tested by functional analysis. Depending on funding, the role of the accessory chromosomes will also be investigated.

In Topic 3 the priority is to develop methods to isolate fungal extracellular vesicles from infected plants using extracellular vesicle biomarkers. These biomarkers will also be used to study extracellular vesicle secretion and host uptake. Knowledge obtained in the model fungus *Colletotrichum higginsianum* will be transferred to other fungal models used in BIOGER. A long-term aim is to develop control strategies based on chemicals that inhibit extracellular vesicle secretion.

In Topic 4 biosensor strains will be used to identify plant-derived signals that trigger expression of fungal secondary metabolites. This new topic will be launched by seeking funding for Masters or PhD projects.

RECOMMENDATIONS TO THE TEAM

The team should improve its leadership position in general scientific journals.

It is recommended that the team where possible target publications in highly respected multidisciplinary journals to increase the citations and visibility of their research work.

The originality of the research topics of ECCP deserves dissemination and attraction of a new generation of researchers via teaching participation at Paris Saclay University. The team is encouraged to pursue its efforts in this direction.

The expert committee recommends that the team actively works to boost their attractiveness to PhD candidates and postdoctoral researchers.

Research on secondary metabolites holds strong potential for biocontrol applications against phytopathogenic fungi and is expected to enhance the team's engagement with socio-economic partners.

Team 4: EPLM: Effectors and pathogenesis in *Leptosphaeria maculans*

Name of the supervisors: Ms Isabelle Fudal, Ms Jessica Soyer and Ms Valérie Laval

THEMES OF THE TEAM

The EPLM team focus is on the interaction between the pathogen *Leptosphaeria maculans* and its host plant *Brassica napus*. The final aim is to produce durable resistance to this pathogen in a close collaboration with socio-economical actors. To that end they analyse the molecular dialogue between the pathogen and its host, its regulation, and the molecular evolution of pathogenicity under the resistance selection pressure. To that end, their team is composed of researchers with different expertise that include plant pathology, fungal genetics, genomics and epigenetics, metabarcoding and molecular biology. In addition, they closely collaborate with other teams at BIOGER with complementary expertise. In such a scenario, this team has produced three major conceptual advances that will help to better fight this disease, including 1) the discovery of the two-speed genome in Leptosphaeria, 2) the consequences of genome structure for gene expression and pathogen adaptation, and 3) the existence of complex mechanisms to avoid recognition by the defense system of the plant.

CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

The previous report saluted the high level of scientific production and recommended to ensure it remains so. This appears to have been the case.

To cope for a relative lack of international attractiveness, especially towards postdocs, it was recommended to organize international seminars and invite high-profile researchers in the unit. The development of collaborations with the leading labs working on the plant partner (rapeseed) was also suggested to better capture the two sides of the pathogenic interaction. These two recommendations were not directly addressed, even though three visiting scientists from international partners (postdocs and PhD students) were hosted in the lab during the evaluation period.

WORKFORCE OF THE TEAM: in physical persons at 31/12/2023

Catégories de personnel	Effectifs
Professeurs et assimilés	0
Maîtres de conférences et assimilés	0
Directeurs de recherche et assimilés	2
Chargés de recherche et assimilés	3
Personnels d'appui à la recherche	7
Sous-total personnels permanents en activité	**12**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels d'appui non permanents	0
Post-doctorants	1
Doctorants	2
Sous-total personnels non permanents en activité	**3**
Total personnels	**15**

EVALUATION

Overall assessment of the team

The EPLM team is a highly productive and internationally recognized group for their research on the fungal pathogen *Leptospheria maculans* and its pathogenic mechanisms. Regularly active in prominent fungal genetics conferences, their members are sought after for presentations and leadership roles. Their high-impact research, often preprinted on BioRxiv, is published in top journals like New Phytologist and PLOS Pathogens. Collaborative projects with socio-economical actors help to not only disseminate their research but to tackle plant disease challenges bridging basic and applied science. The team has a dynamic research environment with a steady flow of grants and new initiatives. Thus, the overall assessment of this team can be qualified as excellent.

Strengths and possibilities linked to the context

The EPLM team is a highly recognised team in the international community. As explained above, their focus is on the fungal pathogen *Leptosphaeria maculans* and its molecular mechanisms of pathogenicity. Therefore, they find their "natural ecosystem" in conferences dealing with molecular fungal genetics such as the Asilomar Fungal Genetics Conference or the European Fungal Genetics Conference, where their members are well known and often invited for talks and chairing of sessions. But also, in plant pathology communities and conferences. Because of this recognition, their members are also part of international evaluations committees such as for instance the evaluation of a Research Group in Germany funded by the DFG where Dr. Fudal was one of the seven panel members, or national evaluations such as the HCERES evaluation where Dr. Rouxel was president. This is further supported by their many collaborations, both at the national level and at the international level reflected in the many high-quality manuscripts published by this team in highly reputed journals such as New Phytologist, PLOS Pathogens, PLOS Genetics, or Mol. Plant Pathology as examples. Their efforts to openly communicate their science is also reflected in that several of these publications are in repositories such as BioRxiv as preprints prior to their final publication. In this way, they contribute to disseminating findings into the scientific community and give recognition to young researchers in a faster way of facilitating their next steps in the scientific career. Their research has many highlights. An interesting one is the Club Phoma in which different French groups and companies have joined forces to combat the stem canker disease meditated by *L. maculans*. In this way, the team which has its main expertise on the fungal partner of the disease is in close interaction with other groups focusing on the plant side. This initiative is supporting one of the PhD Thesis of the team. Another interesting highlight is the development of an epidemic-surveillance tool which is of high interest for the socio-economic partners and thus reflecting a smooth transition between basic research and applied science and reflected in the Feature 7 of the Portfolio. Several of their highlights have been recognised by the INRAE SPE division in 2021 and 2023, and some are also to be seen in Features of the Portfolio such as 3 and 5. The size of the team is as they described it manageable including permanent and non-permanent staff, scientists, technical staff, students and visiting fellows. The many PhD students currently in the team and the four postdocs indicate an active and thriving scientific atmosphere necessary to accomplish the aims of their research, which is in constant expansion with three new topics incorporated during the evaluation period. In this time, this team has been very successful in acquiring grants to fund their research. These grants are from different agencies such as ANR, INRAE or involving local funding or in collaboration with international projects.

Weaknesses and risks linked to the context

There are no major weaknesses that the committee can identify in the research, structure or trajectory of this team. However, the weaknesses that they themselves mention are important self-criticisms that should be investigated and addressed. Thus, it is surprising that given their success in obtaining funding from national sources, their efforts to obtain international funding are not very successful. The second important self-criticism is the difficulty to attract and consolidate personal since the move to Saclay given the high living costs of the area. This is a problem that cannot be addressed directly by the team and would need to be addressed in the context of the whole BIOGER unit. Perhaps and intensive discussion, which they already had, with representative members of each team and the direction of the unit will help to find solutions to a problem that is likely to affect all groups.

Analysis of the team's trajectory

The trajectory of the team is characterized by a form of (successful) continuity. No big change is to be noticed or is anticipated in terms of research axes. The project of the team remains organized in three main axes that correspond well to the work conducted previously by the team. The first axis seeks to understand the mechanisms underlying biotic interactions within the "plant/pathogen ecosystem". The second axis is about understanding the mechanisms of adaptation (e.g. host adaptation and resistance). The first axis is more about deployment strategies and consists in devising and evaluating sustainable disease control methods. Scientifically, a choice is explicitly made to focus on one pathogen (*L. maculans*) and on a restricted set of host and non-host plants in *Brassica* genus, including the plant microbiome.

Such stability is also observed in terms of composition, as the team managed to recruit one research scientist, one engineer and one technician over the period, almost compensating for the loss of staff associated with the relocation to Saclay.

RECOMMENDATIONS TO THE TEAM

Given the difficulties to obtain international funding, one could consider if including a new researcher with the focus on the plant side in the unit will help to overcome this problem and be able to increase the portfolio. This was a recommendation of the past evaluation and although the team has collaborated with other groups in France to overcome this problem, perhaps it would be beneficial to incorporate someone with molecular genetics expertise in *Brassica napus* and extend the possibilities of acquiring international funding. The team is doing excellent research, but it seems modest. They could further increase their international visibility by being more ambitious in their publication output by trying to publish their excellent work in top journals.

CONDUCT OF THE INTERVIEWS

Dates

Start: 5 December 2024 at 8:30 a.m.

End: 6 December 2024 at 1 p.m.

Interview conducted: on-site

INTERVIEW SCHEDULE

Thursday, December 5, 2024

Part 1: General presentations (participation of all members of the unit & representatives of supervising bodies)

08h30 - 08h45 Introduction (Chair of the committee and Hcéres Scientific Advisor)

08h45 - 09h30 Organization, scientific policy and trajectory of the unit (S. Fillinger, V. Laval, I. Fudal, T. Marcel, T. Vidal)

09h30 - 10h00 Discussion with the committee

10h00 - 10h35 Team 2 EPIDEV: Epidemiology and evolution of fungal wheat diseases (T. Marcel, AL. Boixel, F. Suffert, T. Vidal) + trajectory of the new team 6 ADEP (T. Marcel)

10h35 - 10h50 Trajectory of the new team 7 BioSysCo (A. Genissel)

10h50 - 11h10 Discussion with the committee

11h10 - 11h25 Break

11h25 - 12h00 Team 1 AMAR: antifungals: mode of action and resistance + trajectory of the new team 8 GAIA (AS. Walker)

12 p.m. - 12:20 p.m. Discussion with the committee

12h30 - 13h30 Lunch

13h30 - 13h55 Team 3 ECCP: Effectors of cellular communication at the fungal-plant interface (M. Viaud, R. O'Connell)

13h55- 14h15 Discussion with the committee

14h15 - 14h50 Team 4 EPLM: Effectors and pathogenesis in *Leptosphaeria maculans;* (I. Fudal, V. Laval)

14h50 - 15h10 Discussion with the committee

Part 2: Meetings with lab members (closed meetings)

15h15 - 16h00 Meeting with the technical & administrative staff

16h00 - 16h45 Meeting with teacher-researchers& researchers (without the direction of the unit)

16h45 - 17h30 Meeting with PhD students, post-docs and contractual researchers (without supervisors)

17h30 - 18h30 Debriefing of the committee (closed) Pal-B2.02

19h30 Diner of the committee (closed)

Friday, *December 6, 2024*

Part 3: Meetings with funding bodies representatives and unit direction (closed meetings)

09h00 - 10h00 Meeting with the INRAE representatives (MH. Ogliastro, B. Favery – Head of INRAE division Plant Health & Environment)

10h00 - 11h00 Meeting with the direction of the unit (S. Fillinger and J. Soyer, vice-director starting January, 2025)

11h00 - 12h00 Final debriefing of the committee (closed)

12h00 - 13h00 Lunch

13h00 Departure

GENERAL OBSERVATIONS OF THE SUPERVISORS

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HCERES

General observations about the evaluation report

Palaiseau, 11th of March 2025

To whom it may concern,

We would like to thank the HCERES committee for the thorough evaluation of BIOGER institute. BIOGER staff appreciated the committee's conclusions on scientific production, contribution to society, management and resources. The committee's recommendations are all pertinent and shall help BIOGER to shape and orientate its scientific strategy. The committee also gave some clues to increase BIOGER's appeal we can build on in the future.

In particular, we appreciate BIOGER's recognition as "French and European reference center for research on fungal pathogens of wheat and oilseed rape with an excellent international reputation addressing a major societal challenge". We also note the invitation to increase number of publications, if possible, in broad spectrum high-ranking journals to increase the visibility of the unit.

The committee underlined that BIOGER is in strong interaction with breeders and non-academic partners. They also noted BIOGER's success in securing external funding of research projects and gave the following recommendations: i/sustain funding by socio-economic partners, but limit the risk of dependence to this sole funding resource; ii/ diversify funding streams applying for international projects; iii/ encourage leading ANR-type projects by members of the unit. BIOGER's scientist will keep the recommendation in mind, especially within the current political and economic context. Note *in addendum*: two ANR projects (not cited in the report) led by BIOGER scientists have started in 2025. Two other ANR projects are currently in the second phase of submission.

BIOGER agrees with the following observations that need to be addressed in the near future. To identify a future director ("who should be provided administrative support") we organize internal working group meetings prior to discussions with our supervising body. Running costs that BIOGER has to face on the campus represent an important threat. A deep re-thinking of the economic model including an increase of paid extension services is on the agenda in 2025.

Several items were raised by the committee needing improvement that are not in the hands of the unit and that need to be addressed by BIOGER's supervising body (e.g., energy costs of the new infrastructure, salary levels, long-term sustainable technical support).

Again, we express our gratitude to the colleagues of the HCERES committee for their meaningful expertise.

On behalf of BIOGER, yours sincerely,

Sabine Fillinger, Head of BIOGER

science for people, life & earth

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