HCERES

Research units

HCERES report on research unit:

Physiologie, Environnement, et Génétique pour l'Animal et les Systèmes d'Élevage

PEGASE

Under the supervision of the following institutions and research bodies:

Institut National de la Recherche Agronomique - INRA

Agrocampus Ouest – Institut Supérieur des Sciences Agronomiques, Agroalimentaires, Horticoles et du paysage

HCERES

High Council for the Evaluation of Research and Higher Education

<div style="text-align:center">Research units</div>

In the name of HCERES,[1]

Michel COSNARD, president

In the name of the experts committee,[2]

Jan Erik LINDBERG, chairman of the committee

Under the decree No.2014-1365 dated 14 november 2014,

[1] The president of HCERES "countersigns the evaluation reports set up by the experts committees and signed by their chairman." (Article 8, paragraph 5)

[2] The evaluation reports "are signed by the chairman of the expert committee". (Article 11, paragraph 2)

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Evaluation report

This report is the sole result of evaluation by the expert committee, the composition of which is specified below.

The assessments contained herein are the expression of an independent and collegial reviewing by the committee.

Unit name:	Physiologie, Environnement, et Génétique pour l'Animal et les Systèmes d'Élevage
Unit acronym:	PEGASE
Label requested:	UMR
Current number:	1348
Name of Director (2015-2016):	Mr Jaap VAN MILGEN
Name of Project Leader (2017-2021):	Mr Jaap VAN MILGEN (until the end of 2017)

Expert committee members

Chair:	Mr Jan Erik LINDBERG, Swedish University of Agricultural Sciences, Uppsala, Sweden
Experts:	Mr Francois BOCQUIER, Montpellier SupAgro
	Mr Bernard PORTHA, University of Paris 7, Paris
	Mr Stefaan DE SMET, Ghent University, Belgium
	Ms Anne-Helene TAUSON, University of Copenhagen, Denmark
	Mr Marc VANDEPUTTE, Inra-Ifremer, Palavas-les-Flots

Scientific delegate representing the HCERES:	Mr Serge DELROT

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Representatives of supervising institutions and bodies:

Mr Patrick Herpin, Inra Rennes

Mr Romain Jeantet, AgroCampus Ouest

Ms Françoise Medale, Inra Division PHASE

Mr Denis Milan, Inra Division GA

Head of Doctoral School:

Ms Nathalie Theret, Head of Doctoral School VAS - "Vie Agronomie Santé"

1 • Introduction

History and geographical location of the unit

PEGASE is a mixed research unit (UMR) that was created in 2012 as a merger between the mixed research unit GARen (Génétique Animale de Rennes), the mixed research unit for milk production in Rennes (UMR PL) and part of the mixed research unit for Livestock Systems, Animal and Human Nutrition in Rennes (SENAH).

When PEGASE was created, the merging units were at four different locations (St-Gilles, Rennes, Méjusseaume & Le Rheu), within a 15km range. In 2015, the research unit was located at only three sites (St-Gilles, Rennes & Méjusseaume). From 2017 on, all Agrocampus Ouest faculty of PEGASE will be located in one building at the Agrocampus Ouest campus in Rennes.

The unit has a staff of 172 persons, among whom 116 are permanent staff and a total of 26 persons are qualified research supervisors (HDR). PEGASE has 13 permanent professors, 37 permanent researchers and 66 permanent technicians and administrative staff.

Management team

Mr Jaap Van Milgen (head)

Mr Philippe Faverdin (deputy-head)

Ms Sandrine Lagarrigue (deputy-head)

Scientific domains

SVE Sciences du vivant et environnement

Main : Sciences agronomiques et écologiques

Secondary : SVE2_LS9 Biotechnologies, sciences environnementales, biologie synthétique, agronomie

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Unit workforce

Unit workforce	Number on 30/06/2015	Number on 01/01/2017
N1: Permanent professors and similar positions	13	12
N2: Permanent researchers from Institutions and similar positions	37	36
N3: Other permanent staff (technicians and administrative personnel)	95	63
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers from Institutions (Emeritus Research Director, Postdoctoral students, visitors, etc.)	3	
N6: Other contractual staff (technicians and administrative personnel)	5	
N7: PhD students	21	
TOTAL N1 to N7	**174**	
Qualified research supervisors (HDR) or similar positions	**26**	

Unit record	From 01/01/2010 to 30/06/2015
PhD theses defended	33
Postdoctoral scientists having spent at least 12 months in the unit	10
Number of Research Supervisor Qualifications (HDR) obtained during the period	6

2 • Overall assessment of the unit

Introduction

The scientific interests of PEGASE are broad and cover various aspects of the biology of animals used for food production and of livestock production systems. The scientific aim of PEGASE is to understand and predict how animals and animal production systems interact with the environment, and to propose ways to improve their sustainability. PEGASE considers both research and education as main missions of the unit. More precisely, unit members focus on animal welfare, production efficiency, animal product quality, as well as the competitiveness, working conditions and environmental impact of animal production, and they contribute to education and training programs in these areas.

Since its creation in 2012 the unit has undergone a very positive scientific development that is reflected in extensive international and national collaborations, in successful grant applications (e.g. EU, ANR), in collaborations with industry, and in its academic recognition and publication record.

Global assessment of the unit

PEGASE has very strong competences in a range of topics (e.g. physiology, nutrition, genetics, health, welfare, environment) related to livestock production. In order to stay in line with the INRA strategy, research activities have focused on milk production in dairy cows and goats, on meat production in pigs, and on poultry genetics.

The unit has a well developed collaboration with industry and stakeholders (participation in 2 technological mixed units - UMT Research and Engineeering in Dairy farms; UMT Engineering of pig production systems -, 5 technological mixed units – RMT-, participation in Institut Carnot Animal health, nutrition and genetics). PEGASE has also developed collaborations with French and European academia (AgroParisTech, VetAgroSup, University of Rennes 1; Ireland, Teagasc, University College Dublin; The Netherlands, Wageningen University; Denmark, Aarhus University), and with a couple of universities over-seas (e.g. Canada: Agr. Agrifood Canada, University of Guelph, University Laval; United States: University of California LA; Brazil). This is reflected in the publication record of the unit, which shows a high proportion of co-publication with collaborating partners (e.g UMR Herbivores, UMR GenPhySE, UR83 URA, UMR1313 GABI, Agr. Agrifood Canada, Wageningen Univesity, Teagasc, University College Dublin, Newcastle University, Aarhus University). About 35% of total articles are published in collaboration with foreign partners (spread over 42 countries).

The unit has a strong publication record (497 peer-reviewed journal articles during the assessed period, 260 as first author, 337 as first or last author). Along the assessed period, this corresponds to about 1.65 paper/full time equivalent scientist/year. There was a gradual and steady increase in papers published in peer-reviewed international journals (70% increase in published peer-reviewed papers from 2010 to 2015). This includes international journals relevant to the field of study (Animal, Journal of Animal Science, Journal of Dairy Science) and more general journals (Plos One, BMC Genomics, Genetics). In general, papers are of high scientific quality as reflected in the impact factors of journals chosen for publication (rated excellent in the first quartile of JCR ranking, with a few exceptional- PlosOne, Molecular Biology Evolution, Nucleic Acid Research).

The organization of PEGASE has served well the unit since its creation in 2012. However, with the experience gained, there may be reasons to re-evaluate how the unit should be organized in the future (see recommendations).

Overall, the scientific quality and output of PEGASE are excellent. The unit has a very good academic reputation and appeal, interaction with social, economic and cultural environment, and organisation and life. Moreover, the involvement in training through research (32 PhD defended during the reviewed period) as well as the strategy and the five-year plan are good.

Strengths and opportunities in the context

The decision to focus the research activities on sustainable development of livestock production and livestock production systems (limited to milk and pork) makes the unit unique and can be seen as a strength.

Within a fairly short time period, PEGASE succeeded to become a well functioning and creative research unit, which can be largely attributed to the dedicated and democratic leadership of the director and management team.

The unit has well equipped laboratories and well functioning experimental facilities for their target animal species (dairy cows, goats and pigs), which are managed by expert technical staff. The fact that the unit has

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researchers and technical staff on permanent jobs with salaries provides unique possibilities to build long-term competence and expertise in key areas of science and in technical issues.

The ambition to perform and further develop multidisciplinary research within the unit is a strength in the long-term perspective, as problems faced by society become more and more complex. Thanks to its wide range of skills and competences, PEGASE is well placed to be a key actor in providing solutions on these complex problems.

The diversification of research activities at PEGASE is a strength, as it offers possibilities for a broad range of partnerships with other research units, private companies and other stakeholders, and makes the unit competitive in EU and national calls.

The investment in teaching, which is a very positively considered activity with high priority in PEGASE, will provide long-term benefits to the unit and to the society. The unit actively contributes to educate and train a large number of engineers (BSc and MSc programs) and young scientists (PhD's), which will benefit the agricultural sector in particular but also the society as a whole.

Weaknesses and threats in the context

The future projects of each research team are well developed and described, but are not linked to a common future project of the unit. The lack of a future common coherent and clear strategic project for the whole unit can be considered as a weakness.

The diversification of research activities can become a weakness if ambitions to cover "everything" become too strong. This could lead to "spreading resources too thin" with a resulting lack of depth in methodologies and research issues.

Staff reductions at the experimental facilities and laboratories, due to retirements and through internal and external mobility, will be a threat to the future research activities at PEGASE. Retirement of permanent scientific and technical staff, with potential loss of competence and skills, is a threat to the research activities of the unit if the positions are not replaced.

The trend towards more administration for the team leaders and researchers is a long-term threat to the scientific outcome and academic reputation of the unit, because less time will be available for research and outreach activities.

Recommendations

The unit is organized in 7 teams with 11 to 21 persons, of which 4 to 10 are scientific staff. This may not be optimal with regard to the potential scientific outcome of the unit, as the critical mass in each team can become too small. Due to the complexity of research issues addressed and the difficulty to cover all aspects by one single team, many projects are run in collaboration between two or more teams. This seems to function well, but nevertheless there are indications of overlap in activities and competences between teams. Thus, it may be appropriate to consider a reorganization of the unit into fewer but larger teams to overcome this problem. For example, a rethinking of the shape and limits of the two teams SYSPORC and CROISSANCE should be appropriate and is suggested by the committee.

The research activities of the team for Genetics and Genomics (GG) should be better harmonized with the other teams to improve the scientific outcome in dairy cows, goats and pigs. Nutrigenomics could be one area with potential to be developed within the unit and could include several teams of PEGASE.

It is important to accelerate the process allowing to identify and to announce the next director for the unit. A short-term temporary solution may function to run business-as-usual, but will not benefit the long-term life and development of the unit.

In order to cover socio-economic issues and to put problems related to livestock production and livestock production systems into a socio-economic context, it is recommended to seek and develop collaboration with expertise in human and social sciences.

To utilize the full potential of the creative and innovative capacity within the unit, it is recommended to stimulate internal scientific discussions between teams. This could be accomplished by the creation of a forum where informal and free scientific discussions could take place on a regular basis. Thinking "out-of-the-box" should be encouraged.

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3 ● Detailed assessments

Assessment of scientific quality and outputs

One major research goal of PEGASE has been to understand the biological bases of feed efficiency. In growing pigs, the focus was put on residual feed intake (RFI), and in dairy cattle the focus was put on nitrogen efficiency. Studies were conducted to identify relevant animal-oriented traits that can explain the biological basis of feed efficiency and to propose feeding solutions that allow to obtain and to manage efficient animals. The studies were performed at different levels of complexity including molecular, tissue and organ traits as well as whole-animal responses. The main biological mechanisms underlying feed efficiency were identified, and models and tools to control feed composition and efficiency were developed.

Another focus research area of PEGASE was to account for individual variability, due to a demand for homogeneity in terms of quality and quantity. The challenge is to control and take advantage of the variability between individuals without eliminating it. The possibility to use the variability between individuals is a key element in precision livestock farming. The introduction of precision farming and feeding calls for nutritional models that take into account variability between individuals as well as real-time individual phenotypic information. The practical implementation of precision livestock farming requires tools that can be used to manage variability among individuals, such as models, sensors and 3-D imaging tools (e.g. the Inra Porc model and the CowNex simulator)..

A third focus was the consolidation of research on pig farming systems. This work has been built on multidisciplinary approaches involving scientists of the PEGASE teams Sysporc, Adaptation, and Croissance, and with the collaboration of other scientific and industry partners from the pork production chain. This research was mainly conducted through 3 European-funded research programs (i.e., Q-PorkChains, Propig and Corepig) and an ANR program (Andropig). It was shown that muscles of pigs with a higher feed efficiency (low RFI lines) were associated with a lower capacity to catabolize nutrients, reduced nutrient cycling between the liver and skeletal muscle, lower basal metabolic rate and lower resting energy expenditure. The lower energy expenditure in the most efficient pigs was related to lower physical activity and a specific feeding behaviour.

The efficiency of nitrogen utilization may be increased without limiting performance in both pigs and dairy cattle by improving the amino acid balance of the diet in relation to the requirement of the animal. In young pigs, the protein content in diet can be reduced to 13.5% by total replacement of soybean meal by cereals and synthetic amino acids. In dairy cows, fed diets with low or high levels of protein, balancing the essential amino acid profile improved the efficiency of nitrogen utilization.

The unit has strong links to recent scientific knowledge through its extensive national and international research collaborations and networks.

In the FP6 Q-PorkChain project, an integrated method for the evaluation of pig farming system has been developed. The model includes economic and environmental dimensions, animal welfare and health, social acceptability, and quality of products in traditional and conventional production systems. Functional genomic approaches allowed the development of early markers of sensorial and technological quality of meat. The project, coordinated by PEGASE, was built on the collaboration with scientists from five others EU countries.

Together with five other Inra teams, PEGASE revisited systems of feed units for ruminants in order to explain and predict the multiple responses of ruminants to dietary changes and feeding practices (Systali project).

PEGASE researchers have created the CowNex simulator (www.cownex-record.inra.fr), a free tool to calculate protein synthesis and nitrogen excretion in a dairy cattle herd, to estimate the impact of nutritional management on the nitrogen efficiency and on environment. PEGASE showed that it is possible to increase nitrogen efficiency through two mechanisms: by balancing the essential amino acid profile while reducing dietary protein supply and, in ruminants, by favouring nitrogen recycling in the rumen.

The achievements described above are excellent, in that they have resulted in a regular activity of publication in highly ranked journals, in that they come from a multi-tool and integrated set of approaches, and in that they have direct and major applied impact for the meat production chain.

The requirement for Lys, the first-limiting amino acid for growth, was the highest in the most efficient pigs and higher than standard recommendations.

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The results suggest that improvement of feed efficiency by genetic selection should be accompanied by proposing new feeding strategies. Thus, individual feeding strategies should account for the efficiency responses of individual animals rather than on the "average" nutrient requirements of the group or herd.

PEGASE have no explicit policy regarding publication targets, although publishing for impact rather than for impact factors is considered more important. During the assessment period close to 500 scientific papers have been published in international peer-reviewed journals, a PEGASE member being first or last authors in two-thirds of the articles. Over the period assessed, this corresponds to about 1.65 article/year/full time scientist. Most papers have been published in journals ranked as excellent within their respective scientific area (Animal, J. Animal Science, J. Dairy Science, Meat Science). PEGASE also publishes sometimes in more general journals that are ranked as excellent (Genetics, BMC Genomics, J. Physiology London) or excellent (Molecular Biology Evolution, Nucleic Acids Research, PloS One).

The results on feed efficiency have been disseminated at international conferences on animal production. At the EAAP meeting in 2013 (Nantes, France) two half-day sessions were devoted to feed efficiency in pigs and ruminants, and the ruminant session was chaired by PEGASE staff. Moreover, unit scientists have co-authored a book chapter on feed efficiency.

About 35% (175) of the peer-reviewed publications were co-signed with international partners (42 different countries in total), which demonstrates the extensive international collaboration and recognition of PEGASE.

Almost 50% (222) of the peer-reviewed publications were co-signed with scientists from other INRA research units, showing the extensive national research collaborations of PEGASE and is a strong indicator of national recognition.

Short appreciation on this criterion

The scientific quality and output from the unit is excellent.

Assessment of the unit academic reputation and appeal

All PEGASE research teams have participated in at least five ANR or European projects. PEGASE team members have coordinated 6 ANR projects (Andropig, Utopige, Fatinteger, Agralid, Chickstress, Deffilait) and 2 EU projects (Multisward, Feed-a-Gene).

The research teams of PEGASE are all well represented and very active as leaders and partners in different local (UMTs), national (ANR projects, e.g. Andropig, UtOpiGe, FatInteger, Agralid, Chickstress, Deffilait; Casdar projects; RMTs; metaprograms GISA- Integrated Management of Animal Health, ACAAF – Adaptation of Agriculture and Forestry to Climate Change, MEM, SelGen) and international research networks (e.g. Horizon 2020, EU FP6 & FP7 [Q-Porkchains, Rednex, Multisward, ProHealth, Feed-a-Gene]).

Overall, the quality of foreign postdoctoral researchers and recruited scientists is very good.

During the period reviewed, several PEGASE staff members have been awarded prizes, such as the "Distinguished Service Award" of EAAP, the "Étoiles de l'Europe" trophy from the Ministry of Higher Education and Research for the management of the FP7 Multisward project, the "Palmes académiques" by the Ministry of Higher Education and Research, and the "Mérite agricole" from the Ministry of Agriculture.

PEGASE scientists are active in editorial teams of international peer-reviewed journals of high quality, such as Animal (3 members; including the editor-in-chief), Journal of Animal Science (2) and Livestock Science (2), and the highly respected national peer-reviewed journal Inra Productions Animales. PEGASE scientists are active as reviewers in a large number of peer-reviewed international scientific journals of which most have a high to very high quality and scientific reputation.

PEGASE scientists have been frequently invited to give talks at scientific congresses (95/149) and professional meetings (54/149). The main part (62/149) were given in France while the remainder were given in Europe (33), Brazil (10) and the USA (5).

Short appreciation on this criterion

The academic reputation and appeal of the unit is very good, but there is still room for improving international recognition.

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Assessment of the unit interaction with the social, economic and cultural environment

Several of the research teams in PEGASE have been active and very successful in developing models and management tools designed to make it possible for decision makers and the advisory services to evaluate and handle the complexity of livestock production and farming systems.

PEGASE scientists have been very active in communicating research results at national meetings (a total of 333 presentations) with an important participation of professionals, "Rencontres autour des Recherches sur les Ruminants", "Journées de la Recherche Porcine", "Journées de la Recherche Avicole et Palmipèdes à Foie Gras", "Journées Sciences du Muscles et Technologies des Viandes" and "Journées Francophones de Nutrition".

PEGASE is member of two joint technological units (UMT) and five joint technological networks (RMT), which all have been very successful and productive. The partnership with the UMT's and RMT's were established for a 5-year period. The participation in Joint Technical Units (UMT) provides a strong framework for collaboration that goes beyond the peer-to-peer collaborations and which results in collaborative research proposals and projects.

PEGASE scientists are frequently solicited for scientific expertise by animal nutrition companies and for experimental work.

Short appreciation on this criterion

Based on this assessment, the interaction with the social, economic and cultural environment is very good.

Assessment of the unit organisation and life

The present organisation of the unit and the teams seems based on numerous internal participative meetings and discussions, and a SWOT analysis on organisational issues is given.

In general, the coherence of the teams with regard to the scientific objectives is very good. However, the team for genetics and genomics (GG) seems to be misplaced as its research is focused on poultry, which deviates from that of the other teams.

The staff is represented in the management council and in the unit council, which have meetings on a regular basis throughout the year, and there is a high quality communication through newsletters, leaflets and the website.

The teams within the unit have very good accessibility to laboratory resources and to animal experimentation resources. The premises are well suited to support the research activities of the unit. However, the possible shortage of technical staff in the future can limit the possibilities to successfully perform planned research.

There are no indications of any new team being incorporated into the unit. The possibility should be considered that new teams are formed from existing teams to reach a better critical size and better mix the competences.

Short appreciation on this criterion

The unit organization and life is good.

Assessment of the unit involvement in training through research

PEGASE is involved in the engineer specialization "Animal Sciences" of Agrocampus Ouest, the Master degree "Animal Sciences for Breeding for Tomorrow (SAED)" co-hosted with the University of Rennes and Oniris, and co-coordinates the Master degree in biology "Cellular and Molecular Sciences of life (SCMV)", co-hosted with the University of Rennes.

Agrocampus faculty staff of PEGASE, together with INRA colleagues, have been involved in several European training programs, such as "Sustainable pig production" (2009 to 2011; co-organized with ESA of Angers), "Sustainable Livestock housing in Europe" (2014; co-organized with ISA of Lille), the Summer School "Adaptative animals and livestock farming systems to meet global changes" (2014; co-organized with the University of Wageningen), and e-learning programs (FP7 EU-PLF project organized by the catholic University of Leuven in 2015). Moreover, the unit has coordinated an "Education & research" exchange with Brazil involving both outgoing (one Agrocampus faculty, three Inra researchers & two PhD students) and incoming (three Agrocampus faculty, one PhD student & one post-doc) participants.

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The Master of Science program SAED ("Sciences de l'Animal pour l'Élevage de demain", animal science for animal production of tomorrow), created in partnership with Agrocampus Ouest, the University of Rennes 1 and Oniris (Nantes), is coordinated by a PEGASE faculty member. The SAED training program is characterized by global and integrative approaches with a strong focus on the development of methodological and inter-personal skills, which are in line with the skills and expertise of the unit. The employability rate of SAED Master students is 94-100% within the first six months after graduation.

The faculty members of PEGASE also co-coordinate the Master degree in biology "Cellular and Molecular Sciences of life (SCMV)", co-hosted with the University of Rennes.

PEGASE is member of the Doctoral School "Vie Agro Santé" (VAS) organized by the University of Rennes. The VAS Doctoral School centralizes the information related to PhD courses of the PEGASE students on the basis of information provided by PEGASE. Members of PEGASE regularly participate to the different examination committees of VAS and PEGASE organizes an annual meeting for PhD students and visits of private companies. PEGASE participates to the research committee of VAS, and one of the PhD's is the representative of the PhD students in the council of VAS. A total of 33 PhD students defended their theses during the assessment period. All PhDs published one or more scientific papers as 1st author (frequently in Animal, Journal of Animal Sciences, J. Dairy Science, more rarely in PloS One, BMC Genetics…). The unit has 26 HDR and a PhD/HDR ratio of 0.81. The PhD/HDR ratio for the doctoral school VAS is 0.76. After the thesis, the majority of doctors stay in the scientific sector and find permanent positions. This is facilitated by the fact that PEGASE staff has well established networks with different stakeholders and the society :11 doctors found permanent positions in the public scientific sector, 3 in the private scientific sector; 7 got permanent positions in the non scientific sector, 8 are post-docs; 2 are inactive.

Short appreciation on this criterion

The involvement in training through research at master level, engineering degree and doctoral school is good.

Assessment of the strategy and the five-year plan

Much of the research planned for the different teams of the unit is following the same direction as before and is building on earlier results and achievements. In general, this mainly corresponds to low risk-taking projects in the five-year plan.

There is no common coherent and clear strategic project for the whole unit. Although there are co-operation between teams in certain areas, a large part of the planned research activities of the teams are independent of other teams. The possible synergy between teams is not used to its full potential and could be exploited to a larger extent to build integrated projects. This could be accomplished by identifying a common theme for research (e.g. animal robustness) across teams and may be a means to become more competitive for funding.

There are several examples of developed interdisciplinarity in planned projects within the teams of the unit. However, there is room for more interdisciplinarity between teams within the unit and with units and teams outside the unit that can complement the competence and capacity (scientific and analytical) at PEGASE.

The unit has extensive collaboration with non-academic partners and demonstrate many examples of their participation in research projects, which is reinforced by 2 UMT.

The links between basic and applied research could be strengthened by closer collaboration with other teams and units within INRA.

The quality of international and national academic partners is very good, while the quality of non-academic partners is good.

The unit appears to be flexible in directing the research activities to be in harmony with the expectations from the livestock sector and the society.

The SWOT analysis is appropriate and realistic.

The feasibility of the five-year plan as a whole is high in light of the resources available.

Short appreciation on this criterion

The strategy and five-year plan is good, but might include some more risky parts.

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4 ● Team-by-team analysis

Team 1:   Syslait (Systèmes laitiers)

Name of team leader: Mr. Rémy Delagarde

Team scientific domains

Cow nutrition and feeding, herd management, feed efficiency, grazing system, phenotyping

Workforce

Team workforce	Number on 30/06/2015	Number on 01/01/2017
N1: Permanent professors and similar positions	3	3
N2: Permanent researchers from Institutions and similar positions	7	7
N3: Other permanent staff (technicians and administrative personnel)	2	2
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers (Emeritus Research Director, Postdoctoral scientists, visitors, etc.)		
N6: Other contractual staff (technicians and administrative personnel)	1	
N7: PhD students	6	
TOTAL N1 to N7	**19**	
Qualified research supervisors (HDR) or similar positions	**5**	

Team record	From 01/01/2010 to 30/06/2015
PhD theses defended	5
Postdoctoral scientists having spent at least 12 months in the unit	2
Number of Research Supervisor Qualifications (HDR) obtained during the period	2

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● Detailed assessments

Assessment of scientific quality and outputs

The scopes of researches are grazing efficiency, dairy herd management, and environmental evaluation of dairy systems. These researches aim at farmers, advisors, and policymakers. The originality claimed is to combine analytical and systemic approaches. There is for sure an important body of work done in dairy cattle but it is difficult to determine exactly the analytical results contributed by Lactation team (E3) or by Alinut team (E7) although a few papers are co-authored by these teams (respectively 6 and 7 among 136)

Between 2010 and 2015, the Syslait team improved basic knowledge on intake regulation and the prediction of pasture intake, along with long-term evaluation of grazing dairy herds' performance and pasture and new grazing management tools. A special improvement of voluntary feed intake at pasture has been done through experiments, meta-analyses and modelling. At pasture level, effects of plant diversity has been evaluated and found to be more sustainable hence giving an increased milk production, and providing ecological services including the decrease of greenhouse gas emission. It is worth noticing that this botanical biodiversity was lost in planted pure grass pastures. Progresses in that field encompass the development of a new version of the tool called Patur'Plan that includes elements from Ireland and New Zealand specific tools. This is an original and important collaborative work that has resulted in several papers (e.g. Grass and Forage Science, Journal of Dairy Science, Animal, Fourrages, Inra Animal Production).

Dairy cows' management study involves a rare and long term (running since 11 years) experiment combining breeds, feeding and practice in order to evaluate the efficiency of such systems. Many aspects including growth of young animals and economics are included in this experiment. Another experiment with serial analytical measurements conducted in experimental station focuses on feed efficiency of dairy cows. It is planned to study body reserve variations as a key element of the efficiency. The new insight is to include functional events as part of the global biological efficiency. This approach includes measuring numerous productive and functional traits that will allow phenotyping animals and thus serve for selection. Cow nutrition and feeding systems is also in the scope of Syslait team with a special emphasis on protein efficiency. For ruminants, reduction of rumen degradable protein is cited as a means to reduce urinary losses. Development of Systali program for improvement of ruminant feeding system was very important for NRA and is a logical application of recent knowledge. Importantly, this research allows a better knowledge of N flows in cow farming systems. The available knowledge were updated in a collective scientific expert review coordinated by Syslait that helped to identify reliable actions improving the sustainability of livestock farming systems. Significant progresses have also been obtained by multiscale modelling thanks to MELODIE model that includes environmental aspects including elements (C, N, and P), water use and energy flows.

Most of the methodological developments on experiments aimed at a better integration of information from animal level up to the herd level. Syslait expects a lot from automated measurement of Body Condition by 3D imaging for a better understanding of feed efficiency. In vivo estimation of body energy is an old and permanent question. Due to the weak relationship between subcutaneous body fat (3D estimated) and total fat (measured after slaughter), one must be cautious on the possibilities of this method even if repeatability is improved by automated and frequent assessment. It is highly probable that different methodologies must be combined to tackle the issue of individual differences among cows. Measurements of functional traits in dairy cows are considered as a new orientation of research, and phenotyping dairy cows is for sure a new orientation. However, the specificity of such measurements is not detailed and not compared to international teams. The main global scientific question is centred on improvement of feeding efficiency of dairy cows. The investigations proposed are directly linked to farmer's demand and project funding opportunity. The essential methodological progress is for sure done in highly integrated modes covering all the critical points of dairy cows' farming systems. Sensitivity analyses of existing models would probably help to identify the limiting factors and justify the need for new researches. The perspective of data mining within the proposed solutions of the existing models is surprising and questionable. This team has an excellent expertise in cows' nutrition and modelling, and the renewed and original approach is to include in vivo automated body reserve evaluation, which is a keystone if it is a success.

The number of publications is excellent and well balanced between scientific journal and other forms of dissemination (peer-reviewed Journals (136, with 75 as 1st or last author), book Chapters (11), & software publications (18)). The top five products cited by this team are: a collective expertise on nitrogen use (Fourrages. 2012), a description of a model on flows of nutrients at farm level (Animal, 2012), another model on grazing management (Grass and Forage Science, 2011), an on online software (Pâtur'Plan, 2014) and a book on feeding allowances for dairy cows (Modelling nutrient digestion and utilisation in farm animals, 2010).

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Concerning grazing management, there are strong collaborations with an Irish team, which has been extended to New Zealand researchers. For the feeding system of dairy cows, which is rather a National aim, Syslait is an important actor. Collaboration with other Inra research stations located in France results in shared authorship with UMRH-Clermont-Ferrand (22/88), UMR-SAS Rennes (21/88) and UMR MoSAR (10/88). This is a sign of good collaborations with teams involved in complementary topics.

The publication strategy is in line with regard to the topics of the team, with a majority of English papers (Animal, ranked as excellent in the field of Dairy and Animal Sciences is the preferred journal) even though some French support were also used to target the professional readership (Inra Productions Animales, Fourrages).

The research activities of Syslait are clearly driven by practical questions and professional demand. This team succeeded in analysing complex farming systems through modelling and multi-criteria analyses. Since biological integration is the main activity, the results of the team should rather be seen as solutions to problems than as addressing a new fundamental scientific question. Funding through agricultural projects tends to drive this team towards applied research.

Short appreciation on this criterion

Altogether, based on the analysis made above, Syslait has an excellent level of publications in adequate journals.

Assessment of the team academic reputation and appeal

The Syslait team has a very good international reputation that allows them to participate to five EU projects, with one coordination (Multisward) and WP management in two other projects (RedNEx and Prolific). The Multisward project is a real success with a distinctive price given to a Syslait member. In addition, the team participated to four ANR and two Ademe programs, and managed one PSDR program (Laitop). Team members gave 19 invited presentations and participated to many international (127) and national (17) congresses.

One team member of Syslait is vice-president of the European Animal Task Force and two members were respectively president and vice-president of the French scientific committee of the EAAP congress held in 2013 in Nantes. Several members are part of bilateral networks such as Inra-WUR, Inra-Teagasc, and Inra-SRUC, and in the European greenhouse gas consortium. One team member is also co-leader of the group "Livestock Systems and Environment" of Inra-WUR network. Appeal of the team for grazing research is particularly noticeable considering the large number of foreign PhD students and post-doctoral scientists (5 HDR and a PhD/HDR ratio of 1.2) supervised or co-supervised by Syslait (e.g., from Ireland, Chile, Brazil, and Spain).

Syslait team is deeply engaged in Inra management at the national level ("chargé de mission" of the Scientific Direction for Agriculture of Inra, the scientific councils of Phase and MIA departments, and the specialized scientific commission (CSS) "Agronomie Elevage et Environnement"), at regional level (scientific council of Inra Région Poitou-Charentes) and at local levels (Scientific Use Committee (CSU) of experimental units or facilities in Le Pin-au-Haras, Ferlus Lusignan, and PEGASE). Team members contributed to several collective scientific expertise studies (ESCo) for Inra (ESCo Nitrogen - as leader-, ESCo Drought, and greenhouse gas prospects 2030). They are also active members of the Committee for agricultural practices with respect for the environment (CORPEN) of the Ministry of Ecology (on emissions) and of the Permanent Committee of Plant Selection of the Ministry of Agriculture (CTPS) (on selection of forage species), and they have been experts for FAO.

PEGASE, and more especially the Syslait team, with its staff and facilities (IEPL), and Le Pin au Haras experimental station are very attractive and successful to compete for European funds related to research on dairy cows. The demand for applied research on dairy cows is fairly strong, as in other parts of northern Europe, naturally helping in building projects. Syslait members are well represented in several organizations and have a well-recognised position in Europe. This central position of Syslait is most probably due to very active senior members. The renewal of these representatives will be important for Syslait strategy.

Short appreciation on this criterion

The academic reputation of this team is very good.

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Assessment of the team interaction with the social, economic and cultural environment

Syslait is very active in the dairy production sector to promote their results and disseminate their advices. This is often done in conjunction with extension services (UMT RIEL with Idele) and for agricultural (Orne Conseil Elevage) or environmental services (Parc Naturel Regional Normandie-Maine) and cooperatives (CCPA, AGRIAL). They also have strong relationships with private enterprises of the Brittany region (e.g. AGRIAL, CCPA, Euralis, 3D Ouest). It is however not described who is participating to such a number of meetings, discussions groups, expertise and demonstrations (such as SPACE and SIAL).

Team members have frequent interactions with economic partners on any topic concerning practical questions related to dairy farming. They are members of technical committees and frequently invited to give conferences for socio-professional audiences (e.g. SIA, Paris; SPACE, Rennes; Salon de l'Herbe; Prairiales of Normandie; 3R; Journées de l'AFPF).

Short appreciation on this criterion

The interaction with the social, economic and social environment of the Syslait team is excellent.

Assessment of the team organisation and life

The head of the team is an Inra Engineer, while 2 senior searchers are involved in national (Inra) or local tasks (PEGASE Management), which may have positively impacted life in the team. It should be noted that the staff of experimental station strongly increases the work force of the team.

Assessment of the team involvement in training through research

Five doctoral theses were achieved during the period, which is good. The participation of the Syslait team is not directly mentioned in the Master courses of the engineer specialization "Animal Sciences" of Agrocampus Ouest and the Master degree "Animal Sciences for Breeding for Tomorrow (SAED)" which involves 25 students/year in each cursus who frequently do their internship in PEGASE.

As for the rest of PEGASE, investment of Syslait in teaching is very good because they consider that delivering recent research results is part of their mission. In addition, a professor in this team is the head of the master course.

Short appreciation on this criterion

The involvement in training and research of the team is good.

Assessment of the strategy and the five-year plan

The main lines of the project consist in 1) a better phenotyping of inter-individual determinants of feed efficiency of dairy cows, 2) quantification of their medium- to long-term adaptive capacities to varying management strategies, and to 3) better predict and investigate the multi-criteria dimensions of sustainability of dairy production systems. Indications are given of the program that will decline. The projects that are announced are already funded. Some collaboration are indicated in the field of economy.

The projects of Syslait, which the committee would have liked to see more detailed, are largely based on existing skills and what has been successfully done before.

Short appreciation on this criterion

The strategy and five-year plan of Syslait are good, but mainly built on existing knowledge and skills. There is lack of novel and innovative research elements.

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Conclusion

▪ Strengths and opportunities:

The fact that Syslait is specialised on dairy cow is a strength that is clearly identified by partners in this part of France largely dedicated to dairy production. Integrative research is in good connection with calls and projects funding at regional, national and European levels. Syslait shows an excellent reactivity toward societal demand (INRA expertise, contracts with private partners). The experimental facility, together with its technical staff (n=34), and the access to Inra experimental domains (Le Pin au Haras) are real opportunities. This team is very well integrated within European networks with similar questions concerning intensive dairy farming issues. Senior scientists are well recognized and involved at the national level, which creates effective synergies with funding success. This results in a high number of publications in well-recognized journals (e.g. Animal, Journal of Dairy Science, Grass and Forage Science, Journal of Agricultural Science). Further, their original contribution in the development of other products like softwares is a real opportunity.

▪ Weaknesses and threats:

Scientific questions may appear hidden behind technical results. Separation between analytical and integrative researches is not always clearly identified. Syslait results, when compared to Lactation and/or Alinut teams, are at risk to be perceived as mostly engineering. At a time of many debates about animal production systems, the strong demands exerted by the dairy sector professionals on Syslait scientists may be confusing. As a consequence, concerning the main issue of environmental impacts of dairy farming systems, the present work gives the impression that the solutions proposed are rather dedicated to mitigate the negative impacts rather than propose real changes. The present organization of the unit (teams) and funding systems (large projects) favours the share of competences, but is it favourable for creativity and real innovation?

▪ Recommendations:

The committee recommends to better delineate the original scientific results, either biological or integrative, from the applied results. This may be possible with a clearer presentation of what is done within the UMR PEGASE and within the UMT RIEL. Major specific questions (metabolism, ruminal digestion, lactation) related to high producing animals, such as dairy cow as a model, is of great scientific interest. However, we suggest developing an ethical reflexion, involving PhD students, on what should or should not be proposed on dairy selection and environmental practices. The ethical reflexion should anticipate points that may become critical and debatable in future intensive farming systems.

Team 2: Sysporc (Le porc dans les systèmes d'élevage)

Name of team leader: Mr. Ludovic Brossard

Team scientific domains

Pig production systems, animal welfare, animal behaviour, environment, decision making tools

Workforce

Team workforce	Number on 30/06/2015	Number on 01/01/2017
N1: Permanent professors and similar positions	1	1
N2: Permanent researchers from Institutions and similar positions	4	5
N3: Other permanent staff (technicians and administrative personnel)	3	2
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers (Emeritus Research Director, Postdoctoral scientists, visitors, etc.)		
N6: Other contractual staff (technicians and administrative personnel)		
N7: PhD students	3	
TOTAL N1 to N7	11	
Qualified research supervisors (HDR) or similar positions	2	

Team record	From 01/01/2010 to 30/06/2015
PhD theses defended	4
Postdoctoral scientists having spent at least 12 months in the unit	
Number of Research Supervisor Qualifications (HDR) obtained during the period	

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● Detailed assessments

Assessment of scientific quality and outputs

The aim of Sysporc team is to develop innovative pig production systems by creating knowledge at the levels of the animal and the production system, with special emphasis on animal welfare and environment, and by developing decision-making tools for evaluation and management.

One research focus was to better understand the behaviour of pigs in their rearing environment, in order to identify ways for farmers to manage their animals, with expected impacts on performance. The cognitive and emotional capacities of pigs were characterized, and extensive research related to the feeding behaviour of pigs was conducted. Results revealed breed differences in behavioural reactivity and showed that only sweet and caloric reinforcements were efficient stimuli for food preference conditioning.

A new method for pig welfare assessment based on vocalizations was developed and showed clear links between the emotional state of pigs and their calls. An evaluation system based on pigs' posture was developed to allow identification of chronic stress. Interestingly, modelling approaches can be used to relate behaviour and welfare to the rearing environment.

Various efforts in modelling resulted in tools that are useful for basic and applied research. An improved model (Inra Porc model) will allow more realistic simulations of the effects of the various feeding strategies on animal performance, and on the environment and production economy. In addition, methods developed to obtain individual parameters through this model can be used to calculate and evaluate genetic correlations and heritabilities in relation to feed efficiency. A decision-support tool predicts performance and nutritional requirements of lactating sows under different climatic conditions was also developed.

Experimental approaches and Life Cycle Assessment tools showed that changing the diet composition (i.e. fibre content) can be a simple and efficient way to manipulate nitrogen excretion, gas emission and biogas production. A complete model for the prediction of N, P, K, Cu, Zn, C, dry matter and water excretion, and gaseous emissions by pigs and manure was developed to predict the environmental impact of food production at the whole farm level.

Finally, a more general tool for the multi-criteria sustainability evaluation of was developed and applied on 15 pig production systems in Europe was developed. The tool proved be very robust for highlighting the strengths and weaknesses of the systems (i.e., conventional, adapted conventional, traditional, and organic).

The team has an impressive scientific publication record over the past years (2010-2015) with a total of 75 (45%, 34/75 as 1st or last author), peer-reviewed journal articles (e.g. Animal, Journal of Animal Science, Livestock Science, Applied Animal Behaviour, PloS One), 6 edited books and proceedings and 9 book chapters. The team has a total of 284 publications with 141 (50%) as 1st or last author and an average of 4.7 papers/researcher/year during the period as 1st or last author.

Sysporc also has well-developed international collaborations with universities and institutes in EU and over-seas (e.g. WUR, The Netherlands; IRTA, Spain; Newcastle University, UK; Agriculture & Agrifood Canada; University of Guelph, Canada; Brazilian Universities).

Collaboration with several other Inra research teams located in France is demonstrated by shared authorship in peer-reviewed articles with UMRH-Clermont-Ferrand (10/31), ADNC-Rennes (9/31), SAS-Rennes (8/31), GABI-Jouy-en-Josas (7/31), GenPhySe-Toulouse (6/31), URA-Tours (5/31) and SADAPT (5/31).

A major part of the peer-reviewed journal articles are published in high-ranked international journals in their respective fields of research e.g. Animal, Journal of Animal Science, Livestock Science, Applied Animal Behaviour, PloS One).

Short appreciation on this criterion

The scientific quality and output from the team is excellent.

Assessment of the team academic reputation and appeal

During the reviewed period, the team has been involved in seven Casdar projects (with Technical Institutes), three ANR projects, two Inra meta-programs calls and nine EU research programs (FP6, FP7, and H2020). The

involvement has ranged from simple participation to work package leading or general coordination (coordination of 2 ANR projects and 1 EU project).

The team has well-developed and active international research co-operations formalized through projects, often within EU projects (e.g. Q-Porkchains, Aware, AnimalChange, ProHealth, Treasure, Feed-a-Gene).

Sysporc has also well-developed active national research co-operations with other teams of PEGASE and with other Inra units of the Phase division (e.g. UMRH, URA, MoSAR and SAS) and with units from other divisions (e.g. SMART, ADNC and GABI).

The team participates in research networks at the local, national and international levels. Examples are the local GIS network "Cerveau – Comportement – Société", the national GDR network "Ethologie" and "Agri-Bien-être", and establishment of collaborations on animal behaviour in the area of behaviour and animal welfare. Examples for environment and livestock systems are the RMT network "Livestock and environment", under the leadership of a team member, and the RMT networks "Animal welfare" and "Modelling and Data Analysis for Agriculture". The team is also involved in activities and coordination of the UMT (Joined Technical Unit) "Engineering of pig production systems" with Ifip.

Short appreciation on this criterion

Based on the analysis detailed above, the academic reputation and appeal of the team is very good.

Assessment of the team interaction with the social, economic and cultural environment

Relevance and usefulness of team achievements are demonstrated by active and well-developed collaborations with socioeconomic stakeholders (2 contracts with Britanny Region) and with the livestock industry (4 contracts with IFIP, 1 with Techna France Nutrition, 1 with Institut d'Élevage, 1 with Animine), and by participations as scientific experts to commissions for the agro-industry and stakeholders. The team welcomed a CIFRE PhD student.

The Inra Porc model has become a highly appreciated and very useful science-based tool for pig performance simulations in education and for professionals.

Collaborations have been established with equipment manufacturers to initiate studies on precision feeding systems, and consultation of stakeholders was initiated to develop welfare-friendly alternatives to the existing farrowing crates for sows.

Collaboration in projects between the "systems" Syslait and Sysporc teams, related to environmental issues (in CPER and H2020 projects and calls) and in precision livestock farming (joint position proposal), are on-going and will strengthen the PEGASE research capacity.

Short appreciation on this criterion

The team interaction with the social, economic and cultural environment is very good.

Assessment of the team organisation and life

See the overall assessment of PEGASE.

Assessment of the team involvement in training through research

The team is involved in co-organizing and teaching at Master level at CIHEAM in Saragossa (Spain).

The team is involved in student training through the supervision of Masters (1 and 2) and PhD students. This supervision led the team to declare 4 PhD students. Team scientists co-organise and teach at the Master level in different faculty or universities in France (e.g., Agrocampus Ouest, University of Rennes 1, and ESA Angers).

Short appreciation on this criterion

The team involvement in training through research is good, but some members of the team should aim at obtaining the university degree required to supervise research (HDR).

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Assessment of the strategy and the five-year plan

During the next contract, the Sysporc team will focus their research activities on two main areas: production of knowledge on animal and animal production systems, and development of diverse tools for management support and production system control.

In order to understand the basis of the interactions between animals and the system, including housing and human handling, and focusing on aspects that directly impact animal welfare, the following objectives will be studied: 1) the impact of different housing and rearing conditions on behaviour and welfare, 2) the impact of human management, in particular caretaking of piglets to understand the consequences on long-term piglet health and welfare, 3) the understanding of the mechanisms underlying human-animal relationships through the perception of human voice, and 4) the understanding of the relationships between physical and feeding activities and locomotor troubles in sows (Casdar Bealim + project in collaboration with Ifip) and growing pigs (FP7 Prohealth project).

An original project that is highlighted will focus on the development of individualized feeding based on information collected by automatic devices in real-time, which in addition to suitable technical devices will require decision-making tools to handle the information.

The development of methods to assess animal welfare and behaviour, and automated systems to predict and control events with negative impact on welfare and productivity is also planned.

Another future project activity is the development of methodologies and decision support tools based on multi-criteria optimization that can be applied to identify the best (under given circumstances) overall feeding strategy for growing-finishing pigs. This new methodology will also be applied to evaluate meat quality of various European extensive pig production systems using local pig breeds.

In close collaboration with end-users, there will be continued development of the model and software tool InraPorc to account for variability between individuals.

These priorities are logical in relation to research activities in the previous period and will allow further development and refinement of earlier scientific achievements.

Short appreciation on this criterion

The strategy and five-year plan of the team are good, but is mainly built on existing knowledge and skills. There are few novel and innovative research elements.

Conclusion

- **Strengths and opportunities:**

The team is very productive and has a strong, internationally recognized expertise in the multi-scale evaluation of pig production systems, and in the development of decision support tools that contribute to improve these production systems. The team has demonstrated its ability to conduct innovative research projects addressing relevant socio-economic questions. There are many opportunities for future research in this field in view of the great challenges in economic, environmental and social sustainability that must be faced by the current pig production systems.

- **Weaknesses and threats:**

There are no particular weaknesses for this team, apart from the overall challenges of the unit (e.g. diversification, staff reductions, more administration). However, there is a risk that the strong focus put on generating technical knowledge and developing management tools for improving the intensive pig production systems, may not provide adequate answers to the existing socio-economic questions in this field.

- **Recommendations:**

The team is advised to remain focused on its key expertise. However, in order to put problems related to pig production systems into the proper socio-economic context, it is recommended to strengthen collaboration with expertise in human and social sciences. Developing a view on future pig production systems that is as broad as possible is recommended.

Team 3: Lactation (Physiologie de la lactation et synthèse du lait)

Name of team leader: Ms. Hélène Quesnel

Team scientific domains

Physiology of lactation, biological mechanisms of milk production, response to management practices, endocrinology of lactation, colostrogenesis, mammary metabolism

Workforce

Team workforce	Number on 30/06/2015	Number on 01/01/2017
N1: Permanent professors and similar positions	3	2
N2: Permanent researchers from Institutions and similar positions	5	5
N3: Other permanent staff (technicians and administrative personnel)	5	6
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers (Emeritus Research Director, Postdoctoral scientists, visitors, etc.)		
N6: Other contractual staff (technicians and administrative personnel)	1	
N7: PhD students	3	
TOTAL N1 to N7	17	
Qualified research supervisors (HDR) or similar positions	4	

Team record	From 01/01/2010 to 30/06/2015
PhD theses defended	6
Postdoctoral scientists having spent at least 12 months in the unit	
Number of Research Supervisor Qualifications (HDR) obtained during the period	2

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● Detailed assessments

Assessment of scientific quality and outputs

The team aims to better understand the physiological and metabolic mechanisms underlying milk production and the response of lactating females to management practices. Various constraints in milk production were considered, with the aim to preserve production efficiency in sustainable production systems.

The role of prolactin and sex steroids on the potential of the mammary tissue in cows and goats was investigated. Among several interesting results, it was shown that inhibition of pituitary prolactin release during established lactation decreased milk yield and cell proliferation in the mammary gland while cell apoptosis was increased. Another novel finding was that the rate of exfoliation of the mammary epithelial cells (MEC) into milk and the MEC microenvironment determine the milk production potential of dairy ruminants. Ad libitum feeding of goats for a short period before first lactation increased milk production whereas it strongly reduced udder development and milk yield when it was imposed throughout from weaning until parturition.

Because of the essential role of colostrum for offspring survival, and because neonatal mortality is a major issue in pig production, research on colostrogenesis has been targeted to pigs. The concentrations of prolactin and progesterone concentrations in the sow before parturition were correlated with pre-partum markers of energy and protein metabolism. Dietary manipulation was shown to influence colostrum composition, but not yield..

The team also devoted effort to increase the efficiency of amino acid utilization in dairy cows both under low and high metabolizable protein (PDI) supplies (FP7 RedNEx project). Their findings will be used to renew the ruminant feeding system (Inra Systali project). A meta-analysis was used to develop a model and a web tool of mammary metabolism, which allowed for analysing the interactions between milk protein and lactose synthesis, and showed that increasing the PDI supply increased the synthesis of protein, lactose and fatty acids.

The adaptation of the mammary gland to varying milking management was also studied. Although the results of trials made with dairy cows were discouraging, small ruminants showed a better ability to adapt to once-daily milking. The variability of the adaptive potential of dairy cows to lengthened milking intervals was studied within the frame of the Ruminflame project (Inra GISA meta-program). Variation in milk yield caused by a single once-daily milking was identified to include effects of e.g. parity, age at first calving and stage of lactation.

A new line of research demonstrated that a large proportion of the dairy camelids were very difficult to milk, and it was suggested that genetic selection for milking traits and training of animals to be machine- milked could be possible ways to overcome this problem.

In summary, the team has provided important new knowledge on the hormonal regulation of lactation and on factors affecting colostrogenesis. These findings are important for both ruminant lactation performance and neonatal survival in pig production.

The development of non-invasive techniques for investigating the biology of the mammary gland is another objective of the team. They developed a method using MEC isolated from goat milk to investigate the hormonal regulation of lactation and the impact of nutrition during rearing. The milk MEC model was shown to be useful for studies on many factors influencing milk yield, but under certain circumstances other methods should be preferred.

The recruitment of a new Inra scientist allowed the development of analytical tools and models for the study of regulation of the volume and composition of milk.

The team has a very high publication record in the period 2010 – 2015 with a total of 66 peer reviewed journal articles, among which 27 as last authors, 14 as first authors, and 6 book chapters. The team has published the major part of its articles in highly ranked scientific journals within the relevant field of research (e.g. Animal, Journal of Dairy Science, Domestic Animal Endocrinology, Livestock Science, with a team member as last author).

Short appreciation on this criterion

The team has demonstrated an excellent quality of research and scientific publication.

Assessment of the team academic reputation and appeal

The team has well developed international collaborations with other teams within EU and overseas (Canada, New-Zealand, Tunisia). National collaboration with several INRA research units is also demonstrated by the production

of co-authored peer-reviewed publications. Funding has been received from various funding bodies (ANR (3 projects funded), Casdar (1 project), FUI (2 projects), INRA metaprogram GISA.

During the period 2010 – 2015 the team has participated in 3 ANR research projects and in 2 EU research programs within FP6, FP7 or H2020.

The team participates in several international networks (Dairy and Swine R&D, Canada, Universities of Bern and Copenhagen, AgResearch, New Zealand), and their expertise attracts PhD-students and post docs from abroad (4 during the period). During the assessed period, 40% of the articles published by the team were co-authored with foreign universities and research institutes.

A team member is member of the editorial board of the peer-reviewed journal Small Ruminant Research.

During the assessment period, team members received 9 invitations to international plenary conferences. They were also invited as assessors for foreign institutes, and as opponents in PhD defences. Team members were also involved in the organization of the international workshop on Biology of Lactation, and the annual meeting of the European Association of Animal Production.

Short appreciation on this criterion

The number of participation to national and international projects, as well as invited talks, show that the team has a very good academic reputation and appeal.

Assessment of the team interaction with the social, economic and cultural environment

The expertise of the team is useful in public-private partnership within the animal nutrition and health sector, where collaboration is established with six international companies. (e.g. Ajinomoto, Adisseo, Kemin, Nutreco, CEVA Santé Animale, Deltavit).

Dissemination of scientific knowledge occurs in meetings with scientific (76 over the assessed period) and technical (27 over the assessed period) actors of dairy and swine networks, and in review articles. Two team members are on the editorial board of the journal Inra Prod. Anim. Dissemination to stakeholders in the form of articles in at least 3 different professional journals occurs occasionally.

Short appreciation on this criterion

The team has a very good interaction with the social, economic and cultural environment.

Assessment of the team organisation and life

The team has established collaboration with all other PEGASE teams (except GG), which has resulted in peer-reviewed publications. This demonstrates that the PEGASE organisation has fostered inter-disciplinary research activities.

Assessment of the team involvement in training through research

The team is involved in training through research by supervising Master students (1 and 2) and PhD students (8 PhD students were hosted, and 6 PhD were defended, for 4 HDR scientists), as well as international students. Each Ph.D published between 2 and 9 articles as a first author in international journals (mostly J. Animal Science; J. Dairy Research; J. Dairy Science). The new doctors found permanent positions in public (3) or private (2) research structures. A foreign student returned to his country. The team participates in design and coordination of a training module in the master SAED.

Short appreciation on this criterion

The team has demonstrated good ability to be involved in training through research.

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Assessment of the strategy and the five-year plan

The five-year plan of the team consists in further developing their research with special focus on two areas where knowledge is lacking. The first area concerns the key factors explaining the role of cell types other than MEC that affect the renewal of mammary cells and the adaptive capacity of lactating females. The second one, in the field of mammary metabolism, concerns the coordinated synthesis of all major milk components. Focus is almost entirely on the mammary gland and not on the whole animal metabolism level.

(1) The first issue will be addressed in a project regarding cellular plasticity of the mammary gland. The lactation persistency may be related to MEC exfoliation, and improvement of lactation persistency mauy decrease health and reproduction risks around parturition. In the coming years, the team aims to investigate the role of signals from the local microenvironment to evaluate if, in addition to central endocrine regulation, mammary adipocytes and fibroblasts could influence MEC differentiation. The plasticity of the mammary cells will be characterised and manipulation of potential for differentiation of adult mammary stem cells will be evaluated by using differentiated rearing strategies in heifers, dairy cows and dairy goats. Model animal studies using nude mice will be used to functionally characterise interesting cell populations. Furthermore, the development of the mammary gland and cell populations in response to different feeding strategies will be investigated in goats.

(2) For the second issue, studies on the metabolic efficiency and plasticity of the mammary gland will investigate the effect of amino acids on mammary metabolism and synthesis of milk components in order to improve nitrogen efficiency of dairy cows. The team plans to develop a non-invasive approach (e.g. metabolomics), *ex vivo* studies using milk MEC to study the plasticity of the mammary gland, and to combine modelling and (for ethical reasons a limited number of) *in vivo* studies. A new project will also investigate the rate of transport of milk components in the secretory pathways of MEC with regard to the regulation of volume and composition of milk.

(3) Finally, the quality of colostrum and milk and immunity will be further investigated. A holistic approach used in swine focuses at understanding the multifactorial dimension of piglet survival. Topics to be addressed include immunity and influence of nutrition. Studies on the role of maternal management and physiology, immune quality of colostrum and survival of the offspring will now also include calves and kids. The health of the udder and strategies to reduce the use of antibiotics, and the use of probiotic bacteria to prevent mastitis in dairy herds will also be investigated.

The project provides logical development and extension of research activities performed during the previous period, and it can be expected that its different parts will provide new important knowledge in the field.

- Within (1) it is proposed to establish a consortium including international partners and partners from other PEGASE teams with expertise in mammary gland physiology, cattle rearing, stem cell knowledge and modelling tools.

- Within (2) a PhD program will be established in cooperation with mathematicians from Inra (Rennes).

- Within (3) collaboration with other PEGASE teams (Sysporc, Croissance and Adaptation) and other Inra units is planned as well as international collaboration and with industry.

Altogether, this demonstrates a considerable degree of interdisciplinary, collaboration and integration, and the quality of the academic and non-academic partners chosen is very good.

The general feasibility of this five-year plan is good and realistic.

Short appreciation on this criterion

The strategy and plan for the next five-year period is good, and demonstrates the will and ability to develop cooperation with international actors, industrial stakeholders and other PEGASE teams.

Conclusion

▪ Strengths and opportunities:

The research projects build on solid foundation gained during the previous period, and the strategy and plan propose to develop the research area further. Collaborative networks will increase the interdisciplinary aspects of the research. Development of non-invasive techniques will decrease *in vivo* experimentation. The orientation of the research activities will contribute to improve sustainability.

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■ Weaknesses and threats:

The research has a strong focus on mammary metabolism but it includes only very few aspects of metabolism at the whole animal level and its importance for milk production. The goat is used as a model animal, but knowledge gained in such studies will not be entirely applicable to dairy cows.

■ Recommendations:

The team is recommended to continue their research activities with main focus on the strengths of the team. Development of interdisciplinary aspects of the research is welcome as well as orientation of research activities towards increased sustainability.

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Team 4:   Adaptation (Physiologie de l'adaptation, nutrition et santé animales)

Name of team leader: Ms. Nathalie Le Floc'h

Team scientific domains

Pig health, physiology, metabolism, animal's environment, farm management

Workforce

Team workforce	Number on 30/06/2015	Number on 01/01/2017
N1: Permanent professors and similar positions	1	1
N2: Permanent researchers from Institutions and similar positions	3	3
N3: Other permanent staff (technicians and administrative personnel)	5	4
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers (Emeritus Research Director, Postdoctoral scientists, visitors, etc.)		
N6: Other contractual staff (technicians and administrative personnel)	2	
N7: PhD students	3	
TOTAL N1 to N7	14	
Qualified research supervisors (HDR) or similar positions	3	

Team record	From 01/01/2010 to 30/06/2015
PhD theses defended	2
Postdoctoral scientists having spent at least 12 months in the unit	1
Number of Research Supervisor Qualifications (HDR) obtained during the period	

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● Detailed assessments

Assessment of scientific quality and outputs

The Adaptation team aims to better understand the physiological and metabolic responses of pigs to rearing conditions, including management and environment. The ultimate goal of the team is to test and propose strategies and practices ensuring good performance, health, and welfare of pigs from birth to slaughter.

This young team has developed expertise in health evaluation at the animal level. They conduct trials in controlled conditions, using experimental non-infectious models that reproduce disturbances of health and/or wellbeing. The team evaluated variability in adaptive abilities and the pattern of the animal response, to test strategies for mitigating the impact of disturbances, and to develop biomarkers for health evaluation. Growth performance was related to markers of inflammatory, metabolic, physiological and behavioral responses. Field knowledge also allowed the team to evaluate the consequences of chronic stress experienced by sows during pregnancy, analysis of the causes of neonatal piglet mortality, and evaluation of the health and welfare status of pigs in organic farming. Although there is a great need for better evaluation tools of animal health in the pig production systems, the approaches followed mainly serve to better understand the animals' responses to challenges, rather than to develop novel biomarkers.

The team also developed expertise in understanding the metabolic and physiological disturbances associated with health disruptions. A meta-analysis quantified the effects of different challenges of the immune system on feed intake and growth. The team also investigated the metabolic response to different challenges in interaction with other factors like genetics, feeding level, and ambient temperature. Several of these studies revealed major changes in nutrient metabolism.

The team progressed in the identification of internal animal factors influencing health preservation by investigating factors that can be controlled on farm such as the genetic background and male castration. The relationship between growth performance and health was also tested using individual growth, ingestion, and mortality herd data. The team also evaluated rearing entire or immune-castrated male pigs as alternatives for surgical castration on stress endocrine response, immunity and health. The research on the relationship between robustness and animal performances yielded some unexpected but interesting results, and it is clear that more research is needed in this area. The team also showed that alternatives to surgical castration may be implemented in practice without negative consequences for the animals.

The Adaptation team has also studied nutritional strategies preserving health. Introducing fiber in the diet in the immediate period after weaning is probably an additional risk factor. Feed restriction had contrasting effects on health and performance of pigs depending on the period, the duration and the challenge the animals had to face.

Finally, nutritional strategies including feed formulation and feeding plan were found to be key technical levers to reduce the use of antibiotics during the post-weaning period. This is also valuable research in view of the mitigation opportunities that nutritional strategies may provide.

A strength of the team is that they have experience with experimental models for disturbing health and/or wellbeing that allow 1/ to evaluate the animal's adaptive ability to these challenges, 2/ to study the associated metabolic and physiologic responses, and 3/ to test mitigation strategies. This is clearly a multidisciplinary approach that has resulted in new paradigms and research questions. For example, it was shown that acclimation to high ambient temperature might be beneficial in improving the capacity of pigs to reduce the physiological and metabolic disturbances caused by an inflammatory challenge.

The team has produced an impressive list of publications in the period 2010-2015, with 72 peer-reviewed journal articles (of which 47 co-authored with other PEGASE teams, 1st or last author in 51% of the papers. A majority of the peer-reviewed articles are published in high-impact journals in the field of research (highest or second quartile in the respective category) (e.g. Animal, Journal of Animal Science, Amino Acids, PloS One, with team members as last authors). Relative to the number of scientists and supporting staff, this is an excellent output. From the list of most cited publications of the unit, it is felt that the Adaptation team scores similar to the other teams. Overall, the citation record is very good.

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The scientific output and the quality of the research of the Adaptation team are excellent, as shown by the large number of publications produced in good journals in the field. The available expertise is used in a multidisciplinary and collaborative approach to address novel research questions that are relevant for current pig production systems.

Assessment of the team academic reputation and appeal

The team has well established international collaborations with universities and institutes in EU and over-seas (e.g. Newcastle University, University of Edinburg, BOKU, Friedrich-Loeffler Institute, Aarhus University). Collaboration with several other French INRA research teams is demonstrated by co-authorship in peer-reviewed articles with GenPhySe-Toulouse (9/27), UMRH-Clermont-Ferrand (8/27), PRC-Tours (6/27), ADNC-Rennes (5/27), GABI-Jouy-en-Josas (5/27). New collaborations with microbiologists at INRA and foreign institutes have been established to investigate the role of the microbiota in animal physiology as a novel approach.

The team has given 60 presentations and 10 invited presentations at international congresses which are the most influential in the field.

During the period assessed, the team has been involved in 2 ANR projects (Andropig, PigletBiota), 3 FP7 projects (Farewelldock as national coordinator; ProPIG as WP leader and national coordinator; Prohealth as WP leader and National Coordinator), 1 Casdar project (Accec). The team collaborates with other teams from PEGASE and with other Inra units of the Phase, GA, or Animal Health (SA) divisions (e.g. GenPhySE, BioEpAR, ISP, and GABI), Ifip, Anses, as well as internationally (e.g., Newcastle University, University of Edinburg, BOKU, Friedrich-Loeffler-Institut, and Aarhus university). It is clear that the team belongs to a large national and international collaborative network of renowned partners. Members of the team not only participate but also take leadership in national and international projects, which demonstrates the reputation and quality of the team.

The Adaptation team is involved in at least 3 scientific networks dealing with animal health management like Inra metaprograms GISA R2A2 and GISA SAEB, and the COST action PiGutNet. Team members participate to the steering committees of GISA R2A2 and GISA SAEB. The scientists from the team are regularly invited to give presentations (10 invited presentations) or chair sessions at scientific conferences on nutrition and health, biomarkers for health evaluation, stress and immunity, and pain indicators. They are also involved in the editorial boards of the journals *Animal* and *Inra Productions Animales* (until 2012). Hence, the team disseminates its research findings not only in peer-reviewed journals, but also in international conferences, and shares its expertise in scientific networks.

Because the team is young and small, taking leadership of work packages in international projects is a mark of recognition. Full coordination of projects should be envisaged in the future.

The international visibility and academic appeal of the team are very good, considering its active involvement in many national and international projects and networks, and its efforts to disseminate its research findings in the scientific domain.

Assessment of the team interaction with the social, economic and cultural environment

The team disseminates their scientific results and expertise to stakeholders through different media like generalist and technical journals (e.g. TerrAgricoles de Bretagne, Mensuel de Rennes, Science Ouest), conferences, regular participation in the Journées de la Recherche Porcine and agricultural fairs. The team also publishes in French speaking journals such as INRA Prod. Anim., largely used by teachers for undergraduate agricultural students. Members of the team have also participated in training sessions for professionals organized by Agrocampus Ouest or other organizations.

The team developed 8 contracts with private partners (ARIP, Institut de l'Élevage, Cooperl, IFIP, Interbio Bretagne, PharmaPro, J. Soufflet, Zoetis France).

The analytical skills developed for the research programs are also used by other researchers from PEGASE and by researchers and engineers from Inra, INSERM, and Idele or other stakeholders from the agro-industry. For example, the laboratory' set up to measure routinely the main compounds that are responsible for boar taint is now used with other INRA units of the Phase, GA, or Animal Health (SA) divisions (GenPhySE, BioEpAR, ISP, and GABI), Ifip, Anses, as

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well as internationally (e.g., Newcastle University, University of Edinburg, BOKU, Friedrich-Loeffler-Institut, and Aarhus university) in the frame of programs on genetic selection for feed efficiency, stress response or sexual development, and with housing and management practices.

The team is, or has been, involved in expert groups at the national (group "Bien-être animal" from Anses since 2012) and European (EFSA in 2010) levels. A team member is also member of the regional Ethical Committee on Animal Experimentation.

These dissemination activities, the training of young scientists (see further), and the partnerships with private companies and other organizations all reinforce the link with the socio-economic environment, and contribute to the development of a research program in close connection with these socio-economic stakeholders.

Short appreciation on this criterion

The interaction of the team with the socio-economic environment is very good. There is a good balance between novel research at an international competitive level on the one hand, and interaction with the stakeholders and transferring the team's research to practical applications on the other hand.

Assessment of the team organisation and life

See overall assessment of PEGASE.

General information is available for the unit but no specific information is provided for the team.

Assessment of the team involvement in training through research

The team contributes to the training of young scientists (master 1 and 2) and to the training of laboratory students and the recruitment of temporary staff.

The team is involved in the training of Agrocampus students at the master level and in PhD training courses (e.g. co-organization in 2014 with WUR and on behalf of Agreenium of a Summer school).

Short appreciation on this criterion

The contribution of the team to training through research is good. The team is involved in different training programs, primarily at the national level.

Assessment of the strategy and the five-year plan

In line with their expertise and previous activities, the team aims to further contribute to improve pig health and welfare. For that purpose, the team will conduct research on the interaction of pig health and welfare with the animal's environment and farm management. The main focus will be to determine the physiological mechanisms of robustness in pigs and the factors involved in piglet robustness at weaning, and to generating knowledge improving animal welfare in livestock systems. These are unquestionably important issues for the development of sustainable pig production.

The so-called resource allocation theory will be tested by focusing on the competition between productive functions (growth) and non-productive functions (immunity and inflammation) for nutrient utilization. The time course of pig performance will also be modeled taking into account the metabolic and physiological responses in collaboration with MoSAR. This work will further benefit from another collaborative project on modelling supported by the Phase division (T-GAM for "Towards a generic animal model"). By considering the ability of pigs to mobilize its resources to cope with a stress, the project aims to develop innovative production systems using less medication and taking into account the natural adaptive capacities of pigs. Although this is a valuable approach, it is not really clear how the metabolic and physiological work, which is the cornerstone of this team, will benefit from the modeling work. The reverse is probably more the case, which is also fine.

Simple and reliable descriptive markers of robustness validated in weaned pigs will be developed for inclusion in selection schemes or indicators of health status. This work, supported by INRA (GISA meta-program 2014-2015), and a contract with private partners, also involves partners from the Animal Health (UMR BioEpAR) and Genetic (UMR GenPhyse) divisions of Inra. Feeding strategies and feed formulation in post-weaning diets will be further tested in

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collaboration with private companies, with the RiTME and BioEpAR research units, and Ifip (TRAJ project financed by the GISA meta-program). Finally, the influence of intestinal microbiota on weaning traits and robustness in piglets will be studied in the ANR Pigletbiota project (2015-2018) led by GABI. These are highly relevant and timely research questions that are addressed adequately. The novel collaboration aiming to unravel the role of the microbiota is very interesting and should be encouraged. On the other hand, the team is advised to remain focused on their key expertise.

To improvement of animal welfare in pig production systems, the team will continue to evaluate the chronic pain after tail docking and tail biting in the ERA-Net FareWellDock project. A project will be started in collaboration with SRUC and the Roslin Institute on the behavioral and neuroendocrine consequences of tooth resection. Both projects will be run in collaboration with Sysporc team members. The links between boar taint and reproductive performance of males and females will be investigated in the ANR Arome project, in collaboration with GenPhySE and Ifip. The team will collaborate with other PEGASE teams in the FP7 Prohealth project to further investigate the link between sow health and welfare and traits implied in piglet survival. The potential use of feeding strategies to counterbalance maternal environmental scantiness, improve maternal health, and welfare and, consequently, offspring survival will also be tested. These are all relevant issues for the welfare of pigs in future pig production systems and the sustainability of these systems.

The team is well recognized for its expertise on pig health, as shown by its participation, in and coordination of, numerous funded projects and successful collaborations. The five-year plan is building further on the available expertise of the team, addresses novel and interesting research questions, and aims at developing strategies that are important for a sustainable pig production. The plan is ambitious but feasible. It is interdisciplinary and there are ample national and international collaborations. There is a clear link between basic and applied research, and private stakeholders are involved. Points of attention may be to maintain a sufficient critical size of the team, and related to this, a focus on its key expertise.

Short appreciation on this criterion

The five-year research plan of the team is in line with its expertise and mission. It is novel and ambitious but feasible given the ample collaboration. It is expected to increase our understanding on how animal health and welfare can be improved in pig production systems.

Conclusion

- ▪ Strengths and opportunities:

The team is motivated, very productive and has a strong expertise in the physiological and metabolic adaptation mechanisms of pigs to health and welfare challenges. The team has developed adequate models for investigating the responses of pigs to diverse challenges, and has a large national and international collaborative network. The team has shown its ability to conduct innovative research projects addressing relevant socio-economic questions. There are many opportunities for future research in this field, as the health and welfare of pigs is compromised in the current intensive pig production systems and there is a need for understanding the factors that determine the robustness of pigs.

- ▪ Weaknesses and threats:

The team is relatively young and small, and heavily relies on collaborations with other research groups. Most of the projects are run as part of larger projects governed by other groups, in which this team is responsible for metabolic and physiological measurements. This should not necessarily be a problem, and the collaborative nature of the work is very productive and good, but there is a risk that the team mainly serves as support for other research groups and cannot further develop an independent profile. Some basic research on the physiology of animal welfare and health would also be welcome.

- ▪ Recommendations:

The team is advised to remain focused on its key expertise, which is the physiological and metabolic mechanisms of pig welfare and health challenges, and to continue the ample collaboration with other research groups. Nevertheless, the team should consider developing a more independent profile, if possible supported by some more basic research to increase its strength and competitiveness in the long term.

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Team 5:   Croissance (Physiologie et métabolisme de la croissance)

Name of team leader: Ms. Florence GONDRET

Team scientific domains

pig, prenatal development, growth efficiency, pork quality, biomarkers

Workforce

Team workforce	Number on 30/06/2015	Number on 01/01/2017
N1: Permanent professors and similar positions		
N2: Permanent researchers from Institutions and similar positions	7	7
N3: Other permanent staff (technicians and administrative personnel)	6	6
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers (Emeritus Research Director, Postdoctoral scientists, visitors, etc.)	2	
N6: Other contractual staff (technicians and administrative personnel)		
N7: PhD students	2	
TOTAL N1 to N7	17	
Qualified research supervisors (HDR) or similar positions	3	

Team record	From 01/01/2010 to 30/06/2015
PhD theses defended	4
Postdoctoral scientists having spent at least 12 months in the unit	3
Number of Research Supervisor Qualifications (HDR) obtained during the period	

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● Detailed assessments

Assessment of scientific quality and outputs

Improving the efficiency and sustainability of pork production requires specific knowledge on the development of lean and fat tissues during growth.

The originality of CROISSANCE research seems guaranteed, both at the national and international levels. The identified outside competitors are most of the time collaborators of the CROISSANCE team within EU projects.

The main goals of the team are to identify the hierarchy of actors underlying metabolic shifts and to predict pork quality. Experiments involving pigs from the fetal to the pubertal periods, biological tools including genomics approaches, and modelling procedures have been associated to determine how cell characteristics and energy metabolism in tissues can explain responses to prenatal and postnatal challenges. More specifically, the CROISSANCE team has concentrated its efforts in three directions:

1/ identify factors during gestation which contribute to growth retardation at birth;

2/ identify cellular, molecular, and tissue phenotypes involved in growth efficiency;

3/ identify relevant factors reflecting quality of meat products at the pork chain level.

Concerning topic 1, early neonatal death is a major economic loss in pig production and birth weight is considered as the most important factor contributing to neonatal survival.

The dynamic changes accounting for adipocyte and myofiber differentiation, lipid and glycogen accumulation, were clarified. For example, they reported for the first time, greater expression levels of Pref1 in adipose tissue and skeletal muscle and a higher ratio of developmental to adult myosin heavy chain (MyHC) isotypes in muscle from growth-retarded pig neonates.

The team also established how these different traits could be related to differences in physiological maturity at birth, irrespective of body weight variations.

They also proposed that fetal plasma concentrations of fructose and albumin were associated to physiological maturity.

Altogether, these studies provided a first set of tissue or circulating biomarkers allowing the diagnosis of functional (im)maturity at birth.

The team also developed expertise in understanding how a high-protein diet during gestation (in collaboration with FBN, Germany) or food-restriction in early gestation followed by overfeeding (in collaboration with AAC, Canada), modulate adipose and muscle tissues of fetuses and/or neonates. This is an important topic since an adverse environment during early development has the potential to modify phenotypes permanently (developmental origin of health and adult disease concept, DOHaD concept), and appropriate nutritional strategies applied to pregnant sows must be developed to prevent impaired fetal development..

On topic 1, the team published 5 articles in peer-reviewed journals, including 1 AJP-Cell Physiol 2013 (last author), 1 Eur J Nutr 2012 (2nd author), 1 Differentiation 2011 (1st author), 1 PLoS One 2014 (last author)).

Topic 2 is highly relevant in the perspective of improving the efficiency of postnatal growth which is a key target in pig production. Genetic selection to decrease residual feed intake (RFI) represents a relevant way to reduce feed cost and waste, while improving feed efficiency. To analyze the biological bases of RFI two pig lines divergently selected for RFI were used. Pigs selected for low RFI had a higher glycogen content in fast-twitch glycolytic myofibers, which impaired the technological quality of meat. These pigs also had lower glycolytic and oxidative enzyme activities in muscle and liver, as well as reduced activity of the AMP-activated protein kinase (AMPK) in muscle, a sensor acting as a master switch to stimulate oxidation. Transcriptomic profiling of total blood suggested that immunity and protein-modification processes should be considered as additional pathways associated with feed efficiency.

In parallel, the team also showed that muscle protein composition, lipid turn-over in adipose tissue, and redox status of pigs were markedly affected by a severe methionine restriction(in collaboration with the AliNut team).

A simplified dynamic scheme based on sets of differential equations of catabolic and anabolic pathways within and between muscle and adipose cells has been proposed. A new algorithm (free web access) was also developed to

analyse causality networks between genes, enzymes, and their substrates participating in intracellular signalling (in collaboration with CNRS IRISA, Rennes).

Finally, the team has demonstrated that cell populations in adipose tissue and skeletal muscle were affected both by RFI selection and dietary nutrients, suggesting that they are plastic and can be considered as new targets to modulate tissue properties and body composition.

On this topic, the team released 10 publications in peer-reviewed journals, including 1 AJP-Cell Physiol 2013, 1 Eur J Nutr 2016, 8 as last authors).

Concerning topic 3, the team has conducted multi-dimensional studies to clarify the biological bases of pork quality and their modulation by pig production factors. The team highlighted that both breed and production system affected pork quality, through modulations at molecular and tissue levels.

Moreover, the team has identified biomarkers of meat quality traits by running transcriptomics analyses on muscle samples collected just after slaughter. The team has obtained very promising conclusions since variation in expression level of one gene can explain up to 46% of the phenotypic variation of one trait, and about 20 of these biomarkers were also validated on a commercial pork chain. External validation on commercial pork samples is in progress, before being able to propose a generic tool able to predict quality of pork cuts for the meat industry.

This corresponded to 6 publications in peer-reviewed journals, 5 as 1st or last author.

In summary, the main conclusions reached by the team during the period assessed may be summarized as follows:

- the last third of gestation was an important period accounting for physiological maturity of piglet neonates;

- increased oxidative and glycolytic metabolisms in tissues and acceleration of nutrient turnover between organs are key features for lesser growth efficiency of pigs, and affected meat quality;

- development of new tools able to phenotype the diversity of adult stem cell populations during pig growth and demonstration of the plasticity of subsets of these precursor populations with pigs fed different diets;

- development of new bioinformatics tools based on influence graphs between molecules to identify upstream regulatory candidates responsible for molecular and metabolic changes into cells;

- identification of biomarkers of pork quality using transcriptomics. Sixty molecular biomarkers of technological or sensory quality traits have been identified using an experiment (breed x rearing systems) designed to induce a high variability in meat quality. About 20 biomarkers were then validated on other pig samples from a commercial pork chain for their relevance to early assess the quality of the meat.

The list of publications during the period 2010-2015 is impressive. It encompasses a total of 212 publications of all kinds (123 publications as the first or the last authors). 69 publications were released in international peer-reviewed journals (including 39 publications as the first or the last author); 63% of them were co-authored with different teams at PEGASE; 38% of them were co-authored with other Inra Units.

The majority of the papers are published in high-impact journals of the speciality (Animal, J. Anim. Sci., Meat Science are found where team members are last authors). Effort to publish in more generalist journals (AJP, Eur J.,Nutrition, Differentiation, PloS One, as last authors) is noticeable and needs to be amplified.

Short appreciation on this criterion

Based on the analysis made above, the quality of research by the team and its scientific output are excellent.

Assessment of the team academic reputation and appeal

The team has developed a wide and efficient collaboration network with universities and institutes within France and outside France (EU, USA, Canada). This is reflected in co-authorship and multiple national and EU projects. The team has been involved in 4 ANR programs (3 as participants and one as coordinator) and 2 EU programs (including the coordination of 1 work package); since 2015, the team is a partner in 3 EU programs (2 as work package leader).

Team members are section editors for the international peer-reviewed journals _Animal_ and _Livestock Science_. They participate to the GIS AGENAE (BIOPORC committee), to the coordination desk of GIS network "Muscle and Meat",

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and to the Meat sector commission of the competitiveness cluster Valorial (inter-regional level). Members of the team were involved in the board of the Proceedings of the *42th, 43th, 44th, 45th, 46th* and *47th Journées de la Recherche Porcine* (Swine Research Days) Inra et IFIPInstitut du Porc; Ed. IFIP, Paris;

The international congresses that are attended to present the data are the most relevant and the more influential in the field (11 invited presentations).

Team members are experts for defining animal ontology traits for livestock in ATOL (*www.atol-ontology.com/*)

Two foreign post-doc (Spain, Poland) were hosted during the period assessed.

Short appreciation on this criterion

Besides its national position which is central in the field of the pork meat chain, the international interactions of the team are important. Taken as a whole, the reputation and appeal of the CROISSANCE team are very good.

Assessment of the team interaction with the social, economic and cultural environment

The team has elaborated the electronic tool KeyRegulatorFinder (http.//*keyregulatorfinder.genouest.org),* which is a program that allows searching key regulators of lists of molecules (like metabolites, enzymes or genes) by taking advantage of knowledge databases in cell metabolism and signalling.

The team is developing an approach based on expert and statistically-determined sensory and technological pork quality classes. A predictive linear model and a decision tree is used to discriminate pork samples based on a combination of molecular biomarkers. External validation on commercial pork samples is in progress, before being able to propose a generic tool to predict quality of pork cuts for the meat industry.

Part of the present research by the team has the potential to contribute to reformulating nutritional recommendations for pig production.

The team managed two research projects involving public-private partnerships within ICSA, a Carnot institute of animal health, nutrition and genetics.

They participated in an innovative and finalized research call (Casdar) of the French Ministry of Agriculture.

The team coordinated and co-edited a special issue dedicated to update knowledge on muscle and meat across species (http://www6.inra.fr/productions-animales/numerospecial).

The team has been participating for many years to the scientific committees of the "Journées de la Recherche Porcine" and the International Symposia on Mediterranean pigs, and at the SIA fair in Paris: research in your daily life (2013).

Short appreciation on this criterion

The interaction of the team with the socio-economic environment is good. The team should put emphasis on becoming more visible in academia and to the public at large.

Assessment of the team organisation and life

See overall assessment of PEGASE.

Assessment of the team involvement in training through research

The team co-manages each year an obligatory course module on "Robustness and animal adaptation", as well as an optional course module on "Experimental biology" for Master 2 students (SAED, Rennes);

Six PhD students were co-supervised during the reference period (among which 4 were defended).

The team also contributed to the training of young scientists (master 1 and 2) and of students oriented towards a technical career (i.e., IUT, BTS, and Licence Pro).

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Short appreciation on this criterion

The contribution to academic teaching and science training is significant and satisfactory,

Assessment of the strategy and the five-year plan

The scientific objective of the team still remains to better understand the functionalities of skeletal muscles and adipose tissues. But an inflection towards multi-facetted approaches of animal biology is proposed in relationship with the active participation of the CROISSANCE team to 3 EU-funded projects.

Three directions are proposed:

1/ Flexibility of lean and fat tissues to improve animal resistance to environmental challenges.

The strategy is to associate experiments with environmentally-challenged conditions and mathematical modelling to describe and predict the dynamics of changes at animal, tissue, and cellular levels. Through its physiological approach and expertise, the team will focus on the flexibility and resilience of protein and lipid depositions by the animal after exposure to various challenging environmental conditions.

The team will also examine whether fates of (sub)populations towards myogenic or the adipogenic lineages are pre-programmed or can be re-orientated by pro-inflammatory or anti-inflammatory stimuli. In conjunction, a mathematical model will be developed in order to depict and predict stem cell behavior (in partnership with the IRMAR unit, University of Rennes).

2/ Integrate knowledge to define molecular indicators of robustness and predictors of pork quality.

The team proposes to refine tissue indicators (i.e. molecular traits such as mRNA, proteins or metabolites) of growth efficiency and meat quality. Meta-analysis will be used to define relationships between omics data and phenotypes across different experiments. This action is funded by the H2020 Feed-A-Gene project. A proposal coordinated by the GenPhySE unit, in which both the Croissance and GG teams are involved, has been recently submitted to a call of the SelGen meta-program (Inra). The aim is to build a database of co-expressed gene networks in muscle and to confront functional networks and biological pathways to genomic regions. The Croissance team intends to validate subsets of 'molecular' indicators obtained in well-controlled experimental designs for their associations with tissue traits on samples collected on-farm or at slaughter. This is an orientation that the team intends to push during the next years. A postdoctoral in meta-analysis is ensured for 2016 and a new PhD student is planned in 2016 to work on modelling.

3/ Pork chain approach with special emphasis on quality of pork products as dimension of sustainability.

The team proposes to identify links between diversity of pig production systems and intrinsic qualities of pork products. The team will investigate meat quality in pigs submitted to an experimental sanitary stress based on the degradation of hygiene during the growing period (FP7 Prohealth project).

In the frame of H2020 Treasure project, the team will determine the sensory, nutritional, technological qualities, and genuineness of pork products from local pig breeds and production systems. The ambitious aim of this work is to build a quality toolbox used to assess a variety of pork products from different European countries. In the same project, the team also plans to assess consumer acceptability, preferences, and willingness to pay for traditional or local pork products (within Treasure project). This means that the team must collaborate with mathematicians to ensure the feasibility of the prospects. These options are interesting and ambitious. However, taking into account the vicinity of the SYSPORC team, it is highly questionable whether these topics related to the quality of pork products, especially those concerning the food chain and the impact of rearing systems, have to be part of the Croissance team activity (in regard, in addition, to the size of the team).

A general comment emerges from the progressive shift of the Croissance team activities towards more and more omics. The size of the team remaining stable, one may fear that this could lead to less and less physiology. Why to push up strongly this strategy? Can we be so confident that the answer to the valuable questions concerning qualities of pork products will be brought about by big data approaches? This is an important strategic issue which is not discussed by the team. There is a concern that the team progressively loses its wide skills in physiology of adipose and muscle tissues.

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Short appreciation on this criterion

The five-year research plan is logical and in line with the expertise and missions of the Croissance team. The plan is ambitious and clearly driven by its integration in several EU funded grants.

While the five years plan is not totally convincing, its foundations are solid and it can be rated as good.

Conclusion

- **Strengths and opportunities:**

There is a very good balance between the mechanistic and basic studies of physiology/pathophysiology of muscles and adipose tissues in pig, and the studies aiming to design new systemic tools that would improve efficiency and quality of pig farming system.

The team strongly contribute as a knowledge-provider to public decision makers.

The research conducted by the team is really original in the international context.

- **Weaknesses and threats:**

Among the high number of published papers (<200), only a few appeared in generalist journals (PLoSOne, AJP, BMC, Differentiation).

A warning has to be sent concerning the risk for the team to progressively lose its expertise in physiology of adipose and muscle tissues.

- **Recommendations:**

An effort should be made to publish more frequently in generalist journals, in order to improve the international recognition of the team, and to increase the efficiency and spreading of the data generated. Most of the data generated by the team have indeed a significance that is not limited to the pig as an animal product, as it also applies to mammals in general (and human in particular): think of the pig as a model of DOHaD).The recognition of this trait would probably facilitate the above recommendation.

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Team 6: GG (Génétique et Génomique)

Name of team leader: Ms. Pascale Le Roy

Team scientific domains

Genetics and heredity, Genomic selection, Gene expression, Poultry genetics

Workforce

Team workforce	Number on 30/06/2015	Number on 01/01/2017
N1: Permanent professors and similar positions	4	4
N2: Permanent researchers from Institutions and similar positions	2	2
N3: Other permanent staff (technicians and administrative personnel)	5	4
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers (Emeritus Research Director, Postdoctoral scientists, visitors, etc.)	1	
N6: Other contractual staff (technicians and administrative personnel)		
N7: PhD students	1	
TOTAL N1 to N7	13	
Qualified research supervisors (HDR) or similar positions	3	

Team record	From 01/01/2010 to 30/06/2015
PhD theses defended	6
Postdoctoral scientists having spent at least 12 months in the unit	1
Number of Research Supervisor Qualifications (HDR) obtained during the period	

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● Detailed assessments

Assessment of scientific quality and outputs

The GG team focuses on the use of genomic information to analyse the genetic determinism of complex traits, mostly in poultry but also marginally in pigs. The team has a comprehensive approach ranging from identification, description, understanding, to the exploitation of genetic variation. For historical reasons, the focus on poultry differs from the main focus of PEGASE, but the research is original and in line with present trends in animal selective breeding, as proven by the excellent publication record.

The GG team developed new methods using high-density genotyping and sequences to detect a high number of markers, QTLs and e-QTLs for a variety of production and quality traits in several species. With the availability of high-density genotyping, the team also moved forward to GWAS/genomic selection approaches.

The team developed several projects related to the analysis of gene expression underlying fat metabolism and characterization of specific muscles, and studied mechanisms of adaptation to e.g. changes in diets. More specific aspects of parental imprinting, allele-specific expression and RNA editing have also been developed. All of these are original and led to excellent publications.

The team has developed several software tools to help annotate genomes, and especially facilitate functional annotation of QTL (AnnotQTL), identification of co-expressed genes (CoCoMap) and literature searches including Gene ontology terms (GO2PUB) – and developed semantic tools to perform functional analysis of annotated genes sets. Again, this generated excellent publications. The publication of these tools is too recent to judge if they have been adopted and used by a wider community.

Finally, the team also combined its different competences in e-QTL studies, developing statistical methods and also showing the interest of refining phenotypes, as well as of combining positional and functional data.

The team has implemented a new feature, Linkage Disequilibrium Analysis in its QTL mapping software, thus extending its capacities, and have discovered 250 QTLs for production and quality traits of eggs in laying hens, affecting both the mean and the variance of the traits. This represents a unique database and opportunity to understand the genetic basis of the mean, but also of the variance of the traits - especially in a changing environmental context (i.e. evolution of diets).

The team has a very impressive publication record, with 54 peer-reviewed papers (24 as first authors, 18 as last authors) published in excellent journals such as Nucleic Acids Research (2, with one as last author), Genetics (2, as first author), Genome Biology and Evolution (1, not as first or last author), PLoS One (8, with 3 as first author and 1 as first and last author), BMC genomics (4 with 1 as last author), which is very high especially considering the limited number of FTE researchers/teachers (10.8 peer-reviewed paper/FTE over the period). However, surprisingly, despite this excellent publication record, the papers of the team (except 1) do not appear in the highly cited papers of the PEGASE unit. This list, however, is short, and the papers of the team globally have good citation numbers often just below the threshold to appear in the "highly cited" papers of PEGASE. This may be linked partly to the low level of co-authorship with international researchers, which probably limits the initial citation impact.

The team has a very good national collaboration network, especially with other INRA units (GenPhySE, URA and GABI), with 36/54 papers co-signed with other INRA units. International collaborations are much more limited, with only 4/54 papers co-signed with foreign laboratories in the period evaluated. Historical international collaborations on conceptual issues exist, but did not lead to significant publications in the period evaluated. On the more applied side, poultry breeding is privately owned and highly competitive, and research teams around the world cannot cooperate with more than one major private company, which leads to this segmentation, and to competition rather than cooperation.

The journals selected by the team for their publications are excellent and combine top impact genetics journals (Nucleic Acids Research, Genetics, Genome Biology and Evolution, BMC genomics, Genetics Selection Evolution) and more generalist journals (PLoS One, Journal of Animal Science), also excellent in their field.

Short appreciation on this criterion

The team has an excellent level of scientific output.

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Assessment of the team academic reputation and appeal

The team participated to 4 ANR projects (Rules & Tools, Utopige, Fatinteger, Chickstress) during the period, among which they coordinated two (Utopige, Chickstress). They now also participate to the new H2020 project Feed-a-Gene, coordinated by PEGASE (Alinut). This shows a very good capacity to fund research through applying to competitive calls for proposals.

A team member is the director of Biogenouest (a regional network of technology platforms), and another team member is coordinating the network of avian geneticists at Inra (ResAvi).

A team member is associate editor of BMC Genetics, a very good journal in its field.

Short appreciation on this criterion

The academic reputation of the team is very good at national level, more difficult to assess at international level based on the information available. Overall, the academic reputation can be evaluated as good.

Assessment of the team interaction with the social, economic and cultural environment

The Utopige industrial ANR project (2011-2015), coordinated by the team, has provided decisive data for the implementation of genomic selection in poultry breeding, and was built in close collaboration with industry.

Utopige implements data for genomic selection, the latest tool available to speed up selective breeding programs

One scientific paper in JAS was co-signed with Cobb researchers, and several communications were co-written with technical institutes/industry partners presented in national industry-research days.

The fact that a former researcher of the team has been recruited as Scientific Director of Grimaud, the leading poultry selective breeding company in France also demonstrates the interest of the team competences for the industry – and will provide further opportunities to develop collaborations.

Short appreciation on this criterion

The team has a very good interaction with the economic environment, which is expected to continue and even increase in the next years.

Assessment of the team organisation and life

See overall assessment of PEGASE.

Assessment of the team involvement in training through research

The publication record of PhD students (on average 2 papers as first author plus one as co-author) is good and shows proper guidance and supervision. The employability of PhD students is good either in the academic or in the private sector (6/8 employed in the field). The number of theses defended is high (6, for 3 HDRs)

The team manages three master degrees in Animal sciences and Molecular Biology, and is re-designing them to have a readable genetics curriculum in the next contract. It has also managed eight lifelong learning programmes at Agrocampus Ouest – and is now developing MOOCs in quantitative genetics and poultry production.

Short appreciation on this criterion

The team has a very good involvement in training through research.

Assessment of the strategy and the five-year plan

The project aims at further investigating the use of genomic information for selective breeding, with special focus on robustness in poultry, trying to understand the molecular mechanisms at the basis of GxE interactions (especially genotype x diet), and including this knowledge in the optimization of genomic selection in poultry.

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Validation of candidate genes with novel technologies (CRISPR-cas9) is planned. Focusing mostly on robustness traits is clearly in the main trend in Animal science today, and the focus on trait rather than mean variance is clearly innovative.

The project is consistent and exploits the complementary expertises of the team. It seems more integrated as compared to that of the previous period, e.g. by using transcriptomic and QTL detection on the same lines (divergent RFI layers, Novogen industry line)

Continuation of partnership with Novogen is planned, and developments of partnership with industry (Grimaud for a PhD project, SYSAAF for an applied optimisation of breeding schemes)

Relevant partners have been added for the development of CRISPR-cas9 for validation assays for the candidate genes, and relevant industry partners are included.

The project builds on results and partnerships initiated during the previous period, and develops them in line with the capacities of the team, using novel approaches. The plan looks feasible, and is multi-faceted so that difficulties in one aspect should not put the whole plan at risk. However, the team has lost 2 scientists (1 CR, I IE) in the past period, and should recruit a new scientist in the next few years. The recruitment of a young researcher is expected in 2016, who should have a "genetics of traits" profile in order to facilitate collaboration with physiologist colleagues (especially the Adaptation and Croissance teams).

Generally speaking, however, the plan does not seem to be directed towards a better integration in PEGASE with more collaboration on pigs and dairies – and with still a focus on poultry, especially on laying hens. This focus is coherent with the organisation of poultry breeding research units of INRA – and the low level of opening to other PEGASE species is clearly more a consequence of the strategy fixed by the Animal Genetics division than of the wish of the team members. This strategy is understandable in the sense that the Animal Genetics team on dairy is in Jouy en Josas and the one on pig in Toulouse – and PEGASE widely collaborates with them. Still, this general coherence is less readable at the PEGASE level.

Short appreciation on this criterion

The five-year plan is good, and builds on the competences of the team. The role of the new scientist has to be better explicated, as well as the integration in PEGASE.

Conclusion

▪ Strengths and opportunities:

The GG team has a multi-faceted competence portfolio, and has developed appropriate partnerships at the national level to both produce and publish excellent research, and to move towards the industrial application of its results. There would be an opportunity to collaborate more with other teams in PEGASE, but the focus on poultry genetics requested by the Animal Genetics Division clearly limits the possibilities. The project looks more integrated than in the previous period – with a real focus on laying hens, robustness in the sense of variance control, and integrated QTL/GWAS/expression/epigenetics approaches.

The team also shows very good involvement in training and education, which allows a good capacity to disseminate and build useful knowledge for animal breeding.

▪ Weaknesses and threats:

The team has lost two members during the evaluated period. A new position is planned but the profile has to be better defined.

International collaborations are limited, and limit the impact of the team's work as well as its attractiveness for foreign students.

Good relations have been built with a major poultry breeding company. It is good to develop them to improve the team impact, but care should be taken not to become dependent on this exclusive collaboration.

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▪ Recommendations:

The position of the Animal Genetics Division is clearly expressed but limits collaboration opportunities for the team within PEGASE. Possible evolutions of this should be evaluated for the long-lasting integration of the team in the unit. This could have important impact on the choice of the new scientist position planned within the team. The team should develop its international collaboration network, on basic/theoretical issues if it is not possible on the more applied side. The current academic record is excellent, but its impact could be greatly improved by international collaborations.

Team 7:   Alinut (Alimentation et nutrition)

Name of team leader: Ms. Catherine Hurtaud

Team scientific domains

Animal metabolism, pigs and poultry diet, dietary proteins, human diet

Workforce

Team workforce	Number on 30/06/2015	Number on 01/01/2017
N1: Permanent professors and similar positions	1	1
N2: Permanent researchers from Institutions and similar positions	9	7
N3: Other permanent staff (technicians and administrative personnel)	7	7
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers (Emeritus Research Director, Postdoctoral scientists, visitors, etc.)		
N6: Other contractual staff (technicians and administrative personnel)	1	
N7: PhD students	3	
TOTAL N1 to N7	21	
Qualified research supervisors (HDR) or similar positions	6	

Team record	From 01/01/2010 to 30/06/2015
PhD theses defended	6
Postdoctoral scientists having spent at least 12 months in the unit	3
Number of Research Supervisor Qualifications (HDR) obtained during the period	2

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• Detailed assessments

Assessment of scientific quality and outputs

The main objective of the Alinut team is to acquire fundamental and applicable knowledge on animal nutrition. The research takes into account factors such as environmental and animal conditions, among them climate change and genetic characteristics of the animal. The team put emphasis on protein, lipid, energy and mineral metabolism as affected by environmental and animal conditions.

In the area of feed characterisation, the value of by-products from the bio-fuel industry and of vegetable feedstuffs has been investigated for pigs and poultry. The effects of fibre-rich diets on digestive potential in pigs were shown to depend on genetic factors. Rapid and cheap methods for feed evaluation were sought and it appears that Near Infra-Red (NIR) methods bear promise for pigs.

The components of heat production have also been studied, in relation between heat production and fever. New developments include the use of ^{13}C tracers to quantify the oxidation of nutrients and their use for lipogenesis. The combination of gas exchange measurements, use of ^{13}C tracers and blood metabolites has allowed for describing dynamic patterns of nutrient utilization.

Alinut studied the potential of using very low protein diets supplemented with essential amino acids. After Lys, Thr, Met and Trp, Val appears to be limiting. A Val deficiency in growing pigs caused an evident decrease in feed intake. The team also showed that species (pigs and poultry) and tissues respond differently to deficiency of sulphur amino acids.

A better understanding of cycles of bone accretion and absorption is necessary in order to reduce safety margins in the supply of phosphorus and calcium. In the frame of a project initiated in 2012, a methodological approach aiming to find blood biomarkers for bone metabolism monitored a Holstein-Normand dairy herd for 2 years. Milk calcium content was shown to vary with diet, stage of lactation, breed and external factors, especially photo-period. Suitable blood bio-markers for the bone accretion/resorption cycle in lactating animals were found.

The issue of improving the quality of human diets through animal feeding has been evaluated through monitoring of product quality. It was confirmed that pork and rabbit meat can be enriched with n-3 fatty acids by use of e.g. linseed. Antioxidants from plants, supplemented in pig diets the last ten days before slaughter, preserved the n-3 fatty acids in the pork.

Adaptation of animals to environmental conditions has been investigated through assessment of water management in dairy cows and adaptation of pigs to heat.

The research performed by the Alinut team addresses various fundamental aspects of animal nutrition. The findings that improve the understanding of efficiency of feed utilization include the physiological response to selection for different residual feed intake in pigs, and the potential of digestive capacity.

In a strive for more efficient utilization of dietary protein, the team ranked the essential amino acids for pigs, and determined the consequences of deficiency. The finding that pigs and poultry have different strategies to cope with Met+Cys deficiency, and that different tissues respond differently to such deficiency will have an important impact for determining future nutrient requirements for animals in different stages of growth or in other production stages.

Studies into the use of vegetable protein sources that do not compete with human consumption are of great importance as are studies on increased use of fibre rich diet to pigs.

The finding of blood bio-markers for the bone accretion/resorption cycle has an impact on accurate formulation of dietary calcium and phosphorus supply to the needs of the animal which will reduce excretion to the environment, and use less of the limited global phosphorous resources.

With the anticipation of climatic change leading to increased environmental temperature the studies on adaptation of animals, and their use of (limited) water resources, will be very important for future animal production.

The team has an excellent publication record during the period 2010-2015 with 114 peer-reviewed scientific articles, 7 edited books and proceedings and 9 book chapters. Team members were first or last author of 64 and first author of 19 out of the total 114 peer-reviewed publications. Alinut co-authored peer-reviewed publications with all PEGASE teams. International collaboration resulted in many research articles being co-authored by foreign research centres for example from The Netherlands, USA, Australia, Algeria, Brazil and Slovenia.

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The team has published the major part of its articles in highly ranked scientific journals within the relevant field of research (e.g. Animal, 6 articles as last author, 8 articles as first and last authors, 3 articles as first author; Animal Feed Science and Technology,1 article as last author, 1 article as first and last author; Journal of Animal Science, 1 article as last author, 8 articles as first and last authors; 3 articles as first author; Journal of Nutrition, 1 as first and last author).

Short appreciation on this criterion

Based on the evaluation above and the impact of major findings, the team has demonstrated an excellent quality of research and scientific publication.

Assessment of the team academic reputation and appeal

The team had active collaborations with several Inra research units (e.g. URA, GABI, GenPhysE, UMRH, URZ, URTAL), which resulted in co-authored peer-reviewed publications. National collaborations and networking also involved schools of agriculture and several private partners.

During the period 2010 – 2015 the team has participated in two EU projects (ProHealth, 2013-2018 and Feed-a-Gene, 2015-2020, project coordination). National projects included 4 ANR research projects (one coordinated by a team member), the meta-program ACCAF and the team leads 2 programs on the adaptation of livestock to climate change, and participates in 4 Casdar projects and 5 projects with regional funding.

The team is involved in international networks with scientific institutes (e.g. WUR, FBN and ATB) and with industrial partners (e.g. Ajinomoto, Adisseo, Ingaso).

A spanish post-doc was recruited in 2014.

A team member (who is also the director of the unit) was awarded the Mérite agricole du Ministère de l'Agriculture, de l'Agroalimentaire et de la Forêt.

A team member has acted as editor-in-chief of *Animal* for 3 years and another team member participates in the management board of this journal. Team members also act on the editorial boards of *Animal* and *Dairy Sci. Technol.*

Alinut members gave 39 invited presentations in international meetings and 19 in professional meetings.

Short appreciation on this criterion

Based on the large number of international and national projects and networks, the participation to editorial boards and the invitations in international and national meetings, the team has an excellent reputation and appeal.

Assessment of the team interaction with the social, economic and cultural environment

The expertise of the team has proven to be very relevant and useful in public-private partnerships within the animal nutrition and environment sectors as demonstrated by the participation of team members in national and international collaboration with international companies e.g. Ajinomoto, Adisseo, Ingaso, Olmix, Lesaffre, Lallemand Nutrition. The team has also interacted with young consumers through participation in "Science Festival" and visits of elementary schools to experimental facilities.

A considerable part (30%) of the Alinut research articles were co-authored with representatives from private firms.

Transfer of knowledge is ensured through the invitation of team members to conferences organised by private collaboration partners in France or abroad. Team members also contribute with their expertise in brain-storming meetings organised by collaborating private firms.

Short appreciation on this criterion

Based on the utility of the methods routinely deployed by the team, and the communication of results to the public and industry, the team has a very good interaction with the social, economic and cultural environment.

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Assessment of the team organisation and life

The team has established collaboration with all other PEGASE teams, which has resulted in peer-reviewed publications. This collaboration will strengthen the inter-disciplinary aspects of the PEGASE research activities.

A team member is the head of PEGASE.

Short appreciation on this criterion

See overall assessment of PEGASE.

Assessment of the team involvement in training through research

Team members are involved in designing, coordinating and implementing training modules of the Master BAPSA. Other training involves dairy cattle production system and impact on milk chemical composition and its technological properties, feeding the dairy cows, mass spectrometry, indirect calorimetry. However, team members do not participate in regular teaching.

The team has demonstrated its attractiveness by hosting many PhD students (6 PhDs defended, for 6 HDR staff). All doctors published between 2 and 7 articles as first authors in international journals well known in their field (J. Anim. Sci., Animal, Poultry Sci., J. Physiol.). After the thesis, 1 doctor had a permanent position in academic research, 2 had non-research related positions, 1 was inactive at the time of the report. No information is provided for the others.

Short appreciation on this criterion

Some members of the team are involved in training modules, and the number of PhD students shows that the team has a good ability in training through research.

Assessment of the strategy and the five-year plan

The proposed research will focus on three main axes namely (1) the individualization of animal requirements, (2) feed utilization of the animal and (3) the preservation of pork and milk quality.

Within (1), animal needs will be defined at an individual level, in relation with factors related to the animal (physiological status, sex, physical activity, feeding behaviour, intestinal microbiota) and different environmental conditions (diet composition, methods for feed supply, climatic and sanitary environment). Biological markers and signals from biosensors will be used to develop new tools able to implement new feeding strategies. This research will be conducted in collaboration between the Adaptation, Croissance and SysPorc teams. The tools developed will be used for the analysis of traits linked with mechanisms underlying feed efficiency. Markers at the individual level will be integrated in mathematical models at herd level. By this way, precision feeding can be applied in a dynamic approach.

In (2), dietary fibre content and composition effects on nutrient digestibility will be studied through near-infrared technique associated with an indigestible marker, and techniques available for improving the nutritional value of fibre rich diets. The aim is to assess and identify key factors for the nutritional value of feedstuffs and diets. The main focus will be on feedstuffs that do not compete with food intended for human consumption. This is an important research area, but it is also developed by other research teams, so overlaps need to be avoided, and it is not shown convincingly enough that this research is innovative.

Within (3), the link between animal feeding and product quality will be prioritized. Mathematical modelling will be applied to existing datasets. In addition, the impact of using new (particularly fibre-rich) feedstuffs on monogastric animals will be investigated. The approach will bring together nutritional, technological and sensory qualities in order to reduce environmental impact and improve sustainability. The research will involve collaboration with SysPorc, Croissance and Lactation teams.

The proposed research approach is an organic and logical continuation of the previous research program. It may be expected to generate knowledge that can be implemented in animal nutrition to decrease environmental impact and to improve sustainability.

The involvement of other PEGASE teams in the research guarantees that the interdisciplinary aspects of the subject will be properly highlighted.

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Industrial partners will be involved in the research, and the quality of both the academic and the non-academic partners is very good.

The goals for the research seem realistic and feasible to achieve within the time frame. Collaboration with international and industrial partners as well as other PEGASE teams will allow for an inter-disciplinary approach and ensure good opportunities for practical implementation. However, the plan does not convincingly show the innovative aspect of the research, especially concerning the fibre experiment part.

Short appreciation on this criterion

The strategy and the five-year period are good.

Conclusion

- ▪ Strengths and opportunities:

Research on requirements and feed utilization of individualized animals can be expected to produce results that will have a fundamental impact on future nutritional strategies. The interdisciplinary aspects of the research will be ensured through cooperation with other PEGASE teams, international and industrial partners. The impact of environmental challenge on animal response is also a research area that can be expected to generate important knowledge.

- ▪ Weaknesses and threats:

The proposed focus on fibre in diets to monogastric animals is one that is presently explored by other research groups in EU and overseas (e.g. Aarhus University, Denmark, University of Illinois, USA) and therefore overlaps must be avoided. Loss of knowledge owing to staff reductions and retirements can be a threat to the team.

- ▪ Recommendations:

It is recommended that the Alinut team continues and develops its research in the proposed direction.

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5 ● Conduct of the visit

Visit dates

Start: 17/02/2016, 9:00

End: 18/02/2016, 17:00

Visit site: PEGASE

Institution: INRA

Address: Domaine de la Prise, 35590 Saint-Gilles

Conduct or programme of the visit:

(Following HCERES rules)

Wednesday February 17th, 2016

09:00 - 09:20	Closed-door meeting between the visiting committee and HCERES scientific advisor
09:20 - 09:25	Presentation of the evaluation process to the unit by the scientific delegate
09:25 - 10:00	Administrative and scientific presentation of the unit
10:00 - 10:45	Team Syslait
11:00 - 11:45	Team Sysporc
11:45- 12:30	Team Lactation
13:30 -14:15	Team Adaptation
14:15-15:00	Team Croissance
15:15- 16:00	Team Génomique et Génétique
16:00 – 16:45	Team Alinut
16:45 – 17:30	Closed-door meeting (visiting committee + HCERES delegate)

Thursday February 18th, 2016

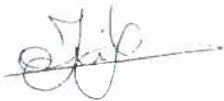|	
08:30 - 09:15	Discussion with scientists and engineers: DR/CR/IR/IE
09:15 - 10:00	Discussion with students and post-docs
10:00- 10:30	Discussion with the head of the Doctoral School VAS
10:45 - 11:15	Discussion with category AI/B/C staff: laboratory technicians*
11:15 - 11:45	Discussion with category AI/B/C staff: experimental facilities + support staff*
11:45 - 12:30	Discussion with the representatives of the managing bodies: Inra-Phase division, Inra-GA division, Agrocampus Ouest
13:30 - 14:00	Discussion with the management council
14:00 - 14:30	Discussion with the director and deputy directors
14:30 - 17:00	Closed-door meeting of the visiting committee in presence of the HCERES scientific delegate

*Discussions were held in French

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6 • Supervising bodies' general comments

Response of the UMR Pegase research unit to the HCERES report

We would like to thank the jury for the evaluation of the UMR Pegase research unit and for the recommendations that were made. We are pleased that the jury assessed the different aspects of our research as good, very good, and excellent. These appreciations were expressed for the unit as a whole and also for the seven research teams, which is very encouraging for the future. A discussion on the different points put forth by the jury will be held with the scientific councils of the Phase and GA divisions of INRA and with the scientific council of Agrocampus Ouest.

May 2nd, 2016

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UMR Pegase

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