

EVALUATION REPORT OF THE UNIT

GAFL - Génétique et Amélioration des Fruits et Légumes

UNDER THE SUPERVISION OF THE
FOLLOWING ESTABLISHMENTS AND
ORGANISMS:

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

EVALUATION CAMPAIGN 2022-2023
GROUP C

Report published on June, 26 2023



In the name of the expert committee¹ :

Lesley Torrance, Chairwoman of the committee

For the Hcéres² :

Thierry Coulhon, President

Under the decree n° 2021-1536 of 29th November 2021:

¹ The evaluation reports "are signed by the chairperson of the expert committee". (Article 11, paragraph 2);

² The president of the Hcéres "countersigns the evaluation reports established by the expert committee and signed by their chairperson." (Article 8, paragraph 5).

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 Lesley Torrance, Emeritus Professor, University of St Andrews, United Kingdom

Experts:

Ms Béatrice Denoyes, INRAE, Villenave d'Ornon (supporting personnel)

Mr Charles-Eric Durel, INRAE, Beaucouze (representative of CSS INRAE)

Mr Patrice Lerouge, Université de Rouen

Mr Michele Morgante, University of Udine, Italy

Mr Pedro Puigdomenech Rosell, Emeritus Professor, Spain

Mr Thierry Rouxel, INRAE, Thiverval-Grignon

HCÉRES REPRESENTATIVE

Mr Steven Ball

CHARACTERISATION OF THE UNIT

- Name: Génétique et Amélioration des Fruits et Légumes
- Acronym: GAFL
- Label and number: UR 1052
- Number of teams: 2 reviewed as one
- Composition of the executive team: Ms Catherine Dogimont

SCIENTIFIC PANELS OF THE UNIT

SVE2 Productions végétales et animales (agronomie), biologie végétale et animale, biotechnologie et ingénierie des biosystèmes

SVE2_2 Biologie végétale fondamentale et appliquée et productions végétales

THEMES OF THE UNIT

The "Génétique et Amélioration des Fruits et légumes" (GAFL) Unit conducts research on the genetics and breeding of fruit and vegetables. They investigate genetic diversity and adaptation to biotic and abiotic stresses and develop tools to enable the development of varieties that produce high quality fruits and vegetables in sustainable production systems with less pesticides. The unit works across conservation, research and innovation conducting basic and applied research. The overall purpose is to deliver outputs that help to address the major global issues of conserving biodiversity and mitigating and adapting to climate change.

There are six major areas of research and development: Genomic studies of Rosid families (Prunus, Solanaceae and Cucurbits); investigating genetic diversity for resistance to pests and diseases; identifying determinants underlying floral and quality traits and abiotic stress tolerance; genome editing in Solanaceae; development of marker technologies to support pre-breeding and genotype-phenotype modelling to design and test the performance of new varieties. They also conserve and characterise valuable germplasm collections.

HISTORIC AND GEOGRAPHICAL LOCATION OF THE UNIT

The GAFL unit is the continuation of a Vegetable Plant Breeding unit founded on site in 1953, therefore not very long after INRA started its activities. In 2007 the unit was merged with the Fruit Tree unit created in 1982 therefore achieving its present structure.

The GAFL unit is located near Avignon, in the centre of Provence, one of the major regions for production of fruits and vegetables in France. The site includes another INRAE unit devoted to Plant Pathology. The unit is located in a region where a number of seed companies and nurseries are located.

RESEARCH ENVIRONMENT OF THE UNIT

GAFL unit is part of the Provence-Alpes-Côte d'Azur (PACA) INRAE centre and depends on the Plant Biology and Breeding (BAP) INRAE department. GAFL fosters strong scientific interactions with other research units of the PACA centre within a collective horticultural experimentation structure. GAFL is also part of the Federative Research Structure (SFR) Tersys (Valorisation of Natural Plant Products, Quality and Environment) to enlarge their scientific interactions to research units of Avignon University.

GAFL is involved in the University Research School (EUR) IMPLANTEUS (Interdisciplinary programme on the production and processing of Mediterranean plants, environment, human health and sustainability) which was selected in the context of the french "Programme des Investissements d'Avenir" (PIA3) with the main objective to set up an international Master's degree.

GAFL is also involved in the "Laboratoire d'Excellence" (Labex) AGRO (Agronomy and Sustainable Development) labeled in 2011 and confirmed in 2019. The objectives of Labex AGRO are to facilitate the interactions between research units and to support international higher education courses, such as the "CultiVar: Training in Plant Breeding", an international initiative for the implementation of exchange between researchers and students within teaching programs on plant breeding.

GAFL has also set up strong collaborations with the "Groupe d'Étude et de contrôle des Variétés Et des Semences" (GEVES) on the fruit variety characterisation and with the "Centre d'Études et de Perspectives" (CEP) Innovation, the world's exclusive variety manager of fruit varieties and rootstocks bred by INRAE, for the creation of varieties of Prunus species.

UNIT WORKFORCE: in physical persons at 31/12/2021

Permanent personnel in active employment	
Professors and associate professors	0
Lecturer and associate lecturer	0
Senior scientist (Directeur de recherche, DR) and associate	5
Scientist (Chargé de recherche, CR) and associate	6
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	45
Subtotal permanent personnel in active employment	56
Non-permanent teacher-researchers, researchers and associates	15
Non-permanent research supporting personnel (PAR)	8
Post-docs	3
PhD Students	13
Subtotal non-permanent personnel	39
Total	95

DISTRIBUTION OF THE UNIT'S PERMANENTS BY EMPLOYER: NON-TUTORSHIP EMPLOYERS ARE GROUPED UNDER THE HEADING "OTHERS".

Employer	EC	C	PAR
INRAE	0	11	45
Université d'Avignon et des Pays de Vaucluse	0	0	0
Aix-Marseille Université	0	0	0
Total	0	11	45

UNIT BUDGET

Recurrent budget excluding wage bill allocated by parent institutions (total over 6 years)	1660.783
Own resources obtained from regional calls for projects (total over 6 years of sums obtained from AAP idex, i-site, CPER, territorial authorities, etc.)	244.829
Own resources obtained from national calls for projects (total over 6 years of sums obtained on AAP ONR, PIA, ANR, FRM, INCa, etc.)	1547.521
Own resources obtained from international call for projects (total over 6 years of sums obtained)	1229.134
Own resources issued from the valorisation, transfer and industrial collaboration (total over 6 years of sums obtained through contracts, patents, service activities, services, etc.)	2458.867
Total in euros (k€)	7141.134

GLOBAL ASSESSMENT

GAFI unit is part of the PACA INRAE centre and depends on the Plant Biology and Breeding (BAP) INRAE department. The GAFI unit wished to be assessed as a single team with two thematic axis: "Resistance to pests and pathogens, diversity and durability" and "Diversity, Adaptation, determinants and integration". The unit conducts research on the genetics and pre-breeding of fruits and vegetables. They investigate genetic diversity and adaptation to biotic and abiotic stresses and develop tools to enable the development of varieties that produce high quality fruits and vegetables in sustainable production systems with less pesticides. The unit works across conservation, research and innovation conducting basic and applied research. The overall purpose is to deliver outputs that help to address the major global issues of conserving biodiversity and mitigating and adapting to climate change.

The organisation and functioning of the unit are very good and comply with the regulations on human resources management, working conditions and quality of life, safety, environment and protection of scientific data and resources.

The output of the unit as a whole is excellent both in number (172 peer-reviewed papers, 19 book chapters and 10 review papers from 13 researchers) and in quality of the publications (1 *Nature Communication*, 1 *New Phytology*, 1 *Plant Physiology* and 8 *Plant Journal* as corresponding authors). 43% of the papers were published with GAFI members as leaders. GAFI staff were also co-authors of papers published in top large audience journals (*Nature*, *Nature Communications*, *Nature Genetics*). The PhD students were co-authors of 40% of papers. Unit members have also edited two books on tomato genome and genetics and breeding of peppers and eggplant.

The unit has an excellent international reputation for vegetable and fruit tree research. It was very successful in getting competitive national grants including three PIA [as collaborator] and eleven ANR projects (two as coordinator). They have also been very efficient at getting smaller-scale projects funded by INRAE, or other national or regional bodies (GEVES, CASDAR, ONEMA, PACA region) and by private companies (14 with seed companies and plant breeders). GAFI was extremely dynamic at the international level and has an outstanding network of international collaborators, as attested by the high number of international projects funded at the European (EU) scale (13) (H2020, PRIMA, Era-Net, Marie Curie EU programs), four of them being coordinated by GAFI members. GAFI has also coordinated three bilateral Hubert Curien projects with Bulgaria, Sudan and Japan. The unit is also recognised for the know-how and expertise of its staff involved in the maintenance/functioning of the experimental facilities, plant production, implementation and conduct of experiments, phytosanitary monitoring and phenotyping.

GAFI has sustained excellent interactions with plant breeding companies and tree nurseries with the objective to set up a continuum between the unit research activities and the innovation processes developed by these private companies and also to initiate new bilateral research topics regarding the agro-ecological transition and climate change adaptation. One of the major non-academic interactions of GAFI is the creation of an INRAE-CEP Innovation Transfer Platform that has strongly facilitated the scientific interactions with this innovation company and the partnership applications to competitive projects.

The unit is strongly involved in variety registration activities at the CTPS (**C**omité **I**nterprofessionnel **P**ermanent de la **S**élection with 12 staff members acting as section chairpersons, scientific members, field experts) with significant contribution to guidelines for registration rules.

GAFI was also very active in providing continuing education to non-academic actors through the organisation of annual meetings with breeding companies and of theoretical and practical training courses on "varietal selection applied to vegetable plants" dedicated to private company technicians.

DETAILED EVALUATION OF THE UNIT

A - CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

The 2016 committee approved the proposal of reorganization of the unit into two large thematic teams instead of the five teams existing before. A number of new scientists and engineers have been recruited and the unit has a policy of accepting training postdocs that in some cases are presented in recruitment concours. The experimental facilities have been reorganized by creating a collective experimental unit with dedicated staff. An effort to incorporate bioinformatic skills has been done through recruiting an engineer and devising a training plan.

B – EVALUATION AREAS

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

Assessment on the unit's resources

The unit has been very active in obtaining regional, national and international grants. Despite the presence of internationally renowned scientists, it nevertheless feels understaffed and feels isolated from the major local universities. Development of a local experimental INRAE unit may increase their technical resources. These resources are all in all adequate and assessed as very good to excellent.

Assessment on the scientific objectives of the unit

The unit is perfectly in line with the objectives of the INRAE plant biology and breeding division and geared to respond to the major challenges of breeding horticultural crops in a changing environment. They are moving to pre-breeding in the framework of agroecological practices as well as using new breeding technologies. This recent trend has been assessed as excellent.

Assessment on the functioning of the unit

The organisation and functioning of the unit is very good. A management board, made up of the DU, the two deputy DUs and five thematic and transversal group leaders, ensures an adequate collective management of the unit and complies very well with the regulations on human resources management, safety, the environment and the protection of scientific data and resources.

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

Strengths and possibilities linked to the context

The unit benefits from a rich scientific environment thanks to the close proximity and interactions with numerous units of the INRAE PACA centre from different INRAE departments, mostly working on the common theme of agroecological approaches in Mediterranean crop systems.

The unit has a highly qualified staff of scientists with some of them who are clearly recognised international leaders in their research field.

The unit appears to be well equipped in terms of scientific and experimental infrastructures. The unit has considerable field and greenhouse facilities as well as having access to a number of technological platforms both at the local campus level as well at the University of Avignon and within INRAE.

The unit has been very active in obtaining grants both at the national as well as international level. They have obtained nine projects at the EU level and in four of these they are leaders while they are partners in the other four. They have also considerable financial resources deriving from interactions with private companies, from Distinctness, Uniformity and Stability (DUS) testing activities and from the licensing of plant varieties.

Weaknesses and risks linked to the context

The unit is feeling understaffed in terms of their scientists, engineers as well as technicians. The unit is reporting difficulties in linking up with the University of Avignon in terms of scientific themes and as a consequence of this it has a limited number of opportunities for PhD thesis grants, for hosting teacher-researchers in the unit and for having prospects of Junior Professor chairs.

The interactions with the newly created (at the beginning of 2021) AHM (Avignon Horticulture Méditerranéenne) experimental unit, an experimental unit shared in the PACA centre where twelve technical staff units were transferred in terms of efficiency of execution of the field experiments are still not well defined.

The obsolescence of the greenhouses and phytotrons is generating high operating and maintenance costs and is also a limiting factor for research projects due to technical issues with controlling correctly the growth conditions. The role of GAFL vs. that of AHM in taking care of the maintenance and/or renewal of these infrastructures is not clear.

The organizational restructuring of the unit has led to the creation of a support team devoted to bioinformatics and biostatistics that however at the present time seems to be largely understaffed to meet the increasing demands in terms of data analysis.

2/ The unit has set itself scientific objectives, including the forward-looking aspect of its policy.

Strengths and possibilities linked to the context

The scientific objective of GAFL is to improve knowledge of the genetic and genomic determinants of resistance to pests and of the adaptive capacities of plants to environmental variations. They are defined in agreement with the strategic plans of its supervisory body (BAP division). They are in perfect line with Strategic objectives "Understanding the response of plants and plant communities to climatic, nutrient and biotic stresses in order to adapt them to climate change in agro-ecological systems" and "Improving plants and plant communities by mobilising selection tools for innovative cropping systems", and GAFL is the only INRAE unit focused on genetics of Mediterranean vegetable species. One strength of the unit is to range its activities from fundamental research (characterisation of genes and understanding of the mechanisms involved) to operational research and methodological contributions to help breeding and respond to the major challenges of climate change and the agroecological transition in horticulture.

The unit is very well established in the local and national environment with strong interactions with other INRAE units such as PV and PSH in Avignon, BFP at Bordeaux or IPS2 at Saclay, strong links with private partners and strong involvement in regulatory structures ("Comité Technique Permanent de la Sélection des plantes cultivées" (CTPS), ANSES). GAFL researchers have been involved in two multipartners PIA projects. GAFL also has strong international collaborations at the EU scale and is involved in several EU-funded projects (four H2020, two PRIMA, one Era-Net) with partners from Spain, Italy, Belgium, Switzerland, The Netherlands, Israel, Tunisia. At a larger scale, it is involved in international initiatives to sequence the genomes of melon and almond and to evaluate their genetic diversity. The unit responds to most of the available incentive, transversal and federative programs of INRAE type METAPROGRAMME, both in the coordination of some of them and in the response to calls for projects.

The strategic scientific orientations are built collectively. There is an incentive that the response to calls are in line with the unit main objectives. Members of the unit develop only original and innovative fundamental research in the themes in which the unit is a leader.

The unit regularly analyses the impact of its research both in terms of societal issues and economic issues: delivery of numerous marker-assisted breeding, new improved breeding methodologies, new tools (including genome editing technology), knowledges and improved plant material useful for breeders, new varieties many of them through co-obtentions with the private sector (new varieties with CEP, generating 0.5 M€ of royalties for INRAE). The unit is strongly involved in variety registration activities at the CTPS (12 staff members acting as section chairpersons, scientific members, field experts) with significant contribution to guidelines for registration rules (e.g., MEDIEVAL report).

Weaknesses and risks linked to the context

There are few mentions of collaborations with the United States or countries in the southern hemisphere.

The involvement of the technical staff in defining the research policy and the corresponding organisation is insufficiently described.

3/ The functioning of the unit complies with the regulations on human resources management, safety, the environment and the protection of scientific assets.

Strengths and possibilities linked to the context

The unit is very good for paying a lot of attention to human resources management in different ways: (i) respect of the gender equality and non-discriminatory recruitment procedures: Parity between women and men is well balanced at the levels of technical staff, ingeniors, non-academic staff, graduate students and postdocs, and a slight advantage for women for permanent researchers and management board (5 women and 3 men); (ii) promotion of lifelong training and skills development of the unit staff by a nominated training correspondent; (iii) integration of a deaf person and promotion of training in French sign language; (iv) support in mobility within and outside the unit to take advantage of professional opportunities or to change activities and work environment ((20 mobilities or leaves over the period).

The unit pays an excellent attention to working conditions and quality of life (teleworking, risk prevention and biosecurity training, welcome coffees, weekly newsletter, human resources reception service ...). Training in management and change management was provided to the new team leaders in order to explain their tasks in their teams and in the management team. The use of a consultancy firm made it possible to facilitate the major organisational changes in the unit in 2017 (2 research teams + 3 support teams ; experimental teams in St Maurice and Amarin gathered into a single Experimental Facility team which then after moved to the new EU Avignon Horticulture Méditerranéenne (AHM).

The rationalized and secured conservation of genetic resources for vegetables and fruit trees and the collection of aphid clones is an excellent/outstanding point of the unit. The protection of vegetable genetic resources for long-term conservation is well performed in a dedicated building, with duplication at the ARCAD unit in progress. The protection of the computer systems of the connected stations is ensured by replicating the profiles on the INRAE data center.

The unit has been committed to the EMS (Environmental Management System) approach since 2018 (disposal as historical waste of underground tanks, waste management, reduction in the use of synthetic plant protection products, etc.) and contributes to the PACA Centre's Sustainable Development Unit. An activity continuity plan (ACP) has been defined to preserve and secure the unit's many resources (e.g., organisation of interventions by mobilizable volunteers especially in the event of a containment failure).

Weaknesses and risks linked to the context

Despite the advantage of AHM, the number of technical staffs of GAFL has decreased since they moved to this new AHM unit.

The strong investment in human resources required to maintain genetic resources can be at the cost of the time needed to establish new international collaborations.

A large part of the greenhouses and growth chambers necessary for the experiments are obsolete and energy-intensive; maintenance and repair costs of these facilities are almost exorbitant. A project to renew part of this equipment is currently being negotiated with funders as part of the 2021-2027 CPER State-Region plan (Phytoscope project).

EVALUATION AREA 2: ATTRACTIVENESS

Assessment on the attractiveness of the unit

The unit has an excellent international reputation for vegetable and fruit tree research. It is present in a number of French and International activities and it has succeeded in getting French and European grants. It has excellent plant growing facilities that have recently been improved. GAFL was also very attractive for the quality of its hosting policy of french and foreign PhD student and post-doc.

1/ The unit has an attractive scientific reputation and contributes to the construction of the European research area.

Strengths and possibilities linked to the context

The strength of the unit is based in a long tradition of work with vegetable and fruit trees. It has managed to renew its infrastructure and to incorporate new methods based in molecular and bioinformatic analysis. It is located in a region with high agricultural activity in fruits and vegetables and it has excellent relation with seed companies and nurseries.

Weaknesses and risks linked to the context

The location is not in proximity with a strong University and that may make it difficult to take part in teaching activities and recruiting young scientists and engineers.

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

Strengths and possibilities linked to the context

During the evaluation period, fifteen PhD students have defended their thesis and thirteen are currently doing their research at the GAFL unit. Among the fifteen PhD student who defended, ten were administratively and financially supported by GAFL and five others were co-supervised by scientists and engineers of GAFL. All students were supported by a national grant (17), a "Convention industrielle de formation par la recherche" (Cifre) grant (4), or PhD funding from their country (7, Brazil, Senegal, Lebanon, Tunisia, Syria and China). In the Unit, PhD students benefited from training courses provided either by GAFL or by the doctoral school of Life and Health of Aix-Marseille University (ED 62). GAFL also encouraged PhD students and post-docs to attend to national and international meetings and to present their research works.

Six GAFL members were involved in the supervision of PhD students with a supervision rate that did not exceed three doctoral students per supervisor at the same time in agreement with national rules.

In addition to PhD students, eight post-doctoral researchers and 39 french master students, as well as two foreign master students, have been hosted at GAFL during the evaluation period. Eight foreign PhD students were also hosted for a short period of time.

PhD students and post-doc, as well as master students, benefited from a good scientific environment in the Unit through the organisation of unit seminars, journal clubs, training in oral presentation and help in producing posters and paper writing.

Except for two PhD students (duration > 4 years), the average PhD duration is about 40 months which is a rather good average duration considering the experimental constraints of their research topics and the COVID pandemic. Among the fifteen former PhD students, seven were hired in private companies, three are currently post-docs, one got a researcher position abroad and one a position at the french ministry of agriculture.

GAFL has also welcomed a turkish researcher in the context of a Programme d'Aide à l'accueil des Scientifiques en Urgences (PAUSE project).

Weaknesses and risks linked to the context

GAFL should improve their policy for the hosting renowned guest researchers.

3/ The unit is attractive because of the recognition gained through its success in competitive calls for projects.

Strengths and possibilities linked to the context

In general, the members of the unit are very active in looking for fundings and reach a quite high rate of success to calls compared to the average.

GAFI is extremely dynamic at the international level and has a strong network of international collaborators, as attested by the high number of international projects funded at the EU scale: GAFI is a partner of 9 projects and leader of four (H2020, Eranet, PRIMA, KBBE, Marie Curie, CPVO and EAFRD). In addition, they commonly are WP leaders (eight projects). Additional attempts to get EU funding have been unsuccessful (16 attempts plus five for Marie Curie grants), but this illustrates how dynamic the unit is to mine for such international projects. At the national level, the unit is (or has been) involved in three PIA projects and led two ANR projects, while being partner of nine additional. They have been also very efficient for success at getting smaller-scale projects funded by INRAE, or other national or regional bodies (GEVES, CASDAR, ONEMA, PACA region), or the private sector (15 projects plus five Cifre over the period) (total of projects over the period = 66). Lastly, it has to be noticed that all scientists except three IE, are involved in coordination of projects or are partners in projects.

Of the 28 PhD over the period, only two were funded by research contracts (but five Cifre were obtained), illustrating the diversity of funding sources for PhD and the success to get funding for PhD outside of research project.

Weaknesses and risks linked to the context

The number of scientists available for the writing of project proposals is quite small as many scientists are too involved in major research administration tasks making it difficult for them to take leading roles in projects at the European and ANR level.

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

Strengths and possibilities linked to the context

The unit benefits of a large panel of infrastructures for experiments in fields, greenhouses, tunnels and controlled chambers (phytotrons), thanks to the new unit AHM. This unit was the results of the merge of GAFI experiment facilities (EF) of Saint Maurice and the Amarine EF for optimizing the staff and the management of experiments.

The unit has strong structures (cell biology laboratory and culture chambers for stable and transient transformation experiments) to develop functional validation and cold chambers for seed conservation. It is also attractive since it has access to many collective structures and platforms managed by the University of Avignon and INRAE (3A microscopy platform, Metaboscope, EPGV, Gentyane, GeT-PlaGe, GenoToul, Migale, GenOuest,...). The unit is also piloting the CRB-Leg, co-piloting of the regional molecular biology platform (LBM) in which the unit contributes to technological development such as a Fragment Analyser, and invested in new phenotyping equipment at the plant level (a CCD Fluorcam for non-destructive monitoring of viral progression in the plant) and at the macro level in orchards (Phenoman digital phenotyping).

The unit is recognized for the know-how and expertise of its staff involved in the maintenance/functioning of the experimental facilities, plant production, implementation and conduct of experiments, phytosanitary monitoring and phenotyping. It created a Varietal Innovation and Transfer Platform for stone fruits with CEP INNOVATION and is hosting an assistant engineer.

Weaknesses and risks linked to the context

Greenhouses and phytotrons are becoming obsolete. In the next regional developmental plan CPER, greenhouses will be renewed but budget has to be found for the renewal of growth chambers.

There is no major equipment in-house, owing to the limited size of the unit.

The fact that the experiments are set up in a transversal unit, AHM (experimental unit), leads to project monitoring and follow-up problems.

EVALUATION AREA 3: SCIENTIFIC PRODUCTION

Assessment on the scientific production of the unit

The scientific production of the unit is quantitatively and qualitatively excellent with high profile publications some of which were driven by the unit as well as collaborative work published in the highest ranking multidisciplinary journals. The production is rated excellent.

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

Strengths and possibilities linked to the context

The quality of the scientific production of the unit is to be considered excellent. The unit has produced a considerable number of publications (172) in the period under consideration, of which 85% are open access and a large fraction of them are in very high profile journals (*Nature*, *Nature Genetics*, *Trends in Plant Science*, *PNAS*, *New Phytologist*, etc.).

The unit has published on a broad set of research topics, with some of the most original contributions being produced in the areas of genome analysis, population genomics, genetic diversity and resources analysis, genetic control of disease resistance traits.

It is worth noting that some of the publications are the result of large international collaborations where the unit always had a highly relevant role.

Weaknesses and risks linked to the context

The considerable breadth of the scientific problems addressed in the publications makes one wonder if the unit will be able to continue to publish at the same level on the same topics in light of the rather limited number of scientists present in the unit and of some recent retirements of key scientific personnel units.

The production of publications that push forward the frontiers of the scientific fields where the unit is active in terms of high risk/high gain science is missing while it would be useful to make the unit more attractive to young scientists and new recruits.

2/ Scientific production is proportionate to the research potential of the unit and shared out between its personnel.

Strengths and possibilities linked to the context

Based on the data provided, the unit has a strong output of published papers given the number of research FTE. The unit published 172 refereed papers from 13 researchers, 43% as leader (first or last author). The articles were published in appropriate journals specialised for the disciplines and many were in leading international journals. In addition, unit staff edited two books (on tomato genome and genetics and breeding of peppers and eggplant) and nineteen book chapters as well as ten review papers.

The unit personnel contributed to publications in a balanced way and tenured researchers contributed on average to 1.8 papers per year. Five engineers also published regularly with an average of 1.7 each.

The unit doctoral students were co-authors of 40% of papers. Among the fifteen PhD students who defended their thesis during the evaluation period, thirteen have published one to three articles as first author.

Weaknesses and risks linked to the context

Only two papers were published in peer community journal and while some papers were published in leading open access journals, given the emphasis on open access we might expect to see more emphasis on this aspect.

Two former PhD students did not publish any articles.

3/ The scientific production of the unit complies with the principles of research integrity, ethics and open science.

Strengths and possibilities linked to the context

G AFL has implemented specific rules for a research integrity including good experimental practices (metrology, technical training, data archiving, lab notebooks) and internal rules (choice of appropriate publication supports, rules for the determination of co-authorship of a scientific production ...).

The unit respects the Nagoya Protocol on Access and Benefit-Sharing and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). GAFL initiated the signature of a Memorandum of Understanding between INRAE and Sudan on the exchange of genetic material (melon, pepper, aubergine).

In addition, the unit research activities aimed at conserving the plant genetic diversity and decreasing the use of chemical products for plant cultivation through the selection of resistant plants.

Eighty-five % of the articles published by GAFL are in open access and pre-prints are deposited in the HAL INRAE depository to make them accessible.

With regards to data generated by GAFL, a data depository was created in 2020 on the INRAE DATAVERSE, making these data accessible to the scientific community.

Weaknesses and risks linked to the context

No weakness.

EVALUATION AREA 4: CONTRIBUTION OF RESEARCH ACTIVITIES TO SOCIETY

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

G AFL has sustained excellent interactions with plant breeding companies and tree nurseries as well as an excellent commitment in disseminating scientific knowledge on plant breeding technologies and green biotechnologies.

1/ The unit stands out by the quality of its non-academic interactions.

Strengths and possibilities linked to the context

G AFL has sustained strong interactions with plant breeding companies and tree nurseries with the objective to set up a continuum between the unit research activities and the innovation processes developed by these private companies and also to initiate new bilateral research topics regarding the agro-ecological transition and climate change. Sixteen projects were carried out during the evaluation period with seed and tree nursery partners (projects Ceylan, ResVirus, Platum, TEV ...). Non-academic scientific interactions are also illustrated through the setting up of Cifre thesis (5), hosting of an assistant engineer from CEP innovation and collaborations with vegetable seed companies for the maintenance of collections.

One of the major non-academic interaction of GAFL is the creation of an INRAE-CEP Innovation Transfer Platform that has strongly facilitated the scientific interactions with this innovation company and the partnership applications to competitive projects (CASDAR, ANR and European projects).

G AFL is also very active in providing continuing education to non-academic actors through the organisation, by GAFL researchers and engineers, of theoretical and practical training courses on "varietal selection applied to vegetable plants" dedicated to technicians (30) originating from breeding institutions. The unit also organised an annual meeting with breeding companies. In addition, GAFL contributed in the creation in 2019 of a MOOC for online training courses.

Weaknesses and risks linked to the context

GAFL clearly has strong links and provides valuable services and knowledge to the non-academic sector, as a result there is strong demand for their work. These interactions are also a valuable source of knowledge to GAFL of industry requirements. However, the unit's strategy to prioritise work to meet these demands was not very clear.

2/ The unit develops products for the socio-economic world.

Strengths and possibilities linked to the context

The unit is situated in a major horticultural region which is also home to many fruit and vegetable companies. The unit is very active in this area and has made many important contributions. A major strength of the unit is its ability to reach out and collaborate with companies and stakeholders across all its activities. For example, the unit has established networks for conservation of genetic resources as well as INRAE-CEP innovation partnership with a transfer platform to move the products of research (markers and knowledge of traits etc) into breeding programmes.

The unit is active in reviewing and protecting intellectual property, with one patent granted and two applied for in the review period. The close collaboration, meetings and networks ensure that the research delivers outputs wanted by the industry. This arrangement attracts a large amount of funding and enables hosting of non-academic partner engineers and staff for training as well as hosting PhD students, activities which will improve the competitiveness of the companies. The many annual meetings, information days, training courses, publication of technical notes and standards keeps the industry up-to-date and informed and allows the objectives of the research, particularly the transition to agro-ecological practices, to be promoted to industry, and facilitates the adoption of outputs. The impact of the work of the unit is apparent when considering the large number of long-term established partnerships and research collaborations with companies and other stakeholders. Twelve members of the unit sit on expert committees showing contribution to developments in biotechnology and influence on variety registration and regulatory matters.

Weaknesses and risks linked to the context

There are no obvious weaknesses in this aspect but some of the unit's staff who have made strong contribution in this area will retire soon which may result in losing some activities in the near future (as noted in the SAD) and there was no indication as to how this will be addressed for example, introducing other staff members.

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

Strengths and possibilities linked to the context

The unit is strongly involved in communicating its research results, knowledge and expertise to the general public by various means: active contribution to the 2018 Salon International de l'Agriculture (10 members on the stand), participation in an information brochure and web page on new plant breeding technologies and green biotechnologies, numerous media appearances (33) in regional and national newspapers, local and national radios and televisions, contribution to 9 videos in various MOOC.

The unit welcomed a very large number of pupils (62) in the third year of secondary school to allow them to discover the different aspects of the research profession, and visited/hosted secondary schools to discuss on various scientific topics.

Weaknesses and risks linked to the context

The unit does not seem to contribute to events for the general public such as "Fête de la Science" or "Nuit Européenne des Chercheurs", where the involvement of PhD or post-doctoral students could be encouraged.

C – RECOMMENDATIONS TO THE UNIT

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

Given the departure to retirement of many permanent people, the committee encourages the GAFL unit to discuss with the INRAE department authorities on its future human resources.

Particular attention must be paid in maintaining a balance between the hiring of scientists and technicians.

The team structure should be improved as it does not necessarily reflect the actual working organisation and the sense of belonging of the technical staff.

It is recommended to increase the interactions between technicians as well as interactions between technicians and other members of the unit.

It is vital for the future of GAFL to implement very active mentoring of young scientists by PIs to achieve the status of group/theme leader.

GAFL should further increase its existing interactions with other INRAE units present in Avignon and seriously consider merging opportunities.

The relationships between GAFL and the AHM experimental unit should be continuously monitored and improved to ensure a more flexible and thus optimal access to experimental facilities.

Recommendations regarding the Evaluation Area 2: Attractiveness

GAFL must advertize and improve the existing welcome documents with all useful information for PhD and post-docs joining the lab.

GAFL should improve their policy for hosting renowned guest researchers

GAFL should increase the number of national and international grants where they achieve the status of coordinators.

Take advantage of the CPER funds to publicize the existence of large scale and up to date facilities available for studies on plant genetics/plant pathology and agroecology and thereby increase their attractiveness.

A better integration in the university teaching landscape of the PACA region should become a priority for the INRAE research units located in Avignon including GAFL. Access to students is essential for the visibility and attractiveness of such units.

Recommendations regarding Evaluation Area 3: Scientific Production

The GAFL unit could improve its excellent output by achieving more leadership in international collaborative projects

The unit is encouraged to further develop their links with pathologists in PV and elsewhere to ensure they have access to appropriate knowledge and experience of the properties (e.g, strain variation) of the pests and pathogens they are working with

The future ambitions to focus on pre-breeding for traits of importance in sustainable low input farming systems must be co-developed in collaboration with scientists (and non-academic stakeholders) who work in agroecology.

Some research staff published few papers or other outputs and as acknowledged by the SAD they should be supported to increase their output.

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

The unit should develop a strategy to ensure they have continuity in the collaborative programmes with the non-academic sector as several key staff are near retirement.

The unit should maintain and extend to more members of the unit its activity towards public forums e.g. for public understanding of science, to contribute to the discussion on new breeding technologies including genome editing to address societal attitudes and concerns.

CONDUCT OF THE INTERVIEWS

Dates

Start: 27 October 2022 at 09:00
End: 28 October 2022 at 18:00f

Interview conducted: online

INTERVIEW SCHEDULE

Thursday October 27, 2022

9h00 Introduction by Steven Ball (Hcéres delegate)
 9h15 **General presentation of the unit**
 10h45 Coffee/body break
 11h00 **Thematic 1** Diversity and domestication
 11h40 **Thematic 3** Floral biology, fruit quality and adaptation to abiotic stresses
 12h40 Restricted debriefing
 13h00 Lunch
 14h00 **Thematic 2 Resistance to pests and diseases**
 15h30 Coffee/body break
 15h45 **Thematic 4 Gene editing, 5 Pre-breeding and 6 Modelling**
 17h00 Restricted debriefing
 17h30 Meeting with non-permanent staff
 (Ph.D students, post-doc, personnel with short-term contracts)
 18h00 End of the day

Friday, October 28, 2022

Restricted sessions

9h00 Meeting with the support staff (in French) (AI, TR, AT)
 9h30 Meeting with the scientists (DR, CR, IR, IE)
 10h00 Coffee/body break
 10h30 Meeting with the supervising bodies
 (Peter Rogowsky BAP division, Jean-Philippe Nabot PC)
 11h00 Meeting with the unit's direction (DU, DUA)
 11h30 Closed meeting of the committee
 12h30 Lunch
 13h30 Closed meeting of the committee
 18h00 End of the day

GENERAL OBSERVATIONS OF THE SUPERVISORS

DER-PUR230023105 – GAFL

Avignon, June 12, 2023

We would like to thank the expert committee for the time they took to evaluate our unit and for their very positive report. We collectively agree with the committee's recommendations. We have started to take them into consideration and are now thinking about how to implement them to develop the unit's project for the next five years.

For instance, a steering committee has been established in 2023 to decide collectively on experimental trials and the renewal of experimental facilities and infrastructures; it includes the heads of the AHM UE (renamed A2M Arboriculture et Maraîchage Méditerranéen) and the heads of the GAFL and PSH research units, and meets every two weeks.

Yours sincerely,


Head of GAFL

Catherine Dogimont


Catherine DOGIMONT
Directrice de l'Unité GAFL

BAP division

Isabelle Litrico (Head of the INRAE Plant
Biology and Breeding Division)



la science pour la vie, l'humain, la terre



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Rejoignez-nous sur :



<https://www6.paca.inrae.fr/gafl>

The Hcéres' evaluation reports are available online:
www.hceres.fr

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