Metaprogramme Adaptation of Agriculture and Forest to Climate Change (AAFCC)

Call for Expressions of Intent 2017

The complete proposal form must be completed and sent to the address below:

accaf@inra.fr

before 31/12/2017

Contacts

Scientific matters	Administrative and financial matters
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AAFCC METAPROGRAMME

COMPLETE PROPOSAL

Acronym of the proposal	LACCAVE 2.21
Title of the proposal	Towards integrated and resilient systems to cope with climate change for the grape and wine industry

Coordinator		**Co-coordinator**	
First name	OLLAT	**First name**	TOUZARD
Last Name	Nathalie	**Last Name**	Jean-Marc
Title	Dr	**Title**	Dr
Position	IR HC	**Position**	DR – vice director
Name of research unit	EGFV	**Name of research unit**	Innovation
Division assignment	EA	**Division assignment**	SAD
E-mail	Nathalie.ollat@inra.fr	**E-mail**	Jean-marc.touzard@inra.fr
Address	ISVV, 210 chemin de Leysotte, 33882 Villenave d'Ornon	**Address**	Centre INRA-Montpellier Supagro, 2 place Viala, 34000 Montpellier
Phone	0557575930	**Phone**	0499612465

Axes relevant to the proposal (please tick at least one)	
1	A. Design and implementation of less vulnerable and/or more resilient agricultural, forest or natural systems in a context of increased risks
2	B. Design and/or deployment of tools to support public or private adaptation strategies
	C. Identification and assessment of medium- and long-term adaptation strategies, including breakthrough options
3	D. Contribution to the CC-SAFE portal for services for agriculture and forest

Type of proposal

☒ In-depth project (2 to 3 years)

☐Exploratory project (up to 2 years)

Length

☐12 months ☐24 months ☒ 36 months

Keywords (5 maximum, separated by ;)
Wine industry; resilient systems; agro-climatic indicators; simulation; adaptation strategies;

Abstracts: (1500 characters in Arial 11)
LACCAVE 2.21 is a fully new project that aims at coordinating research on adaptive strategies and the definition of resilient systems in the French wine industry. The project focuses on systemic options, participatory methods and operational outcomes. These objectives are requested by researchers and many stakeholders, and have not been developed so far. 22 units have joined the project that also explicitly aims to extend the previous research network to international collaborations. LACCAVE2.21 will be organized in four operational WPs and one managerial WP (WP0). As a think-tank, WP1 aims at delivering global and integrated expertise on major issues for adaptation of the wine industry. WP2 will release ecoclimatic indicators and projections of vine performances to scientists and stakeholders for the design of more resilient production systems, and as contribution to the CC-SAFE portal of services. WP3 will launch several participative initiatives to construct at local scales resilient systems combining low-pesticides inputs and adaptation to climate change. Finally WP4 aims at establishing an international network on systemic adaptation in the Mediterranean vineyards, in the frame of a European project application.

This form should not exceed 25 pages. The presentation should be written in English. *The research projects will be evaluated by the Scientific Advisory Board of the metaprogramme with the assistance of the steering committee, according to the relevance of the project to the priorities of this call and the amount requested.*

Involved Teams (coordinator and co-coordinator (if relevant) are indicated as N°1 and 2, respectively)								
Partner N°	Type (UMR, UR,…) and number of the unit	Acronym and name of the unit	INRA center	Division assignment	First name of the scientific leader of the project	Last name	Email address	Main research Field
1	UMR 1287	EGFV	Bordeaux	EA	OLLAT	Nathalie	Nathalie.ollat@inra.fr	Ecophysiology, genomics and genetics, determinism of adaption to changing environment
2	UMR 951	Innovation	Montpellier	SAD	TOUZARD	Jean-Marc	Jean-marc.touzard@inra.fr	Economics, innovation studies
3	US 1116	AgroClim	Avignon	EA	GARCIA de CORTAZAR-ATAURI	Inaki	Inaki.garciadecortazar@inra.fr	Agroclimatology, climate change impact studies, crop modelling, phenology modelling
4	UMR 1131	SVQV	Colmar	BAP	DUCHENE	Eric	Eric.duchene@inra.fr	Genetics, ecophysiological modelling
5	UMR 1334	AGAP	Montpellier	BAP	PEROS	Jean-Pierre	Jean-pierre.peros@inra.fr	DAAV team : Genetic diversity , QTL and association studies, innovative methods of breeding
6	UMR 1083	SPO	Montpellier	CEPIA	SABLAYROLLES	Jean-Marie	Jean-marie.sablayrolles@inra.fr	Enology
7	USC 1366	Oenologie	Bordeaux	CEPIA	DARRIET	Philippe	philippe.darriet@u-bordeaux.fr	Enology, sensory analysis, secondary metabolites, microbial community, experimental economy
8	UMR 1230	SYSTEM	Montpellier	EA	GARY	Christian	Christian.gary@inra.fr	Cropping system design and assessment
9	UMR 1065	SAVE	Bordeaux	SPE	DELMAS	Chloé	Chloe.delmas@inra.fr	Grapevine pests and diseases, interactions between biotic and abiotic stresses, cultural practices

10	UMR 1110	MOISA	Montpellier	SAE2	HANNIN	Hervé	Herve.hannin@supagro.fr	Agrifood chain, economics
11	UMR 729	MISTEA	Montpellier	MIA	NEVEU	Pascal	Pascal.neveu@inra.fr	Data and knowledge management, functional statistics
12	UMR 759	LEPSE	Montpellier	EA	SIMONNEAU	Thierry	Thierry.simonneau@inra.fr	Plant ecophysiology; mitigation of climate change impacts with genetics and management practices.
13	UMR 1221	LISAH	Montpellier	EA	PREVOT	Laurent	Laurent.prevot@inra.fr	Soil Science, hydrology, landscape modelling, vineyards water use
14	UMR 1347	AgroEcologie	Dijon	EA	MARON	Pierre-Alain	pierre-alain.maron@inra.fr	Soil, biodiversity, microbiology, ecology,
15	UE 0999	UE Pech Rouge	Montpellier	CEPIA	SAURIN	Nicolas	Nicolas.saurin@inra.fr	Grapevine water status management, grape quality, oenology
16	UE 1086	UE Ferrade	Bordeaux	BAP	DELIERE	Laurent	Laurent.deliere@inra.fr	Integrated management, production system development
17	UE 0871	UE SEAV	Colmar	BAP	LEY	Lionel	Lionel.ley@inra.fr	Integrated pest management, training systems
18	UE 1057	Vassal	Montpellier	BAP	MARCHAL	Cécile	Cecile.marchal@inra.fr	Genetic resources identification, characterization and conservation
19	USC 1368	I2M	Bordeaux	MIA	BAUDRIT	Cédric	cedric.baudrit@u-bordeaux.fr	AsCo team: Complex data and heterogeneous knowledge assembling
20	UMR uB/CNRS 6282	Biogeosciences	Dijon		BOIS	Benjamin	benjamin.bois@u-bourgogne.fr	Climatology, modeling and agroclimatology,

								disease ecology
21	UMR 6554	LETG	Rennes		QUENOL	Hervé	herve.quenol@univ-rennes2.fr	Climatology
22	Montpellier SupAgro/IRSTEA	ITAP	Montpellier		TISSEYRE	Bruno	Bruno.tisseyre@supagro.fr	Precision viticulture

Associated Partners (if relevant) *Laboratory/team that is not associated to INRA cannot be funded*						
Partner N°	**Organisation**	**Partner family name**	**Partner first name**	**Title**	**Expertise /skills brought in the project by the partner***	**Type of organization** *(university, company, technical institute, etc.)*
1	FranceAgriMer	AIGRAIN	Patrick	Dr	Economy – Strategy – Agricultural sector	State organisation
2	INAO	GAUTIER	Jacques		Reglementation – Appelation systems - Environment	State organisation
3	APCA	LEVRAULT	Frédéric		Agronomist	Technical Institute
4	IFV	LEMPEREUR	Valérie		Oenologist	Technical Institute
5	IRSTEA – UMR G-EAU	ROLLIN	Dominique	Dr	Gestion de l'Eau, Acteurs et Usages	Research Institute
6	ESA-INRA USC GRAPPE	NEETHLING	Etienne	Dr	Adaptation to climate change at terroir levels, mitigation, sensory analyses, systemic approach	Engineer school
7	Uni Bordeaux UMR EPOC	SWINGEDOUW	Didier	Dr	Climatology, modelling at decade scale	University
8	INRA UMR EEF	BREDA	Nathalie	Dr	Dendrochronology	Research Institute
9	INRA UMR AGIR	AUBERTOT	Jean-Noël	Dr	Agronomy, Crop pathology, PestObserver	Research Institute

*, this information will be used to evaluate the complementarities of the proposal partners and the quality of the consortium (see also box below).

For each unit, list of 5 articles relevant to AAFCC MP topic:

EGFV:

Lecourieux F, Kappel C, Pieri P, Charon J, Pillet J, Hilbert G, Renaud C, Gomès E, Delrot S, Lecourieux D (2017) Dissecting the biochemical and transcriptomic effects of locally applied heat treatment on developing Cabernet Sauvignon grape berries. Frontiers in Plant Science 8, 53

Le Roux R., de Rességuier L., Corpetti T., Jégou N., Van Leeuwen C., Madelin M. and Quénol H. (2017). Comparison of two fine-scale spatial models for mapping temperatures inside winegrowing areas. Agr. Forest Meteorol., 247, 159-169.

Ollat N., Van Leeuwen C., Garcia de Cortazar-Atauri I. and Touzard J.-M., (2017). The challenging issue of climate change for sustainable grape and wine production. OENO One 51, n°2, 59-60.

Martinez-Luscher J, Kizidelnic T, Vucetic V, Dai Z, Luedeling E, Van Leeuwen C, Gomes E, Pascual I, Irigoyen JJ, Morales F, Delrot S. (2016). Sensitivity of grapevine phenology to water availability, temperature and CO2 concentration. Frontiers in environmental Sciences, 12 July 2016, https://doi.org/10.3389/fenvs.2016.00048.

Rossdeutsch L, Edwards E, Cookson SJ, Barrieu F, Gambetta GA, Delrot S, Ollat N (2016) ABA-mediated responses to water deficit separate grapevine genotypes by their genetic background. BMC Plant Biology 16:91-106

Innovation:

Belleti A., Marescotti A. Touzard J.-M. (2017). Geographical Indications, Public Goods and Sustainable Development: The roles of actors' strategies and public policies. World Development, 98 : 45-57. doi:10.1016/j.worlddev.2015.05.004

Delmotte, S., Couderc, V., Mouret, J.-C., Lopez Ridaura, S., Barbier, J. M., Hossard, L. (2017). From stakeholders narratives to modelling plausible future agricultural systems: integrated assessment of scenarios for Camargue, Southern France. European Journal of Agronomy, 82, 292-307. DOI : 10.1016/j.eja.2016.09.009

Ollat, N., Touzard, J.-M., Van Leeuwen, C. (2016). Climate Change Impacts and Adaptations: New Challenges for the Wine Industry. Journal of Wine Economics. 11:1-11. doi:10.1017/jwe.2016.

Schmitt E., Galli F., Menozzi D., Maye D., Touzard J.-M., Marescotti A., Six J., Brunori G. (2017). Comparing the sustainability of local and global food products in Europe. Journal of Cleaner Production. doi :10.1016/j.jclepro.2017.07.039

Touzard J.M. (2017). Innover face au changement climatique. Innovation : Revue d'Economie et management de l'Innovation, 54 : 5-13

AgroClim:

García de Cortázar-Atauri, I., Duchêne, E., Destrac-Irvine, A., Barbeau, G., Rességuier, L. de, Lacombe, T., Parker, A.K., Saurin, N., Leeuwen, C. van, 2017. Grapevine phenology in France: from past observations to future evolutions in the context of climate change. OENO One 51, 115–126. doi:10.20870/oeno-one.2016.0.0.1622

Caubel, J., García de Cortázar-Atauri, I., Vivant, A.C., Launay, M., de Noblet-Ducoudré, N., 2017. Assessing future meteorological stresses for grain maize in France. Agricultural Systems. doi:10.1016/j.agsy.2017.02.010

Caubel, J., Launay, M., García de Cortázar-Atauri, I., Ripoche, D., Huard, F., Buis, S., Brisson, N., (2014). A new integrated approach to assess the impacts of climate change on grapevine fungal diseases: the coupled MILA-STICS model. Journal International de Sciences de la Vigne et du Vin. 48 (1)

Fraga, H., García de Cortázar Atauri, I., Malheiro, A.C., Santos, J.A. (2016). Modelling climate change impacts on viticultural yield, phenology and stress conditions in Europe. Global Change Biology. doi:10.1111/gcb.13382

Parker A., Garcia de Cortazar I., Chuine I., Hofmann R., Trought M. and Van Leeuwen C. (2013). Classification for timing of flowering and veraison of a wide range of Vitis vinifera cultivars . Cienc. Tec. Vitivinic., 28, 13-17.

SVQV :

Duchêne E, Huard F, Dumas V, Schneider C, Merdinoglu D (2010) The challenge of adapting grapevine varieties to climate change. Climate Research 41: 193-204

Duchêne E, Butterlin G, Dumas V, Merdinoglu D (2012) Towards the adaptation of grapevine varieties to climate change: QTLs and candidate genes for developmental stages. Theoretical and Applied Genetics 124: 623-635

Duchêne E, Huard F, Pieri P (2014) Grapevine and climate change: what adaptations of plant material and training systems should we anticipate? Journal International des Sciences de la Vigne et du Vin. Special LACCAVE: 59-67

Duchêne E (2016) How can grapevine genetics contribute to the adaptation to climate change? Oeno-one 50: 113-124
Duchêne, E. (2016). "Savoir s'adapter sans s'uniformiser, le défi des cépages français face au changement climatique." The conversation. 5/12/2016 https://theconversation.com/savoir-sadapter-sans-suniformiser-le-defi-des-cepages-francais-face-au-changement-climatique-69534
AGAP
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Houel C, Chatbanyong R, Doligez A, Rienth M, Foria S, Luchaire N, Roux C, Adivèze A, Lopez L, Farnos M, Pellegrino A, This P, Romieu C, Torregrosa L. (2015). Identification of stable QTLs for vegetative and reproductive traits in the microvine (Vitis vinifera L.) using the 18K Infinium chip. BMC Plant Biology 15:205.
Rienth, M., Torregrosa, L., Luchaire, N., Chatbanyong, R., Lecourieux, D., Kelly, M. T., Romieu, C. (2014). Day and night heat stress trigger different transcriptomic responses in green and ripening grapevine (vitis vinifera) fruit. BMC Plant Biology, 14, 108.
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Torregrosa L, Bigard A, Doligez A, et al. (2017) Developmental, molecular and genetic studies on grapevine response to temperature open breeding strategies for adaptation to warming. OENO One, 512
SPO:
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Ollé D, Guiraud JL, Souquet JM, Terrier N, Ageorges A, Cheynier V, Verries C., (2011). Effect of pre- and post-véraison water deficit on proanthocyanidin and anthocyanin accumulation during Shiraz berry development. Aust. J. Grape Wine Res. 17, 90-100.
Pinasseau L, Vallverdú-Queralt A, Verbaere A, Roques M, Meudec E, Le Cunff L, Peros JP, Ageorges A, Sommerer N, Boulet JC, Terrier N, Cheynier V., (2017). Genetic diversity of grapevine polyphenomics response to drought (2017). Frontiers in Plant Science, doi: 10.3389/fpls.2017.01826
Tilloy, V., Cadiere, A., Ehsani, M., Dequin, S., (2015). Reducing alcohol levels in wines through rational and evolutionary engineering of Saccharomyses cerevisiae. International Journal of Food Microbiology, 23, 49-58
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Allamy, L., Darriet, P., Pons, A. (2017). Identification and Organoleptic Contribution of (Z)-1,5-Octadien-3-one to the Flavor of Vitis vinifera cv. Merlot and Cabernet Sauvignon musts. J. Agric. Food Chem. 65, 1915−1923.
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Pons A., Allamy L., Schüttler A., Rauhut D., Thibon C., Darriet P. (2017). What is the expected impact of climate change on wine aroma compounds and their precursors in grape? OenoOne 51:
System :
Fermaud M., Smits N., Merot A., Roudet J., Thiéry D., Wéry J., & Delbac L. 2016. New multipest damage indicator to assess protection strategies in grapevine cropping systems. Australian Journal of Grape and Wine Research, 22(3), 450-461.
Gaudin R., Kansou K., Payan J.C., Pellegrino A., Gary C., 2014. A water stress index based on water balance modelling for discrimination of grapevine yield and quality. Journal International des

Sciences de la Vigne et du Vin, 48, 1-9.
Guilpart, N., Metay, A., Gary, C., 2014. Grapevine bud fertility and number of berries per bunch are determined by water and nitrogen stress around flowering in the previous year. European Journal of Agronomy, 54, 9-20.
Guilpart, N., Roux S., Gary, C.,Metay, A., 2017. The trade-off between grape yield and grapevine susceptibility to powdery mildew and grey mould depends on inter-annual variations in water stress. Agricultural and Forest Meteorology, 234-235 : 203-211.
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Save :
Calvo-Garrido C, Teixidó N, Roudet J, Viñas I, Usall J, Fermaud M (2014) Biological control of Botrytis bunch rot in Atlantic climate vineyards with Candida sake CPA-1 and its survival under limiting conditions of temperature and humidity. Biological Control, 79, 24–35.
Charrier G, Torres-Ruiz JM, Badel E, Burlett R, Choat B, Cochard H, Delmas C.E.L., Domec JC, Jansen S, King A, Lenoir N, Martin-StPaul N, Gambetta GA, Delzon S. (2016) Evidence for hydraulic vulnerability segmentation and lack of xylem refilling under tension. Plant Physiology, 172: 1657-1668.
Delmas C.E.L., Fabre F., Jolivet J., Mazet I.D., Richart Cervera S., Delière L., Delmotte F. (2016) Adaptation of a plant pathogen to partial host resistance: selection for greater aggressiveness in grapevine downy mildew. Evolutionary Applications, 9 : 709-725.
Drieu R, Rusch A (2017) Conserving species-rich predator assemblages strengthens natural pest control in a climate warming context. Agricultural and Forest Entomology 19: 52–59
Lens F., Picon-Cochard C., Delmas C.E.L., Signarbieux C., Buttler A., Cochard H., Jansen S., Chauvin T., Chacon Doria L., del Arco M., Delzon S. (2016) Herbaceous angiosperms are not more vulnerable to drought-induced embolism than angiosperm tree. Plant Physiology, 172: 661–667.
Moisa:
Aigrain P., Brugière P., Duchêne E., Garcia de Cortazar I., Gautier J., Hannin H., Giraud-Heraud E., Ollat N., Touzard JM., (2016) Travaux de prospective sur l'adaptation de la viticulture au changement climatique : Quelles séries d'événements pourraient favoriser différentes stratégies d'adaptation ? Congrès de l'OIV. Bento Goncalves, Brésil.
Aigrain P., Brugière P., Duchêne E., Garcia de Cortazar I., Gautier J., Hannin H., Giraud-Heraud E., Ollat N., Touzard JM., (2016) Adaptation au changement climatique : l'intérêt d'une démarche prospective. Congrès de l'OIV. Bento Goncalves, Brésil.
Aigrain P., Brugière P., Duchêne E., Garcia de Cortazar I., Giraud-Heraud E., Gautier J., Hannin H., Lagacherie P., Lebon E., Ollat N., Teil G., Touzard JM., 2016. Lessons from a Prospective Study on the French wine industry under climate change, in Proceedings of ClimWine 2016, April 10-13, Bordeaux, France pp253-262.
Hannin H., Touzard J.M., 2013. Viticulture en Languedoc-Roussillon : Innover ou disparaître ? Tribune publiée dans Midi Libre 19 mai 2013.
Hannin H. , d'Hauteville F. (2010). La vigne et le vin Mutations économiques en France et dans le monde. Les Etudes n°5323. Ed La documentation française. 240p
Mistea:
Muljarto A., Tireau A., Neveu P., Salmon J.M. (2015). Development of viticulture and vinification ontology for experiment data and knowledge integration. INFORSID
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Muljarto A., Salmon J.M., Neveu P., Charnomordic B., Buche P., Tireau A., (2015) A generic ontological network for agri-food experiment integration - Application to viticulture and winemaking.
Ollat N., Quénol H., Barbeau G., Van Leeuwen C., Darriet P., Garcia Cortazar A., Ojeda H., Duchêne E., Lebon E., Vivin P., This P., Sablayrolles J.M., Teil G., Lagacherie P., Giraud-Héraud E., Neveu P., Touzard J.M. (2015) Adaptation to Climate Change: Which are the main challenges for the French wine industry ? Proceedings of the Xe Symposium International d'Oenologie, Bordeaux, 29-30 june 2015. 12-16.
Symeonidou D., Croitoru M., Sanchez I., Neveu P., Pernelle N., Sais F., Roland-Vialaret A., Buche P., Mulyarto A., Schneider, (2014). Key Discovery for Numerical Data: Application to Oenological Practices In book: Graph-Based Representation and Reasoning, pp.222-236.

Lepse:
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Pellegrino, A. et al., 2014. Management practices impact vine carbohydrate status t o a greater extent than vine productivity. Frontiers in plant science, 5(June), pp.1–13.
Prieto, J.A. et al., 2012. A leaf gas exchange model that accounts for intra-canopy variability by considering leaf nitrogen content and local acclimation to radiation in grapevine (Vitis vinifera L.). Plant Cell and Environment, 35(7), pp.1313–28. Available at: http://www.ncbi.nlm.nih.gov/pubmed/22329397.
Simonneau, T. et al., 2017. Adapting plant material to face water stress in vineyards : which physiological targets for an optimal control of plant water status ? Oeno One, 51(2), pp.167–179.
Valle, B. et al., 2017. Increasing the total productivity of a land by combining mobile photovoltaic panels and food crops. Applied Energy, 206(September), pp.1495–1507. Available at: http://dx.doi.org/10.1016/j.apenergy.2017.09.113.
Lisah:
Galleguillos M., Jacob F., Prévot L., Faúndez C., Bsaibes A. (2017) "Estimation of actual evapotranspiration over a rainfed vineyard using a 1-D water transfer model: A case study within a Mediterranean watershed," Agricultural Water Management, vol. 184, pp. 67 – 76.
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Baumann, K, Dignac, MF, Rumpel, C, Bardoux, G, Sarr, A, Steffens, M, Maron, PA. 2013. Soil microbial diversity affects soil organic matter decomposition in a silty grassland soil. Biogeochemistry 114: 201-212.
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Teams skills, disciplines and complementarity 1 page max.

LACCAVE 2.21 is based on a large scientific network, related to 7 INRA divisions, combining highly complementary skills in order to address the issue of adaptation to climate change. The project endorses climatologists working at different scales (P20, P21, EPOC), soil scientists (P13, P14, P20), hydrologists (P13, G-EAU), agro-climatologists (P3, P19, APCA), ecophysiologists (P1, P12, P15, P20), agronomists and viticulturists (P1, P2, P3, P8, P16, P17, IFV, APCA), geneticists and specialists of genetic resources (P1, P5, P18, IFV), plant pathologists (P9, P14, P16, IFV), oenologists (P6, P7, P15, IFV), numeric resources and data management processes (P11, P19, P22) and economists(P2, P7, P10, FranceAgriMer, INAO, IRSTEA). Experimental, ingeniery and modelling approaches are developed by members of the consortium and will be mobilised for the project. Several groups have already been involved in systemic approaches at different scales and on different subjects either in LACCAVE 1.0 (P1, P2, P3, P4, P10, P20, P21, FranceAgriMer, INAO) or in other projects (P8, P9, P16, P17, IFV).

In comparison to LACCAVE 1.0, the consortium has been strengthened for environmental sciences (soil and water), plant pathologists, systemic agronomy, and numeric resources and data management. As the objective is to provide adaptation tools and expertise which meet the requirements of the actors, we decided to endorse associated partners involved in R&D and industry organisations (IFV, France-AgriMer, INAO, APCA) External scientific groups (GRAPPE, EPOC, EEF, AGIR) will also be part of the network, regarding their expertise in the field of climate, climate change or indicator development.

The consortium is re-inforced with the participation of the UMR I2M AsCo team specialised in numeric and data management and three non-INRA groups which are unavoidable on the issue of adaptation to climate change of the French wine industry.

- UMR I2M AsCo team «assemblage des connaissances»: knowledge elicitation, heterogeneous knowledge representation, uncertainty processing and reasoning, agent-based systems, probabilistic relational models, multicriteria analysis.
- UMR Biogeosciences: Climatology, dynamical and statistical climate downscaling, agroclimatology (modelling in grapevine development and phytopathology), GHG soil emission, grape moth (Lobesia botrana) ecology.
- UMR LEGT: environmental geography, spatial approaches to analyse interactions environment-society, natural and anthropogenic dynamic processes for environment and landscape design, global changes and climatic risks,climatology, dynamical and statistical climate downscaling, international networking, in charge of Life ADVICLIM project.
- UMR ITAP (UMR RNSR : 200118630A) : Equipment for sustainable agriculture and for services related to the environment, information and related systems, decision support systems, ecotechnologies, eco-design, environmental assessment, life cycle analyses.

FUNDING 2 pages max.

Please fill in the table enclosed (Excel file) with the details of the funding requested and report here the total amount: 200 000€

Type	2018 (6 months)	2019	2020	2021 (6 months)
Travel, networking, dissemination	24 000	36 000	30 500	7500
Small equipments				
Operational costs (Bench fees, etc.)	14 000	49 200	32 200	6600
Sub-contractor (for technological service contracts)¤				
Total	38 000	85200	62 700	14 100

If you have obtained other funding for this project, specify the funder and the amount

Recipient Team/Partner	Funder name	Amount (Euro)
EGFV/Œnologie/AgroClim /LETG (projet AVVENIR)	CIVB	320 000
Innovation (Hub regional)	CSA Booster/KIC Climat	145 000 (2 years)
LEPSE (projet SunAgri3)	PIA-ADEME	195 000
Innovation (project tackling climate change)	Muse (Montpellier University)	120 000 (3 years) including90 000 for a PhD partially dedicated to the wine industry

If you have asked for other funding, specify the funder approached and the amount requested

Recipient Team/Partner	Funder name	Amount (Euro)
SAVE/UE Ferrade/UE Colmar/System	Agence Française pour la Biodiversité	274 000
System	2 options 1- Région Occitanie (50) + ACCAF (50) 2- Région Occitanie (50) + INRA Département EA (25) + ACCAF (25)	48 000 (Ph-D co-funding)
Innovation	DIGITAG (convergence institute)	48 000 (Ph-D co-funding)

Thesis

Construction and evaluation of technical management scenarios adapted to climate change at vineyard levels (plot and landscape) (full description in Annexe 1)
Scientific objectives
Adaptation can be defined as the set of organization, localization and technical changes that societies will have to implement to limit the negative effects of climate change and to maximize the beneficial ones. Several technical and organizational levers have been previously identified. The design of cropping systems and agricultural systems is based on several approaches, based either on mathematical optimization or on the exploration and evaluation of a solution space [50], mobilization of scientific knowledge in the form of models (design by simulation [4], or combining scientific and expert knowledge through participatory approaches [63]. If a formalization of knowledge is necessary for their sharing in participatory approaches (conceptual model, role play, etc.), the mobilization of simulation models is less common [23]. The thesis aims at exploring the hypothesis that the combination of growing practices at the level of the plot and their spatial distribution in the vineyard landscape could give significant leeway to adapt a perennial crop such as grapevine to climate change. In a watershed, actors involved in viticulture and water management will be mobilized to design and evaluate adapted cropping systems and to define evaluation criteria. A chain of models will produce indicators that capture the impacts of climate change on the sustainability and resilience of this agroecosystem. This will allow for an integrated assessment of adapted cropping systems by the stakeholders. The originality of the thesis project lies in (1) the coupling of scales, plots, place of technical operations, farms where they are decided and coordinated, and watershed, where their environmental impacts appear, and (2) the coupling of participatory design methods and model simulations, considering several levels of integration.
Methods
Agricultural Systems Design: the thesis will implement a participatory approach to design, build and evaluate, iteratively, scenarios of adaptation of wine systems to climate change, at various scales (plot, farm, watershed) and criteria of assessment, with a focus on productive and environmental performances and their stability (resilience) in a climate change situation. Methodological skills of the team will be mobilised [23, 24, 43, 64] and the climate change component will be integrated [25]. The evaluation indicators will be defined with the stakeholders of the territory, and quantified by simulation of the different co-constructed scenarios, under constraint of climatic scenarios resulting from the projections of the IPCC. **Modelization**: at plot scale, several existing models will be combined. The ability to use various water balance models (WaLIS, Hydrus-1D and SVAT) and STICS model adapted for grapevine will be tested. At landscape scale, the OpenFLUID software platform [29] will be mobilized. It is dedicated to modeling the functioning of complex landscapes and is mainly focused on flows. Especially the project will be based on the coupling between the distributed hydrological model MHYDAS [54] and the decision-making model of Dhivine soil maintenance practices [51] already tested to experiment virtual farming practices at the scale of small watersheds [61]. **Case study**: several candidate watersheds are considered: - The Roujan wine catchment area (1 km^2) where hydrological fluxes and practices have been monitored for 25 years under the ORE OMERE; - the lower Peyne valley (80 km^2), a wine-growing catchment area encompassing the Roujan watershed, for which a detailed soil characterization [19], a spatialization of viticultural practices [5], a spatialized estimation of water consumption of grapes [34], and a spatialization of surface water tables [38, 74] have been performed; La Peyne is one of the test sites for ANR

projects ALMIRA and RUEdesSOLS; - the Rieutort basin, located in the Hérault wine-growing plain, bordering the foothills of the central massif, covers 45 km^2, of which 15.4 km^2 are devoted to the cultivation of vines (SP3A project, area capture of drinking water supply, capture "Grenelle"). The selection criteria will be: the presence of stakeholders concerned with adaptation to climate change and water management, and the available documentation of the watershed (nature of soils, land occupations, components of the water budget ...).	
Name of the supervisor	C. Gary (P8), L. Prévot (P13), L. Hossard (P2)
Date of beginning	1/10/2018
Co-funder	Région Occitanie (sollicité)
Ecole doctorale de rattachement	GAIA (Montpellier SupAgro)

Description

1. Context (2.5 pages)

- *Scientific issues:* The LACCAVE 2.21 will address the issue of systemic adaptations to climate change (hereafter noted as CC) in the French wine industry. Indeed this sector identified this issue and reduction of phytosanitary inputs as key challenges for the XXIst century. Adaptation will require the mobilization of several levers in a complex way [41; 42; 53; 57; 60; 75; 78], including those related to environmental issues [10; 18; 69]. The 2012-2016 LACCAVE project (hereafter named LACCAVE 1.0) assessed the impacts of CC on grape and wine, identified numerous adaptation options considered individually, and designed national strategic scenarii for 2050 (www6.inra.fr/LACCAVE). Among potential strategies, systemic adaptation based on both scientific and applied knowledge were pointed as the main options but were not explored and tested, as they have to be supported by a new participatory research paradigm[13]. Consequently LACCAVE 2.21 aims at delivering scientific and operational knowledge, indicators, tools, methods, innovations and adaptive strategies at various scales to respond to the systemic and participatory challenge generated by CC in the wine industry.

- *Relevance to the adaptation of agriculture and forest to climate change*: Adaptation, as defined by the set of technical, spatial and organizational changes that societies will have to implement to limit the negative effects of climate change and to maximize the beneficial ones [40], will be the core of LACCAVE 2.21. Based on LACCAVE 1.0 outcomes, the project will address this issue in a systemic and highly multidisciplinary way, and take into account the interaction with other pressures (pest control, societal demand, resources and land use conflicts). Mitigation and environmental impacts (potential mal-adaptation) will also be considered. LACCAVE 2.21 will mainly focus on medium-term adaptation options and aims at defining both local and national operational adaptation strategies (cropping systems, landscape management, wine sector policies) based on simulated eco-indicators, model projections and participative methods. LACCAVE 2.21 will involve several stakeholder partnerships to set-up participative approaches which will indeed ensure co-constructions of solutions and multicriteria assessment. The main objectives are to support the national industry to design action plans for adaptation and to design resilient and adapted systems taking into account various levers (spatial distribution, plant material, soil management, growing and wine making practices, organizational and regulation constraints). To support these objectives several tools will be delivered and made available to public: expertise on complex issues as “drought management”, eco-indicators, models and an innovation platform. The development of international networking is among the objectives of LACCAVE 2.21 in order to share expertises, skills and experiences. Indeed, LACCAVE2.21 considers the French wine industry as a “generic laboratory” for studying and promoting adaptation strategies, bringing tools and insights for other wine industries worldwide.

- *State of the art :* The links between grape production, wine quality, climatic conditions and geographical origins are tied, making ongoing climate change a quite challenging issue for the wine industry, a key economic sector in many countries, especially in France [55, 57]. In addition, considering the climate sensitivity and complexity of this industry, as well as the numerous interactions and institutions that are involved in its evolution, it could be considered as an example or a model to manage adaptation for many agro-food sectors [53, 57].

How climatic conditions will be affected locally, how local climate will interact with topography, resulting in a high climatic variability at vineyard scale, how vine performances, berry composition and wine quality will be modifed, what can be done to adapt vine growing and wine making practices to these new conditions ? How can policies and institutions evolve to help the sector adapt? Here are some of the numerous questions the wine industries have to face in the following decades [1, 58]. General trends of already observed and expected climate change and their impacts on grape growing show that the planet is warmer than at any time in our recorded past, and extremes in temperature and precipitation have increased. Most vineyards throughout the world face the same situation. Some vineyards from low latitudes may be endangered in the following decades while others from high latitudes may increase their potentiality to grow grapes [12, 32, 37, 39, 41, 49, 65, 67. Everywhere, there is an agreement that both mitigation and adaptation strategies will be necessary to cope with these modified climatic conditions and that multidisciplinary and systemic approaches are needed to design these strategies [8, 21, 53, 56].

Climatic modelling at the appropriate scale is crucial to simulate future conditions [48, 63]. In particular, high resolution atmospheric modelling provides useful information to understand climate variability at high spatial and temporal scale and to allow better decision-making for adaptation at the terroir level [73]. Water availability will become a major concern and should be considered in a complex manner. Considering that simulations for precipitations are characterized by a large uncertainty, it is determinant to analyze the evaporative demand of the atmosphere which has so far shown different evolutions according to the considered vineyard. Wind appears to be a key component of these variations [66, 70]. Studies on the impacts of climate change on grapevine physiology are numerous. Phenology, driven mainly by temperature, is the first component to be affected and is a key parameter for varietal adaption [32, 35, 71]. However temperature effects are complex and carbon balance at the whole plant level should be considered [46, 77]. Interactions with high CO_2 have to be taken into account and impacts of future climatic conditions may be larger than might be predicted from experiments examining factors one by one [28, 47, 52]. Fruit composition, especially aroma compounds, is a real matter of concern. These molecules contribute to the typical identity of wines and are highly variable according to climatic conditions and growing practices [62]. The evolution of pest and diseases is another important issue which is much more difficult to document [44]. Worldwide repartition of diseases does not really help to get clear idea of risk occurrence in the future [7]. To face these new conditions and ensure the sustainability of the industry, adaption should be considered at various spatial scales and at every step of the production and value chains [3, 76, 80]. At short term scale, winemaking and oenological practices may contribute to properly process grapes despite their higher sugar and lower acidity contents [26]. At longer time scale, site selection, soil and landscape management or plant material selection present a high potential to face the new climatic conditions [60, 79]. Looking at the past to understand the future may be very informative and some traditional practices abandoned recently may have a high adaptive potential [78, 68]. A major challenge will be to adapt plant material to these new conditions. New approaches, as ecophysiological modelling, should be developed [8, 32, 81] and could be very promising to develop new varieties and rootstocks better adapted to drought [27, 72]. However, adaptation should be considered as a systemic issue, including not only technical changes, but also organizational, economic and regulatory aspects [9, 2]. Adaptive capacities of stakeholders and consumer acceptance of changes need also to be taken into account in the process [33]. Decision-making tools, based on a combination of indicators, bio-physical, multi-agent modelling and participative approaches are urgently required and need to be combined in order to support stakeholders to define a priori adaptation strategies [56, 67].

- *Potential structuring impact for INRA* : LACCAVE 2.21 will associate 19 INRA teams from 7 INRA divisions, and 3 teams from CNRS, Bourgogne University and Montpellier Supagro as main partners, most of them already involved in projects related to Climate change or wine industry. It will also bring 2 additional INRA teams, 2 state organisations, 2 R&D bodies and 1 research institute as additional partners in the consortium. Consequently, through the LACCAVE 2.21 project, INRA will endorse the leadership and coordination roles for national research dedicated to the adaptation to climate change of the wine industry (and more generally on wine industry). LACCAVE 2.21 will also provide an example for other adaptation studies and participatory approaches.

- *Relevance to the call and the axes and originality*: LACCAVE 2.21 will mainly contribute to the first CEI2017 priority by focusing on the co-design and comparison of innovative production systems, more resilient and adapted to new climatic conditions. It will also provide consistent inputs to the CC-SAFE portal for services (priority 4) and to priority 2 by testing new methodology which combines participatory method and modelling. LACCAVE 1.0 was successful to build a common scientific knowledge about climate change, to raise the awareness of the industry and to collect information about key concerns of the actors. Based on that, LACCAVE 2.21 is a fully integrated project and will relay strongly on multidisciplinarity (from climatology to social sciences) and participative approaches to work on operational adaptation solutions for the industry. Various participative methods will be developed in the different WP (2, 3 and 4) in order to take into account as better as possible the different requirement and perception of the participants (scientists and stakeholders) about climate change impacts on grapevine and on vineyards. Expertises, indicators and models developed during the project will support the definition of applied solutions based on stakeholder requirements.

2. Technical and scientific description of the proposal

- *Scientific aims*

Based on the results of LACCAVE 1.0, the fully new proposal LACCAVE 2.21 will target the **development of operational adaptive strategies focusing on systemic options, participatory methods and operational outcomes**. Networking and international collaborations will be promoted. LACCAVE 2.21 is organized in four operational WPs and one managerial WP (WP0). WP1 aims at delivering global and integrated expertise on major issues for adaptation of the wine industry, functioning as a true think tank. WP2 will release ecoclimatic indicators and projections of vine performances to scientists participating at WP1 and WP3 and stakeholders for the design of more resilient production systems, contributing to the CC-SAFE portal of services. WP3 will launch several participative initiatives to construct at local scales resilient systems combining low-pesticides inputs and adaptation to climate change. Finally WP4 aims at establishing an international network on systemic adaptation in the Mediterranean area, in the frame of a European project application.

- *Methodology*: the project will be based on a combination of participatory methods, both at scientific levels (WP1, WP4) and with stakeholders (WP1 and WP3), modeling (WP2, WP3), data management (WP1, WP2, WP3), systemic approaches (WP1, WP3).

- *Expected results* **:** The results will include expertises on complex issues related to climate change, eco-climatic and plant indicators, crop models to manage adaptation strategies, adaptation strategies and scenarios defined at different levels with the stakeholders, other funded projects. The results will be delivered as publications, both scientific and applied (reports, booklets, information sheets), press releases, data bases, websites, an Open Innovation Platform, and strategic plans by stakeholders.

- *Link with other on-going projects or actions:* LACCAVE 2.21 is coordinated at the European level with the Life-Adviclim project and the CSA-Booster (KIC Climat). Interactions with the 4 ‰ Initiative should be established. At national level, it will develop links with at least the SOERE-Tempo, the SALSA project (ECOPHYTO2) if funded and the “Plan national de lutte contre les dépérissements de la vigne”. It will also be coordinated with several regional actions as AVVENIR and Sunagri3-PIA or Montpellier MUSE. Strong interactions with APCA projects ORACLE and CLIMENVI will be developed. Added value of LACCAVE 2.21 is to build a link between the other funded projects, to avoid redundancy, to gather the expertise and the results from the other projects in order to support stakeholders to build their own strategy for adaptation.

- *Description of the project :*

The work-flow is illustrated on Fig.1 (annex 2). Milestones and deliverables are summarized in annex 3.

WP0: Management and communication

Coordinators: N. Ollat (P1), J-M. Touzard (P2)

Project and financial management: The LACCAVE 2.21 coordinators will be in charge of the implementation of the project in front of ACCAF committee. A steering board involving WPs coordinators will be set up and will meet twice a year to report about the progress for each WP and plan further activities. Networking activities and expertise work in WP1s will be carefully monitored. An international scientific advisory board will be set-up, in perspectives of an European project application (WP4). In order to use funds efficiently, they will be collectively managed by project and WP coordinators. Procedures will be defined and presented to the participants during the launching meeting. All participants will meet annually.

Data sharing and storage: A share point has already been set up to prepare the intention letter (https://sites.inra.fr/site/LACCAVE 2-21) and will be further used to exchange documents within the steering board. The diffusion list accaf-LACCAVE@inra.fr will be maintained with the new Mercure service. The website https://www6.inra.fr/LACCAVE will be further developed for scientific exchanges and intranet facilities may be offered. In addition a data management plan will be set-up by the steering committee in collaboration with P11, P19 and P22. The best option will be defined to manage heterogeneous data collected within LACCAVE 2.21. Data from WP2 (indicators) will be available on SAFE climate service portal. Data about innovations (WP1 and WP3) will be available on the Open Innovation Platform https://www.agrisource.org (P2) in the framework of the CSA Booster project (Climate KIC).

Communication: Communication tools targeting various audiences will be implemented in close collaboration with INRA communication services... For stakeholders and students, the Open Innovation platform (https://www.agrisource.org) will be targeted.

WP1: Development of integrated expertises to manage adaptation

Coordinators: N. Ollat (P1), E. Giraud-Héraud (P7), L. Prévot (P13)

The objective of WP1 is to build an integrated expertise, involving partners and external experts working as a think-tank, about challenging issues related to the adaptation to CC of the wine industry. Previous studies have shown that adaptation strategies should take into account many parameters as bio-physic constraints, innovation availability, resource management, economic viability, actor perception and readiness to change i.e…., before they can be implemented and change into more resilient productive systems. Benefiting from LACCAVE 1.0 outcomes, the following topics have been identified as priorities for adaptation issues and the following key words will be considered.

Topic 1: **Water management**: drought events, water status measurements, impacts on grapevine performance, need implementation, resource management, regulations, technical options.

Topic 2: **Biotic environment in vineyards facing climate change**: pest and pathogen biology, plant-pathogen interactions, plant resistance, cultural practices, climatic drivers and threshold, risks, emergent diseases, overcoming strains, dieback crisis, biotic and abiotic stress indicators, PestObserver.

Topic 3: **The soil component, the hidden challenge**: animal and microbial diversity, carbon sink, erosion, soil climate, fertility, soil management, landscape infrastructures, water harvesting, water holding capacity, root development.

Topic 4: **Varietal ideotypes:** targeted traits based on climatic indices at regional level, existing variability among varieties and rootstocks, phenotype simulation based on modeling, genetic determinism, shared protocol, new breeding strategies, cultural practices interactions.

Topic 5: **Numeric and data to facilitate the emergence of new knowledge**: tools and models for complex data exchange, interoperability and analyses, heterogeneous data, data reliability, spatial and temporal scales, mix-methods (quantitative, symbolic, multi-scale), semantic.

Topic 6: **Vineyard localization, up to where?**: variability and climatic projection at local scale, landscape, multi-scale nomadism (from plot to country), territorial issues (diversification, land competition, resource management, regulation, sourcing, appellations).

Topic 7: **Which wines for tomorrow ?:** Targeted fruit composition traits (primary and secondary metabolites, aroma), new and resistant cultivars, variability, heterogeneity, harvest and wine-making processes, extractability, ageing parameters, consumer preferences, wine types

Topic 8: **Value chain approach for adaptation:** global quality management, interactions between innovations, interactions between producer and consumer issues, relevant representations, assessment tools for value chain adaptation (cost-benefit / multi-criteria), global and foresight approaches.

Time table and deliverables for the entire WP1:

- Workshops: once a year for each topic with reports (M12, 24, 36)
- One Master student for each topic (year 2 or year 3) (M18 or M30)
- Document release per topic: book, literature review, position papers, reports, leaflets for the industry and teaching units (at different levels) M36
- Methods for heterogeneous data management, traits and methods for breeding, varieties to evaluate (M24)
- Identification of lack of knowledge or definition of research priorities, especially in preparation of WP4 (M7)

Topic	Partners in charge	Partners involved	External partners
1	1, 13, 15	12, 11, 8, 5, 2, 10	IFV, INAO, FAM, IRSTEA, Agences de l'eau, APCA, GRAPPE, etc…
2	9, 8, 20	1, 3, 4, 7, 12, 14, 15, 16, 17, 20, 21	IFV, APCA, EEF, AGIR, GRAPPE
3	1, 13, 14	2, 7, 16, 20, 22	IFV, IRSTEA, ACAR, etc..)
4	4, 5, 1	3, 9, 6, 7, 8, 12, 15, 18, 20	IFV, etc…
5	11, 19, 22	1, 2, 3, 21	IFV, APCA
6	21, 10	1, 2, 3, 13, 16	INAO, FAM, Sciences Po, GRAPPE, EPOC,
7	6, 7, 15	1, 2, 4, 16, 17, 20	IFV, INAO, GRAPPE
8	2, 10	1, 3, 4, 7, 20	INAO, FAM, EHESS. ISVV-Kedge-BSA, GRAPPE

WP2: Tools for adapting viticulture systems: Ecoclimatic Indicators and Models

Coordinators : I. Garcia de Cortazar-Atauri (P3), T. Simonneau (P12), P. Vivin (P1)

In recent years, several INRA research groups have developed and used ecoclimatic indicators (agroclimatic indicators calculated over phenological periods) and process based models developed at different scales (from plant organ to the crop field scale) to assess the impact of climate on the development and growth of different crops, including grapevine [2; 5; 28]. The objective of WP2 is to better integrate and structure already formalized knowledge in dispersed process-based models and already developed indicators. These tools will allow assessing the potential climatic risks and opportunities affecting grapevine production in different vineyards in France. Results obtained will be shared with WP1 and WP3 in order to contribute and support their respective analysis.

Task 2-1: Vineyard Agroclimatic Processing Chain (I. Garcia de Cortazar-Atauri)

In the framework of the development of tools related to the SAFE climate services portal, LACCAVE2.21 will test the first version of the Agroclimatic Processing Chain (APC platform) and provide a series of spatialized indicators to characterize the evolution of the climatic conditions in French different vineyards. Since 2014, Agroclim (P3) is developing a set of ecoclimatic indicators [14; 15] in order to evaluate the suitability of crops in the context of climate change. This methodology has already been successfully tested for vineyards [14; 36].

In order to better define the set of indicators to be calculated using the APC platform, a participatory workshop will be organized in close link with WP1 with all the research units involved in the definition of some indicators (describing biotic or abiotic stress) and in collaboration with ORACLE and ClimXX1 networks (APCA national projects). This shared analysis will allow correctly taking into account winegrowers' perception of the climate evolution, and therefore providing them information to sensitize stakeholders and producers about the development of strategies to adapt to climate change.

Task 2-2: Modeling for plant performance projections (T. Simonneau, P. Vivin)

Crop models have been widely used to assess the impact of climate change on production and use of resources [11]. However, they exhibit several limitations when dealing with objectives specific to a fruit perennial like grapevine (e.g. multi-year impacts on yield and quality) with specific adaptive levers (e.g. inter-row weed cover, canopy management, selection of rootstock or scion). Process based models have been developed to circumvent these limitations by detailing the mechanisms related to the different adaptive levers (N and water balances as a function of weed cover, influence of microclimate on primary and secondary components of quality, effect of plant architecture on microclimate…,). The French community involved in LACCAVE2.21 gathers a unique set of expertise on such submodels dedicated to phenology [35]; functional-structural relations from organ to whole plant scale [20, 59], water balance [17; 45], pest and diseases [16; 82] but they most often lack extensions to yield or fruit quality by contrast with crop models.

Here, the objectives are 1) to reinforce the modelling toolbox for LACCAVE2.21 partners so as to explore the consequences of adaptive practices at plant and plot levels while 2) bridging the gap between process based submodels and the widely used crop model STICS, which has also been developed by a LACCAVE2.21 partner [11].

Thus, we propose: 1) to identify which submodels studied by the partners deal with mitigation of climate change impacts (either through modification of plant or soil microclimate, or via changes in physiological traits acting upstream on yield or quality) and how they can simulate the effect of adaptive practices (as identified in WP1); 2) to identify which component of the process-based submodels are the most influential on plant response to climate change; 3) to couple the relevant submodels with a dedicated version of STICS; 4) to organize available data in order to evaluate the performance of coupled submodels ; 5) to evaluate their capacity to characterize the impacts of climate change on grapevine (quality compounds, intra-plant variability, multi-year effects) using future climatic scenarios and 6) to look for adaptive strategies by optimization.

WP2 will interact with other WPs in several ways. Participatory approaches and outcomes of WP1 will participate to identify bio-physical levers which impact plant performances and to describe how they can mitigate effects of climate change (topics 1 to 4, 7). This information will be integrated in a systemic modelling of the vine and grape development in WP2. The modeling will also incorporate key morpho-physiological traits identified in WP1 as essential for plant adaptation to climate change (topics 1, 2, 4, 7). Traits will be translated into parameters with appropriate equations compatible with the whole crop model approach. WP1 participants will ask to test these new modelling to test existing genotypes in future climatic conditions of the different regions (topics 4 and 6). Integrative modelling will also be used in WP3-2 to make projections as regards influence of complex combinations of technical levers on economic, environmental, agronomic and technical performance of the system. The projections made with different climatic scenarios will also participate to define new ecoclimatic indices for which the targeted performance could be reached. Ultimately, optimization will be a way to find solutions that satisfy multiple constraints by combining the different levers (not considered individually). The optimization approach will possibly incorporate constraints on the use of pesticides (with the aim to reduce their use). It will also provide to WP3 a spatialized view of the main risks expected in the three studied regions of DEPHY network.

Deliverables and time-table (M=month):

- Participatory workshop (with participants of WP1 and WP3 activities) to define the set of indicators per vineyard allowing the characterization of climate change impacts (biotic and abiotic stress) and grapevine feasibility (M12) and to identify a list of submodels to simulate the effect of adaptive practices. (M12; M24)
- Coupling of selected submodels with the crop model STICS (M24)
- Series of existing datasets to evaluate the coupled submodels and recommendations for new datasets (M24)
- Spatial computation using the Agroclimatic Processing Chain of a defined set of indicators for French vineyards (using DRIAS database at 8km x 8 km scale) (M24)
- Assessment of the capacity of the process based submodels to simulate climate change impact on integrated traits when coupled with STICS (M36).

Participant teams: P3, P1, P12, P8, P9, P7, P20 + APCA (F. Levrault, M. Badier)

WP3: Co-construction of solutions, adaptation strategies and resilient production systems

Coordinators : C. Gary (P8), H. Hannin (P10)

This WP mobilize participatory approaches to co-construct with stakeholders solutions for adaptation at different scales : i) a national adaptation strategy ; ii) resilient cropping systems ; iii) climate smart innovations .

Task 3-1: Towards a national adaptation strategy (H. Hannin, N. Ollat)

A major outcome of the foresight exercise of LACCAVE 1.0 (www6.inra.fr/LACCAVE/Prospective) has been the **set-up of a national group of representatives of the French wine industry** under the umbrella of FranceAgriMer and INAO (two external partners of LACCAVE 2.21). In close collaboration with the LACCAVE partners, this working group aims at defining a national action plan to cope with climate change. The group will be fueled with the results of both LACCAVE projects and the outcomes of the six regional presentations of the foresight exercise made in 2017 in six wine regions. The achievements of LACCAVE 2.21 will be highly relevant to fulfill the objectives of the national group. This group will be a unique opportunity to exchange with the industry (main organizations and leaders), to communicate our results in an applied way, and to answer to the requirements and questions of the industry about adaptation to climate change. P10, with FAM and INAO, will lead the coordination of this group to facilitate the communication between scientists and stakeholders. The process will be also followed and analyzed by researcher in political science, in collaboration with the MUSE project “tackling climate change” (how local and national policies are integrating the climate change issue) The group will meet every 3 months and communication tools developed in WP0 will be validated in that frame.

Task 3-2: Participative design and assessment of climate-smart cropping systems in viticulture (C. Gary)

The objective of this task is to set up a method of participative design of cropping systems in viticulture that would be both sustainable (in ecological, economic and social terms) and adapted to climate change; the method is to be implemented in a range of conditions, and should produce scenarios of technical change adapted to local conditions.

Cropping system design has been developed over the two last decades, based on activities of knowledge engineering, prototyping and assessment included in a progress cycle, with the participation of various stakeholders (e.g. [64]). In viticulture, such an approach has been implemented to design and assess cropping systems with low pesticide use [22; 43]. The most ambitious prototypes aim at combining technical innovations with the promotion of ecological regulations, based on the promotion of diversity at crop, field and landscape scales (cf. Inra MP EcoServ and SMaCH). Are these agroecological systems adapted to climate change? Does diversity also bring resilience? These questions remain to be addressed by introducing the specific constraints of a changing climate in the design process [6]. WP3 activities will capitalize on the experience of a national network (DEPHY – 'Ecoviti') that carries out cropping system design and assessment in 3 contrasted wine-producing regions: Alsace (continental), Bordeaux (Atlantic) and Languedoc (Mediterranean).

Several types of co-design events will be organized:

- one brain-storming meeting per region with a large range of stakeholders (cf task 3.1), dedicated to the identification of expected changes in grape and wine production due to climate change, of possible bottlenecks and of technical levers that could be mobilized to cope with them (cf WP1 and WP2);
- meetings dedicated to the design of prototypes of cropping systems suited to climate change and of scenarios of their implementation in landscapes.

These prototypes will be assessed for their performance under climate change according to GIEC climate scenario and projections for France (www.drias-climat.fr) by designing experiments or in silico simulations with available indicators that could be tested in the 'Ecoviti' network as well as quantitative or qualitative models (in collaboration with WP2). This study will focus on water management in relation with changes in temperature and precipitation regimes in order to consider interactions between the vineyard and landscape scales and to combine technical changes at these two spatial scales.

Task 3-3: **Alternative participative initiatives to track and implement innovations for adaptation (J.M. Touzard, H. Hannin, N. Ollat)**

Other participative initiatives associated with side-projects (CSA-Booster: P1, P2, P6, P11, P12 ; AVVENIR: P1, P7, P9, P21 ; VIN & ADAPT P2, P3, P8, P15) will track existing innovations already implemented by actors and will define the conditions to develop innovations seeking to reduce pesticide inputs and adaptation to climate change, including grape varieties resistant to dryness and high temperature, practices to reduce of sugar content, agro-ecology and agroforestry practices, new information systems and decision making tools, insurance systems, …. In this task, oenologists will also be involved and the potential use of behavioral economy approaches adapted from other studies will be estimated (InterReg Sudoe Vinovert). The task 3-3 will be closely connected with WP1, i) by providing some practical knowledge/solutions to WP1 topics, and ii) by valorizing WP1 outcomes into innovation processes. Two main operations will be carried out, in collaboration with the CSA booster initiative (Climate KIC Open innovation platform focusing on the wine industry) : i) a wide inventory of climate smart innovations in the wine industry, described by a dedicated analytical framework, and shared on the KIC open innovation platform ; ii) the analysis of/participation to 3 or 4 concrete process of innovation, selected according to their relevance and potential complementary insights for LACCAVE 2.21. Collaboration will be developed with both INRA "innovation domains" initiatives, Inra transfert and the Research network on innovation (https://rrien.univ-littoral.fr/) which is promoting innovations for adaptation to CC.

Deliverables and time-table (M=month):

- A methodological framework for designing climate-smart vine growing systems (M12)
- The identification of climate change constraints and available technical levers specific to the 3 case studies (M18)
- Some scenarios of technical change for the adaptation of viticulture to climate change in the 3 case studies (M24)
- The ex-ante assessment of contrasted management scenarios with indicators of resilience and water balance models at field and landscape scales (M36)
- A national action plan for the industry to cope with climate change (M12) and report/article illustrating how the governance of the wine industry takes into account the CC issue (M24)
- Technical sheets describing innovations, available to the KIC Open Innovation Platform (M24)
- Innovation workshop co-organised with INRA transfert and the CSA booster project (M36).

Participant teams: P1, P2, P3, P4, P8, P9, P13, P10, P17, P20, FAM, INAO, IFV

WP4: To build an European project on the adaptation of Mediterranean vineyards.
Coordinators: J-M. Touzard (P2), S. Delrot (P1), I. Garcia de Cortazar (P3)

The objective of WP4 is to build a European research proposal on adaptation to climate change in the Mediterranean vineyards. The challenge is twofold:

- to develop new scientific knowledge on the conditions and forms of adaptation in the wine industry, using the Mediterranean area as a “true research laboratory”. The Mediterranean area presents a wide range of climatic conditions and wine production systems, including extreme examples (vines under drought and high temperature)[30, 31]. Common controversies and experimentations can also be observed in all Mediterranean vineyards, concerning, for example, the contrasted situations of irrigated vs non irrigated vines [68] These situations make it possible to inform, compare and test different options of adaptation, anticipating possible changes from one region to another (i.e. exploring Sicilian, Spanish or Moroccan systems of production for future plantation in Provence and Languedoc…).

- to be able to extend at the European scale a multidisciplinary scientific and partnership network initiated in France, through the LACCAVE project. Wine scientists and organizations still have various contacts or bilateral collaborations within the Mediterranean area (through GIESCO or OIV conferences, Inter-Reg or FP/H2020 European projects, COP negociations…), but there is no Mediterranean network on “adaptation of wine industry to climate change”. For INRA, the aim is also to consolidate an international leadership position on this theme.

Until now, no research project has targeted the Mediterranean area to deal globally with the issue of adaptation to climate change for the wine industry. First contacts have already suggested the high scientific potential of such project and the expectations of many potential partners, including major institutions such as Climate KIC or OIV.

The researchers involved in LACCAVE2.21 have identified the opportunity offered by the PRIMA initiative (Partnership for Research and Innovation in the Mediterranean Area) supported by H2020 and ANR. The future PRIMA calls (2018, 2019, 2020) include a specific line on “adaptation of Agriculture in the Mediterranean area”. This context emphasizes the need for strong research consortium covering southern and northern Mediterranean countries, with different disciplines and connections to professional partners. Nevertheless other calls could be elected, according to the evolution of both our future scientific consortium and the research founding opportunities.

We decided to develop the WP4 work during the 3 years of the LACCAVE2.21 project, providing the final project proposal in 2019, for starting in 2020. Three reasons may be advanced:

- This "preparation time of a project" will already produce new knowledge on the state of the art, the diversity of situations, experiments and partners in the Mediterranean countries. It is a collective new expertise, which will have *per se* a very important value (report and position paper)

- The European project is ambitious with a high potential impact. It requires a lot of preparatory time in order to build interinstitutional relations (especially between northern and southern Mediterranean countries), commitment and capacities. For that, we will also ask an additional support to INRA DARESE (founding dedicated to European projects preparation)

- The future project will clearly be an international extension of the LACCAVE2.21 project (for 2020-22), which will have thus played the role of a "project booster", in accordance with one of the main objectives assigned to the Metaprogrammes.

Time table and deliverables

- identification of partners and major topics/questions, first institutional contacts (M1>M7)
- Short missions in 2018 and 2019, including working sessions with local scientists and identification of concrete situations in different vineyards: in Spain (Universities Valencia, Madrid and Menendez-Pelayo), Italy (Piacenza, Florence), Portugal (Lisbon, Porto), Greece (Athens, Tessalonica), Morocco (IAV Rabat), Tunisia, Lebanon (M1>M9)
- Workshop for project construction (Bordeaux or Montpellier, M4) : potential partners will be invited to participate to the launching meeting of LACCAVE 2.21 in October 2018.
- Writing of the proposal (2019) which would start in 2020 (M5>M10)
- Six mission reports (state of issues and research in each country, identification of main questions, partners and potential case studies) M6
- A global report on "adaptation to climate change in the Mediterranean vineyards" (collective expertise) that could lead to a first scientific position paper (academic journal) M15

Participant teams: An European project can not involve too many partners. Consequently teams with complementary skills and the most interested in European development will only be associated to this application.

3. International aspect (if relevant)

LACCAVE2.21 aims to be a driver for international research on adaptation to climate change in the wine industry. For this purpose, specific attention will be given to develop new International collaborations, strengthening the INRA international leadership on this topic.

- The LACCAVE1.0 international scientific advisory board will be relaunched and renewed. This initiative that has already proved to be useful to promote discussions on results, comparisons with foreign vineyards, scientific events, or the writing of international position papers (Van Leeuwen et al., 2013). Membership will be offered to Pr H. Schultz (Geisenheim U., Germany), Pr G. Jones (Oregon U., USA), Dr J. Tonietto (Embrapa, Brazil), Pr F. Zamora (Tarragone U., Spain), Dr A. Malheiro (Portugal), Dr A. Parker (New Zealand). The board will be invited to participate to LACCAVE 2.21 main events and publications (reviewing, invited conferences), to provide advices on strategic choice (WP4) and to drive the scientific committee of the final event (see below). Additional funding will be looked for to support activities of the board (Inra departments, Agropolis foundation, ISVV…).

- International collaborations will also be developed within tasks of WP1, WP2 and WP3. In WP1 each group will be encouraged to write international reviews and to collaborate with research teams from abroad relevant each topic. Foreign expertises, especially from southern countries (Spain, Italy etc..), will be highly useful to elaborate French adaptation strategies. In WP2, the development of tools (agroclimatic indicators and modelling) will benefit from contributions of European and international programs [32]; In WP3, tasks 3.1 and 3.3 will develop specific collaboration with (and receive support from) Climate KIC, promoting the LACCAVE2.21 solutions at the European level.

-WP4 is specifically dedicated to international collaborations, through the construction of an ambitious European project on adaptation to climate change in vineyards of the Mediterranean Area (PRIMA initiative). Short missions are planned to build a network with teams not already connected (Italy, Greece, Tunisia, Morrocco, Spain…) and one deliverable will be the international mapping of research on the topic. These international collaborations will include both scientific and professional partners, leading to an ambitious European proposal.

- Finally, the contribution of LACCAVE 2.21 to international scientific events will be strengthened, providing communications (and , when possible, specific sessions) in both general “wine and vines” conferences (GIESCO, OIV, Enology, grapevine physiology or breeding…) and “adaptation to climate change” conferences (CSA congress, COP events,). LACCAVE 2.21 plans also launch a second edition of the international conference “sustainable grape and wine production under climate change” (Climwine 2021), leading to the release of special issues in international academic journals.

4. Diagnosis of missing competences (inside or outside of INRA)

The implementation of the project would be facilitated if the consortium would involve specific skills in:

- Participatory approaches would be facilitated if **scientists involved in social and human sciences** would join the consortium which is mainly based on economists. Previous studies from LACCAVE 1.0 showed that perception and adaptation capacities are highly important to implement successfully adaptation strategies. The identification of human and organizational constrains and the implementation of relevant participatory approaches in order to combine environmental and climate change issues would probably be helpful. Sociologists of LISIS (SAD & SAE2 departments) who are developing participatory research have been contacted. M Cerf, M Barbier and PB Joly have expressed their interest to act as advisors for LACCAVE 2.21. They could be invited to participate to workshops and co-manage at least one Master student following WP3 tasks.
- Taking into account the number of involved teams and the ambitious objectives of the project, the recruitment of a **project manager** (IE CDD 24 months) would improve greatly the functioning of the consortium and the achievement of the operational outcomes, as well as the dissemination plans. Consequently fundings will be requested (stakeholder organisations or other calls) to try to create this position.

5. Expected Impact

- **Expected impacts of the results**: LACCAVE 2.21 proposal has been elaborated by taking into account the outcomes of LACCAVE 1.0 and the feedback of participants and stakeholders. Consequently expected results may have impacts in various directions :

- *On a scientific point of view*: LACCAVE 2.21 will strengthen the leading position of the French research on the issue of adaptation to climate change in the wine industry. Therefore, the LACCAVE steering board should encourage participants to publish their disciplinary works in international journals, but also collective and multidisciplinary studies in high rank peer review journals (not only for grapevine and wine sectors). LACCAVE 2.21 should also help the participants to establish more disciplinary projects and look for specific funding. The vision that the wine industry and our approach could be considered as a model study for adaptation to climate change should be promoted. More specifically, the studies on eco-climatic indicators, crop models to manage adaptation strategies, assessment tools for adaptation strategy in value chain and the set-up of low-inputs and climate change adapted systems should be considered as key point of interest. LACCAVE 2.21 will also contribute to the training of Master and pH-D students.
- *On the applied point of view*: LACCAVE 2.21 aims at delivering operational outcomes to help the stakeholders to define adaptation strategies at various levels of time and space. LACCAVE 2.21 participants will work with the objective that the wine industry may define at the national level an action plan to cope with climate change. At regional and local scales, LACCAVE 2.21 will work with R&D institutes to support the implementation of adaptation strategies. Expertises taking into account the complexity of several key issues related to climate change and adaptation, indicators, outcomes of crop models, specific cropping systems will be delivered. In addition, participatory approaches will allow the orientation of specific studies in order to better meet the requirements of the actors and also the improvement of the appropriation of expertises, tools and innovations by the final users.

- **Stakeholders**: LACCAVE 1.0 contributed largely to improve the awareness of stakeholders for climate change. Consequently LACCAVE 2.21 will closely associate them at various levels of the project. France Agri-Mer, INAO, APCA, IFV will be partners in the different tasks. More specifically, WP3 will be based on participatory actions at different levels (WP3-1: national, WP3-2: estate and landscape, WP3-3: individual for the Innovation platform).

- **Dissemination strategy**: Dissemination will be follow up by the steering board. Aknowledgments to LACCAVE 2.21 and ACCAF will be requested for any communication. A logo will be designed to improve the visibility of the project. Outcomes of the project will be disseminated through different ways. In WP1, each topic will deliver an expertise work as a book, review, policy paper or student reports. Scientific and extension journals (or edition) will be targeted. Among others, the LACCAVE website will be used for scientific dissemination and the Innovation Open Platform for applied results and innovation. A communication plan should be defined in collaboration with the CSA booster project. SAFE climate services portal will be fueled with eco—indicators and outputs of models delivered by WP2.2. Communications in national and international conferences by the participants will be monitored and participants will be asked to launch their presentation on LACCAVE website.

Answer to reviewers' comments

Explain how you have taken into account the comments of the reviewers in this new version of the proposal.

Articulation of WP2 with the rest of the project should be strengthened: WP2 will highly interact with other WPs in several ways. In order to better define the set of indicators to be calculated using the APC platform (WP2-1), a participatory workshop will be organized in collaboration to WP1 and WP3 participants with the specific goal to define of a set of indicators describing biotic or abiotic stresses. This "definition step" will be performed in close collaboration with ORACLE and ClimXX1 networks (APCA national projects). It has to be mentioned here that LACCAVE 2.21 has now included in its final proposal, the objectives of the HISTOVIGNE letter of intent which are to develop methods and set of indicators to characterize a posteriori the exposure level to biotic stresses and climate variability. Involved partners of HISTOVIGNE will be mainly associated to WP1.1 and 1.2 and to WP2.1. Globally this shared analysis will allow to take into account key processes and concerns regarding the climate evolution, and therefore providing information to sensitize stakeholders and producers about the development of strategies to adapt to climate change.

For WP2-2, WP1 participants will be specifically requested to identify possible technical levers which can affect the plant performances and to detail how these levers can mitigate the effects of climate change. This information will be integrated in a systemic modelling of the vine and grape development in WP2 as fully described p 22 of the present proposal. The projections made with different climatic scenarios could also help to define new ecoclimatic indices for which the targeted performance could be reached. Ultimately, optimization will be a way to find solutions that satisfy multiple constraints by combining the different levers (not considered individually). The optimization approach will possibly incorporate constraints on the use of pesticides (with the aim to reduce their use). It will also provide to WP3 a spatialized view of the main risks expected in the three studied regions.

WP4: Despite relationships exist between participants and foreign groups, there is no existing formal international network which could be ready to submit a proposal in 2018. Adaptation to climate change is a complicated issue, highly related to contextual parameters in each country. Extended exchanges are necessary to define common objectives and to establish a consortium with complementary skills in order to build a high-level proposal and increase the chances of success at PRIMA call. For that purpose, we will also request an additional support to INRA DARESE (founding dedicated to European projects preparation). Nevertheless we will be careful to other international calls (ERANET, ARIMNET). So far, we have not targeted a COST action. We previously submitted unsuccessfully an international networking application to ACCAF (Netvine in 2012) with the objective to launch a COST action. At this time this objective was not considered by reviewers as ambitious enough to be supported.

The budget has not been reduced for several reasons. First we included new activities related to the HISTOVIGNE letter of intent which had an initial budget of 30 k€. In the LACCAVE 2.21 the budget dedicated to this work (now merged with WP1-2 and WP2-1) has been reduced to 15.5 k€. Secondly LACCAVE 2.21 is based on many participatory approaches which will require numerous meetings and national/international travelling activities for the 19 funded partners and additional partners. For example, each topic in WP1 will receive only 1000 euros per year for meetings and travelling activities and 3600 euros only for a single Master student for the entire project. We also decided to manage funds collectively in order to use them more efficiently and to finance mainly networking activities and collaborative works among participants or additional partners. Only WP or task leaders will receive funds in 2018 and the steering board will decide how to share them for the following years. Important co-funding has already been gathered to support additional activities related to LACCAVE 2.21. In case ACCAF funding should be reduced towards the end of the project, other sources of funding will be requested.

Letter of Intent : LACCAVE 2.21

Assessment of the project by the head(s) of the unit(s) (DU)

P1: Unit: *EGFV*
Name : *Serge DELROT*

LACCAVE 2.21 is a follow-up project of the previous 4-year programme LACCAVE which was very successfully coordinated by Nathalie Ollat and Jean-Marc Touzard. It builds up on the past achievements made during LACCAVE, and needs to be extended given the long time frame needed to assess and to put into force possible solutions concerning the adaptation of a perennial plant like grapevine to climate change. The programme perfectly fits with the main lines of research of our laboratory, and through a multidisciplinary and traversal approach, it addresses a very timely and economically important topic. It will be useful for the grape and wine industry, and allow to strenghten links between scientitsts and socio-professional structure. This should pave the way and favor the preparation of projecst at the European level.

Signature :

P2 : Unit: UMR INNOVATION
Name : TOUZARD Jean-Marc (DUA, INRA)

This project addresses three challenges: i) to continue the work begun with LACCAVE by promoting a global and multidisciplinary approach adaptation to CC in the wine industry ; ii) to offer new scientific perspective by focusing on both the co-design of innovative production systems and the management of usefull information to users; iii) to open new collaboration in order to launch an ambitious international project. The UMR Innovation is fully involved in this project (at least 3 researchers) with contributions in social science and innovation studies. The project will be strategic for our unit, because the wine sector is considered as a model to produce generic knowledge on innovation for adaptation to CC.

Signature :

P3: Unit: *US 1116 Agroclim*

Name : *Marie Launay, directrice adjointe*

Favorable opinion

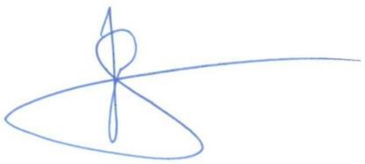
Signature :

P6: Unit: *UMR SPO*

Name : *Sablayrolles Jean-Marie*

Favourable opinion

Signature :



P7 : Unit: *USC1366*

Name : *Pr Philippe DARRIET Unité de recherche Œnologie, USC 1366 INRA (CEPIA)*

Validation for implication of USC 1366 members in the project

Signature :

P8: Unit: *UMR System*

Name: *Christian Gary*

UMR System is currently engaged in the participative design and assessment of agroecological (low pesticide) cropping systems in viticulture, in the framework of a national network of research and experimentation. The present project is an opportunity to explore levers of adaptation to climate change and introduce them into this design process, as agroecological vineyards should also be climate-smart and resilient.

Signature:

P10: Unit: *MOISA*

Name : *Paule Moustier*

This project that follows the previous LACCAVE Project in which Dr Hervé Hannin was also involved is very important for our Research Unit. I approve this current intent to go further on this research on Climate Change and its impact on Wine industry; the part concerning Moisa will be driven by Dr Hervé Hannin.

Signature :

P12: Unit: *LEPSE*

Name : *Bertrand Muller*

The 1st project LACCAVE has demonstrated the added value of an inter-disciplinary approach to tackle the intertwinned responses and adaptation of grapevine to climate change. Beyond a number of concrete scientific outcomes, it has set-up a community that now needs both some support to continue its animation through a set of research axes (this project) and a boost to be translated into more long-term (for instance H2020 based) funding. For our own research unit (LEPSE), LACCAVE will remain a key project since it allows the strong insertion of T Simonneau's group with other groups in genetics and modeling and perfectly aligns with the priorities of both the group and the research unit (analysis and modeling of genetic and agronomical responses of plant responses to climate change with a focus on drought and elevated temperature). I therefore strongly support the project and ensure that our Unit will continue to contribute through commitment of staff and access to facilities.

Signature :

P15: Unit: UEPR

Name : OJEDA Hernan

Favorable

Signature :

P16 : Unit UE Ferrade

Accord pour participation

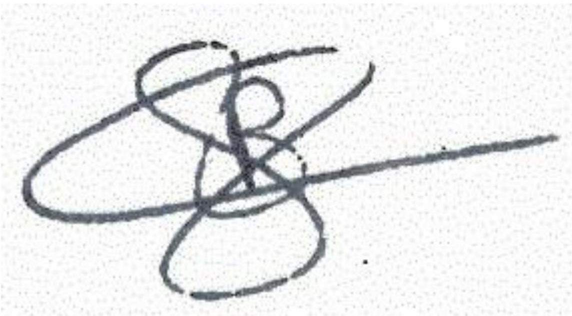
Signature :

P19 : Unit: *I2M*

Name : Batsale Jean-Christophe

Avis très favorable

Signature :



P22: Unit: ITAP

Name : Tewfik Sari

Avis favorable

Signature :

INRA
SCIENCE & IMPACT

"Adaptation of Agriculture and Forest to Climate Change" metaprogramme

Assessment of the project by the head(s) of the unit(s) (DU)

Unit: Unité Mixte de Recherche INRA Université de Strasbourg

UMR 1131 *SVQV (Santé de la vigne et qualité du vin)*

Name : *Frédérique Pelsy*

Assessment
Climate change is a main concern for French viticulture. Our research unit is already involved in deciphering grapevine genetic traits strongly influenced by environmental conditions. Thus, I give support to this project aiming at identifying the levers for potential adaptation to future climatic conditions.

Signature :

INRA
SCIENCE & IMPACT

"Adaptation of Agriculture and Forest to Climate Change" metaprogramme

Assessment of the project by the head(s) of the unit(s) (DU)

Unit: UMR AGAP

Name : Patrice This

I hereby support the participation of the Research Unit AGAP (UMR 1334, INRA /CIRAD/ Montpellier Supagro) to the LACCAVE 2.21 Project, and in particular, the team "Diversity, adaptation, breeding of grapevine (DAAV)".

DAAV, is a research team whose scientific project aim at the development of new grape cultivars, in particular cultivars more resilient to climate changes, and is therefore, running research activity directly related to the main objectives of LACCAVE 2.21 project.

I completely approved the participation to the LACCAVE 2.21 project.

Signature :

UMR 1334 AGAP
Cirad - Inra - Montpellier SupAgro
Amélioration Génétique et Adaptation des Plantes méditerranéennes et tropicales
CIRAD TA A-108/03 - Avenue Agropolis
34398 MONTPELLIER CEDEX 5 - FRANCE
http://umr-agap.cirad.fr

"Adaptation of Agriculture and Forest to Climate Change" metaprogramme

Assessment of the project by the head(s) of the unit(s) (DU)

Unit: *SAVE*

Name : *Denis Thiery*

Assessment

Analyzing drought impact on grapes and the consequences it has on pests is a major concern for future years. Understanding the mechanisms will certainly allow novel trends in grape protection and thus the reduction of pesticide use. This project is important for viticulture but also for the research conducted at INRA as a model system (both for INRA SPE and the research unit Save).

Signature :

Assessment of the project by the head(s) of the unit(s) (DU)

Unit: *MISTEA*

Name : *Pascal Neveu*

Assessment

Signature :

Assessment of the project by the head(s) of the unit(s) (DU)

Unit 1: *acronym*

Name : *name of the head of unit*

Assessment

Signature :

Unit 2: LISAH

Name : Jerôme MOLÉNAT

I fully approve the LISAH's involvement in this project

Le Directeur de l'UMR LISAH
J. MOLENAT

Signature :

Unit 3:

Name :

Signature :

Unit 4:

Name :

Signature :

"Adaptation of Agriculture and Forest to Climate Change" metaprogramme

Assessment of the project by the head(s) of the unit(s) (DU)

Unit: *Agroecologie*

Name : Philippe Lemanceau

P. LEMANCEAU
Directeur

Assessment
Favorable

Signature :

Assessment of the project by the head(s) of the unit(s) (DU)

Unit: *SEAV*

Name : *Lionel LEY*

Avis favorable

Signature :

Assessment of the project by the head(s) of the unit(s) (DU)

Unit: *Unité Expérimentale Domaine de Vassal*

Name : *Hernàn Ojeda*

Favorable

Signature :

Assessment of the project by the head(s) of the unit(s) (DU)

Unit: *Biogéosciences*

Name : *Emmanuel FARA*

I hereby support the participation of the Research Unit Biogeosciences (UMR 6282 UBFC/CNRS) to the LACCAVE 2.21 Project.

Three of our five research teams are currently running high-quality scientific research activities on the impact of climate change on vitiviniculture. This crucial initiative aims at bringing insights into the adaptation of vine and wine industry to climate change throughout the 21st century.

More specifically, our teams have developed skills and scientific expertise in research areas that are directly related to climate change and vitiviniculture, namely:

- *the Climate Research Center (CRC) is currently analysing the relationship between climate change and grapevine pests and diseases in Northern France. CRC is an internationally-recognised research group that studies climate change and its impact using dynamic modelling, field measurements and spatial analyses.*
- *The SEDS research group is currently working on the contribution of soils to greenhouse gas emissions by evaluating the transfer of carbone within the Critical Zone.*
- *The ECO/EVO group is working on grape moth / grapevine interactions and is currently addressing the consequences of warmer temperatures on these ecological relationships.*

I am convinced that the contribution of Biogeosciences will provide a major and relevant added value to the LACCAVE 2.21 program and I therefore fully support the participation of our research unit to LACCAVE 2.21

Signature :

Pr. Emmanuel Fara
Head of the Biogéosciences Research Unit
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21000 Dijon
emmanuel.fara@u-bourgogne.fr
http://biogeosciences.u-bourgogne.fr/en/

Assessment of the project by the head(s) of the unit(s)

Unit: *UMR6554LETG*

Name : *Françoise Gourmelon*

Assessment

Signature :

UMR 6554 LETG CNRS
IUEM
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29280 PLOUZANÉ
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Annex 1 :

Demande de bourse de thèse

Dossier de proposition de sujet de thèse

Déposée sur site Darese

En même temps que la soumission de la demande de projet dans l'application Darese, les directeurs d'unité ou leur représentant y attachent ce formulaire.

<table>
<tr><td>Centre INRA</td><td colspan="2">Montpellier</td></tr>
<tr><td rowspan="2">Unité</td><td>Codique</td><td>1230</td></tr>
<tr><td>Intitulé</td><td>UMR System</td></tr>
<tr><td>Titre de la thèse*</td><td colspan="2">Co-construction et évaluation de scénarios de gestion technique des paysages viticoles adaptés au changement climatique</td></tr>
<tr><td colspan="3">Résumé (10 – 15 lignes)</td></tr>
<tr><td colspan="3">Le projet de thèse vise à explorer l'hypothèse selon laquelle la combinaison d'interventions aux échelles de la parcelle et du paysage donne des marges de manœuvre significatives pour adapter une culture pérenne comme la vigne au changement climatique. Dans un bassin versant, les acteurs de la viticulture et de la gestion de l'eau seront mobilisés dans une procédure de conception-évaluation de scénarios d'adaptation et de leurs critères d'évaluation. Une chaîne de modèles produira les indicateurs rendant compte des impacts du changement climatique sur la durabilité et la résilience de cet agroécosystème. Cela permettra une évaluation intégrée des scénarios d'adaptation par les acteurs. C'est dans la combinaison des échelles (impliquant le couplage des modèles) et des méthodes de conception (par simulation et participative) que réside l'originalité du projet. La thèse s'inscrit dans le projet Laccave 2, et elle s'appuiera sur l'expertise et les réseaux que les équipes encadrantes mobilisent dans différents projets en cours.</td></tr>
<tr><td colspan="2">Projet proposé à un métaprogramme ? si oui, lequel ? ⇨
Si oui, intérêt pour le métaprogramme (1/2 page max) ⇩</td><td>ACCAF</td></tr>
<tr><td colspan="3">Ce projet de thèse s'inscrit dans le projet Laccave 2 (Towards integrated and resilient systems to cope with climate change for the grape and wine industry) soumis à l'appel à manifestation d'intérêt 2017 du méta-programme Accaf. Le projet Laccave 2 vise à développer des stratégies d'adaptation de la viticulture au changement climatique, en s'appuyant sur des approches systémiques et sur des méthodes participatives avec les acteurs de la filière. La thèse contribuera en particulier au WP3 du projet (Towards a national adaptation strategy and co-construction of resilient production systems) qui doit produire une méthode de conception participative de systèmes viticoles qui soient durables et adaptés au changement climatique. Cette méthode, mise au point sur un site atelier, doit être générique de manière à pouvoir être étendue à différents bassins viticoles pour produire des scénarios de changement technique adaptés aux conditions locales.
Comme le projet Laccave 2, cette thèse contribuera au 1er objectif de l'AMI 2017 en étant consacrée à la conception de systèmes de culture et de paysages agricoles plus résilients et adaptés à de nouvelles conditions climatiques. Elle mettra en œuvre une approche multi-échelles (parcelle, exploitation agricole et paysage) et explorera des scénarios basés sur la diversification (par exemple l'introduction de cultures de service dans les vignes) à ces différentes échelles. Conformément au 2ème objectif de l'AMI 2017, la co-construction de scénarios d'adaptation donnera des références pour l'action aux parties prenantes mobilisées. Enfin, elle contribuera à alimenter le portail de services CC-SAFE (4ème objectif de l'AMI).</td></tr>
<tr><td colspan="3">Champs Thématiques du (des) département(s) concerné(s)</td></tr>
<tr><td colspan="3">CT1 : Agronomie des systèmes agricoles
CT4 : Physique et écologie des paysages</td></tr>
<tr><td colspan="3">Enjeu(x) transversal(aux) du (des) département(s) concerné(s) :
Si le département a défini des enjeux structurants, des défis ou des programmes dans son SSD, les indiquer ici</td></tr>
</table>

EnjS5 : Evaluation, conception et pilotage de systèmes agricoles multi-performants OO4. Mettre en œuvre une démarche d'évaluation et de conception multi-échelles de systèmes agricoles basés sur la diversification des cultures FS4. Développer les méthodes d'invention et de conception des systèmes agricoles, qu'elles soient expérimentales, mathématiques, participatives, combinant des connaissances de nature diverse EnjS3 : Gestion, protection et restauration des ressources air, eau et sol OO2. Développer les approches de gestion intégrée des milieux et de leurs ressources naturelles afin d'optimiser leur usage agricole tout en préservant, voire restaurant, leur qualité et les services écosystémiques qu'ils procurent FS3. Comprendre et prédire l'évolution des ressources en fonction des changements climatiques et anthropiques

** Le titre doit pouvoir être publié sur le site web du département et d'autres supports de communication pendant le déroulement de la thèse, sauf exception dûment argumentée*

Financement envisagé

Financement(s) demandé(s) ou acquis (préciser l'organisme détenteur du co-financement si non INRA)		
Département INRA sollicité ou structure sollicitée (MétaP, autre)	**Statut du financement : acquis ou demandé**	**% de financement concerné**
Métaprogramme Accaf	demandé	25-50%
Département EA	demandé	0-25%
Région Occitanie	à demander en décembre 2017	50%

Encadrement

Responsable(s) de la thèse	Christian Gary (UMR System)	**HDR ?** *(O/N)*	O
Directeur(s) de la thèse (si différent du(des) responsable(s)	Laurent Prévot (UMR Lisah) Laure Hossard (UMR Innovation)	**HDR ?** *(O/N)*	N N
Nombre de doctorants dirigés actuellement par le(s) responsable(s) de la thèse	2	**Nombre de post-docs ou CDD dirigés actuellement par le(s) responsable(s) de la thèse**	1

Liste de 5 publications récentes du (des) responsable(s) de la thèse, en rapport avec le projet proposé
Delmotte S, Couderc V, Mouret JC, Lopez-Ridaura S, Barbier JM, Hossard L, 2017. From stakeholders narratives to modelling plausible future agricultural systems. Integrated assessment of scenarios for Camargue, Southern France. European Journal of Agronomy, 82, 292-307. Galleguillos M, Jacob F, Prévot L, Faúndez C, Bsaibes A, 2017. Estimation of actual evapotranspiration over a rainfed vineyard using a 1-D water transfer model: a case study within a Mediterranean watershed. Agricultural Water Management, 184, 67-76. Mailly F, Hossard L, Barbier JM, Thiollet-Scholtus M, Gary C, 2017. Quantifying the impact of crop protection practices on pesticide use in wine-growing systems. European Journal of Agronomy, 83, 23-34. Montes C, Lhomme JP, Demarty J, Prévot L, Jacob F, 2014. A three-source SVAT modeling of evaporation: application to the seasonal dynamics of a grassed vineyard. Agricultural and forest Meteorology, 191, 64-80. Rapidel B, Ripoche A, Allinne C, Metay A, Deheuvels O, Lamanda N, Blazy JM, Valdés-Gómez H, Gary C, 2015. Analysis of ecosystem services trade-offs to design agroecosystems with perennial crops. Agronomy for Sustainable Development, 35, 1373-1390.

Université d'inscription de l'étudiant en thèse	Montpellier SupAgro
Ecole doctorale	GAIA
Composition prévue du comité de thèse *(nom, laboratoire)*	• Membre 1 : Marc Corbeels (UR Aida) • Membre 2 : Jacques Wery (UMR System) • Membre 3 : Guillaume Martin (UMR Agir) OU Jean-Marc Blazy (UR Astro) • Membre 4 : Marie Thiollet-Sholtus (UMR Aster) OU Jean-Marc Barbier (UMR Innovation) • Membre 5 : Delphine Leenhardt (UMR Agir)

Description du projet (4 pages maximum)

Enjeux socio-économiques et scientifiques auxquels répond le projet

Le changement climatique est identifié comme un défi pour la viticulture, avec des impacts déjà observables sur la précocité, le volume et la qualité des récoltes. Les effets d'élévations de teneur en CO_2, de température et de changements de régime pluviométrique sur la physiologie et la production de la vigne sont maintenant bien identifiés (Jones et al., 2005 ; van Leeuwen et Darriet, 2016). Les effets sur la filière ont également été analysés (Ollat et al., 2016). Une prospective récente[1], conduite dans le cadre du projet Laccave (www6.inra.fr/laccave), a permis d'identifier plusieurs trajectoires possibles de la filière. Il en ressort globalement que le statu quo conduirait à un repli de la filière, tandis que des combinaisons d'innovations techniques et organisationnelles seraient susceptibles de permettre une adaptation.

Certains auteurs considèrent que le changement climatique conduira certainement à un déplacement massif des zones de production viticoles vers les latitudes élevées (Hannah et al., 2013). D'autres tempèrent cette conclusion en arguant des nombreux leviers d'adaptation dont dispose la filière pour permettre aux régions viticoles actuelles de perdurer (van Leeuwen et al., 2013). Cette controverse témoigne d'un enjeu scientifique majeur autour des marges de manœuvre offertes par la gestion des systèmes viticoles, à différentes échelles, pour s'adapter aux évolutions du milieu physique.

Le projet Laccave a permis d'identifier une large gamme de leviers d'adaptation[2]. Il reste à définir les règles d'assemblage de ces leviers d'action, en combinant plusieurs échelles d'intervention selon les points de vue des différents acteurs concernés. Il reste également à développer les outils d'évaluation intégrée (i.e., multi-critère) de ces scénarios de changement technique pour l'adaptation au changement climatique.

Etat de l'art scientifique – Originalité du projet

Il est prévisible que l'influence du changement climatique sur la production viticole se fasse principalement via l'augmentation des températures, et par l'augmentation et l'intensification des périodes de stress hydrique. Plusieurs voies d'adaptation de la viticulture, non exclusives entre elles, sont envisageables : adoption de cépages plus tardifs et plus tolérants au stress hydrique, modulation des modalités de travail du sol pour favoriser l'infiltration de l'eau, irrigation, voire des changements de localisation des vignobles dans le paysage (Ollat et al., 2016). Quelles que soient les adaptations envisagées, leur évaluation doit prendre en compte de manière détaillée la situation des parcelles dans le paysage : épaisseur et type de sols conditionnant la réserve utile (Galleguillos et al., 2017), présence ou non de nappes superficielles pouvant contribuer à l'alimentation hydrique de la vigne (Guix-Hébrard et al., 2007), distance aux sources d'eau et débit de ces sources pour l'irrigation. En termes de conséquences environnementales, l'évaluation de l'effet de nouvelles pratiques et de leur distribution spatiale doit être conduite à l'échelle du bassin versant, tant en termes de quantité d'eau ruisselée (Colin et al., 2012), de recharge des nappes (Dagès et al., 2009) qu'en termes de contamination des eaux par les pesticides (Crabit et al., 2016). Enfin, en termes de production viticole, l'évaluation doit être faite à l'échelle de l'exploitation agricole et du bassin de collecte (coopérative par exemple).

A notre connaissance, il n'existe que très peu d'études couplant les processus en termes de gestion technique, de fonctionnement hydrique et de production viticole, de l'échelle de la parcelle à celles de l'exploitation agricole et du bassin versant. Dans le cadre du projet SP3A (Andrieux et al., 2014 ; Paré, 2011), le chainage de modèles de décision, d'évolution des états de surface, de bilans hydrique et azoté, et d'un modèle hydrologique a été réalisé, mais les auteurs soulignent le besoin de passer à un couplage de ces modèles, avec rétroactions entre eux, ce qui permettrait de mieux adapter les itinéraires techniques simulés aux conditions hydriques. En effet, la gestion adaptative du fonctionnement hydrique des parcelles viticoles est nécessaire à la réalisation de compromis durables entre production viticole et impacts environnementaux (Ripoche et al., 2011).

La conception de systèmes de culture et de systèmes agricoles s'appuie sur plusieurs approches, basées soit sur l'optimisation mathématique, soit sur l'exploration et l'évaluation d'un espace de solutions (Martin et al., 2013). La 2ème voie peut mobiliser des connaissances scientifiques sous forme de modèles (conception par simulation, Bergez et al., 2010), ou combiner connaissances scientifiques et expertes à travers des approches participatives (Rapidel et al, 2009). Si une

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[1] http://www6.inra.fr/laccave/content/download/3256/32764/version/1/file/N40_A4-Prospective%20Vin%20et%20Vigne.pdf

[2] https://colloque.inra.fr/climwine2016

formalisation des connaissances est nécessaire à leur partage dans les approches participatives (modèle conceptuel, jeu de rôles, etc.), la mobilisation de modèles de simulation est moins courante (Delmotte et al, 2013).

L'originalité du projet de thèse réside dans (1) le couplage des échelles parcelle, lieu des actes techniques, exploitations agricoles où sont décidés et coordonnés ces actes, et bassin versant, où s'expriment leurs conséquences environnementales, et (2) le couplage de méthodes de conception participative et de simulations à l'aide de modèles, en considérant plusieurs niveaux d'intégration.

Question de recherche proposée au candidat

La combinaison de changements techniques à la parcelle, et de leur distribution dans le paysage en réponse aux stratégies des exploitations viticoles, peut-elle contribuer à l'adaptation de la viticulture au changement climatique ?

Hypothèses de travail

1- Dans un territoire, la co-construction de scénarios d'adaptation par les acteurs en charge de la production viticole et de la gestion de l'eau permet d'identifier leurs contraintes, leurs objectifs, et les leviers d'action mobilisables, à différentes échelles, pour l'adaptation au changement climatique.

2- Le couplage de modèles et d'indicateurs rendant compte (i) du fonctionnement des cultures, (ii) du fonctionnement des composantes biophysiques du paysage (sols, eau) et (iii) de la distribution spatiale et de la dynamique des pratiques culturales permet d'évaluer la durabilité et la résilience des systèmes viticoles face au changement climatique.

3- La combinaison de changements techniques à la parcelle et de changements dans leur distribution spatiale dans le paysage donne des marges de manœuvre supplémentaires pour adapter la viticulture au changement climatique.

Matériel nécessaire (disponible et/ou à produire), et méthodes envisagées

Conception de systèmes agricoles

La thèse mettra en œuvre une approche participative de la conception, pour construire et d'évaluer, de manière itérative, des scénarios d'adaptation des systèmes viticoles au changement climatique. Afin de réaliser ses objectifs, elle devra être multi-échelle (parcelle, exploitation agricole, bassin versant) et multi-critère, avec un focus sur les performances productives et environnementales et sur leur stabilité (résilience) en situation de changement climatique. Les équipes d'encadrement mobiliseront le savoir-faire méthodologique acquis dans le domaine de la conception-évaluation participative de scénarios sur différents terrains (Delmotte et al., 2013, 2016 ; Lafond et Metral, 2015 ; Rapidel et al., 2009) notamment en intégrant la composante du changement climatique (Delmotte et al., 2017). Les indicateurs d'évaluation seront définis avec les acteurs du territoire, et quantifiés par la simulation des différents scénarios co-construits, sous contrainte de scénarios climatiques issus des projections du GIEC.

Modélisation

A l'échelle de la parcelle, plusieurs modèles simulant le fonctionnement hydrique de la vigne sont disponibles et ont été testés avec succès. Le modèle WaLIS (Celette et al., 2010) a été conçu pour simuler le partage de l'eau entre la vigne et l'enherbement. Le modèle de transferts hydriques Hydrus-1D, adapté à la vigne, a permis la simulation des flux hydriques sur un ensemble de parcelles (Galleguillos et al., 2017). Un modèle SVAT multi-sources a été spécifiquement développé pour le cas des vignes enherbées (Montes et al., 2014). L'aptitude du modèle STICS-vigne à représenter des situations pédologiques variées été récemment vérifiée (Meyer, 2016) en contexte languedocien.

La plateforme logicielle OpenFLUID (Fabre et al., 2013) est dédiée à la modélisation du fonctionnement des paysages complexes et est principalement focalisée sur les flux. Elle propose une représentation topologique de l'espace sous forme d'unités spatiales connectées et un système de couplage de modèles, dans l'espace et dans le temps. Le couplage entre le modèle hydrologique distribué MHYDAS (Moussa et al, 2002) et le modèle décisionnel de pratiques d'entretien des sols Dhivine (Martin-Clouaire et al., 2016) a déjà été réalisé sous la plateforme OpenFLUID, permettant l'expérimentation virtuelle de pratiques culturales à l'échelle de petits bassins versants (Paré, 2011).

Etude de cas

La thèse sera centrée sur une étude de cas, pour laquelle plusieurs bassins versants candidats sont envisagés :

- le bassin versant viticole de Roujan (1 km²) fait l'objet d'un suivi hydrologique et des pratiques depuis 25 ans dans le cadre de l'ORE OMERE ;
- la basse vallée de la Peyne (80 km²), bassin versant viticole englobant du bassin versant de Roujan, pour lequel une caractérisation détaillée des sols existe (Coulouma, 2008), a fait l'objet de

travaux à l'échelle de la petite région : spatialisation de pratiques viticoles (Biarnes et al., 2009), estimation spatialisée de la consommation en eau de la vigne (Galleguillos et al., 2011), spatialisation des nappes superficielles (Guix et al., 2007, Taylor et al. 2013) ; la Peyne est l'un des sites test des projets ANR ALMIRA et RUEdesSOLS ;
- le bassin du Rieutort, localisé en grande partie dans la plaine viticole héraultaise, en bordure des premiers contreforts du massif central, s'étend sur 45 km^2, dont 15,4 km^2 sont consacrés à la culture de la vigne (projet SP3A, aire de captage d'alimentation en eau potable, captage « Grenelle »).
Les critères de choix seront : la présence d'acteurs concernés par l'adaptation au changement et la gestion de l'eau, et la documentation du bassin versant (nature des sols, occupations des sols, composantes du bilan hydrologique…).

Programme de recherches

Tâche 1. Co-construction de scénarios d'adaptation au changement climatique et d'indicateurs d'évaluation par les acteurs de la production viticole et de la gestion de l'eau dans un bassin versant

Cette tâche définira les scénarios de changement technique à différents niveaux d'intégration (parcelle, exploitation agricole, bassin versant) et les indicateurs nécessaires à leur évaluation en termes de durabilité et de résilience.
Elle produira en particulier :
- un cadre conceptuel partagé entre les différents acteurs, structurant les relations entre les enjeux de l'adaptation de la viticulture au changement climatique et les leviers d'action mobilisables à différentes échelles (ex. diagrammes ARDI, Etienne et al., 2011) ;
- plusieurs scénarios d'évolution des systèmes techniques (parcelle, exploitation agricole) et de leur distribution dans le bassin versant ;
- un ensemble d'indicateurs d'évaluation de ces scénarios, en termes de durabilité environnementale (impacts quantitatifs et qualitatifs sur la ressource en eau), économique (production viticole) et sociale (acceptabilité des changements techniques) et en termes de résilience (variabilité interannuelle des indicateurs de durabilité).
Une attention particulière sera portée à la ressource en eau dont l'approvisionnement peut être subi (impact du changement climatique sur la distribution interannuelle et inter-saisonnière des pluies) ou maîtrisé via l'irrigation avec des conditions d'accès et de volume variables selon la source (adduction d'eau, forages, retenues collinaires, etc.).

Tâche 2. Modélisation couplée des systèmes biophysiques et techniques, de la parcelle au paysage

Le focus mis sur la ressource en eau oblige à un couplage étroit des échelles de la parcelle et du bassin versant, en considérant les dimensions biophysiques et techniques des systèmes de culture. Cette tâche s'appuiera sur la plate-forme OpenFLUID (Fabre et al., 2013) qui permet de spatialiser l'occupation du sol et la circulation de l'eau dans le paysage. Des avancées sont attendues sur deux points :
- le couplage de modèles de bilan hydrique à la parcelle et d'élaboration du rendement de la vigne, en s'appuyant sur les relations récemment établies entre état hydrique et composantes du rendement (Guilpart et al., 2014) ;
- le couplage d'un générateur d'itinéraires techniques avec les modèles de culture et hydrologiques, en étendant le modèle Dhivine (Martin-Clouaire et al., 2016) des pratiques d'entretien du sol à l'ensemble des pratiques culturales liées au fonctionnement hydrique et à l'élaboration du rendement des parcelles viticoles.
Une attention particulière sera portée (1) aux impacts du changement climatique (température et pluviométrie) sur la vigne et le fonctionnement hydrologique et (2) aux impacts spécifiques des pratiques d'adaptation au changement climatique (dont l'irrigation) sur les itinéraires techniques viticoles.

Tâche 3. Evaluation intégrée de scénarios d'adaptation au changement climatique dans un bassin versant dominé par la viticulture

Les modèles de simulation permettront de produire les indicateurs d'évaluation des scénarios de changement technique. On considérera non seulement la valeur moyenne de ces indicateurs mais également leur variation inter-annuelle, au regard des variations prédites (et des incertitudes associées) par les modèles climatiques (ex. Bregaglio et al., 2017). La résilience pourra être évaluée dans différents domaines : agroécologique (capacité de l'agroécosystème à résister à des perturbations), technique (capacité du système technique à compenser les effets des perturbations) et paysagère (capacité de l'organisation spatiale des pratiques à atténuer les effets des

perturbations).
La sensibilité des différents indicateurs aux différents leviers techniques sera évaluée aux différentes échelles considérées. Cela nécessitera d'identifier des approches exploratoires sur différentes leviers (gammes variétales pour la vigne et l'enherbement, seuils d'irrigation, etc.). Il est important que les compromis éventuels entre différentes échelles soient identifiés (par exemple, des actions favorables au niveau local mais défavorables à l'échelle supérieure).
L'ensemble de ces indicateurs et analyses sera mobilisé dans la procédure de protypage pour être évalué par les acteurs de la viticulture et de la gestion de l'eau, au regard des objectifs sur lesquels ils se seront accordés dans la tâche 1.

Calendrier

Tâche/Mois	6	12	18	24	30	36
Comité de suivi	x		x		x	
Tâche 1	▒	▒	▒			
Publication 1				▒		
Tâche 2		▒	▒	▒		
Publication 2					▒	
Tâche 3				▒	▒	
Publication 3						▒
Rédaction de la thèse						▒

Publications envisageables

Publication 1 : Co-construction de scénarios d'adaptation de la vigne au changement climatique.

Publication 2 : Intégration d'un modèle d'itinéraires techniques, d'un modèle de culture et d'un modèle hydrologique dans une plateforme de modélisation des flux dans le paysage agricole.

Publication 3 : Evaluation de scénarios d'adaptation de la vigne au changement climatique en bassin versant Méditerranéen.

Compétences cognitives et techniques acquises par le doctorant

Conception participative de systèmes de culture

Modélisation couplée de différents processus, à différentes échelles spatiales

Gestion de projet

Publication et communication scientifique

Partenariat scientifique et industriel dans lequel s'inscrit le travail

Les partenariats scientifiques s'appuieront sur différents projets de recherche :

- ACCAF Laccave 2 *Towards integrated and resilient systems to cope with climate change for the grape and wine industry*, en particulier WP1 (*development of integrated expertises to manage adaptation*) et WP2 (*tools for adapting viticulture: ecoclimatic indicators and models*);

- ANR TransMed ALMIRA (2014-) *Adaptation des mosaïques paysagères dans les agrosystèmes pluviaux méditerranéens pour une gestion durable de la production agricole, des ressources en eau et en sol ;* ce projet met notamment en œuvre des simulations à l'aide du modèle SWAT, dans des scénarios climatiques et d'occupation du sol régionalisés, sur 3 sites en Tunisie, Maroc et France (basse vallée de la Peyne) ; la plateforme OpenFLUID sera utilisée pour des simulations plus fines sur le bassin versant de Roujan ;

- ANR RueDesSols (2015-) *Estimation de la Réserve Utile en Eau des sols par mesures directes et inversion de modèles de cultures, à l'échelle de la parcelle agricole et du territoire* ; la basse vallée de la Peyne est l'un des sites de ce projet ;

- Arimnet 2 Semiarid (2017-2020) *Sustainable and Efficient Mediterranean farming systems: Improving Agriculture Resilience through Irrigation and Diversification* ; le projet vise à évaluer la résilience des systèmes agricoles méditerranéens en relation avec la diversité et la gestion de l'eau, dans un contexte de changement global.

Les partenariats avec les acteurs de la viticulture et de la gestion de l'eau dans le cadre des projets en cours seront valorisés.

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Candidat

Candidat pressenti (O/N)	N	**Nom, Prénom**	

Si le candidat est déjà connu, joindre un CV complet (études, diplômes, expériences professionnelles)

Autres informations (1/2 page maximum)

Avis du directeur d’unité

Avis du directeur de l’unité

1. **Priorité accordée au projet, en cas de demandes multiples**

Ce projet de thèse est prioritaire pour l’UMR System.

2. **Avis sur le projet scientifique**

Ce projet de thèse est une excellente opportunité d’assembler les compétences disponibles dans les UMR Lisah, Innovation et System pour conduire une évaluation intégrée de systèmes agricoles adaptés au changement climatique. Il bénéficiera d’une part de l’expérience de collaboration des trois unités et d’autre part de la dynamique du projet Laccave 2 (en cours d’évaluation par le métaprogramme ACCAF). Il permettra d’explorer un front de recherche sur l’articulation, dans une démarche participative, de différents niveaux d’intégration dans la conception de systèmes agricoles. Avec ces unités partenaires, l’UMR System développe son investissement sur ce front de recherche, en particulier en Méditerranée.

3. **Avis sur le candidat (si connu au moment du dépôt du projet)**

Date et nom du DU
2 octobre 2017, Christian Gary, DU de l'UMR System

Avis du directeur de l'unité

1. **Priorité accordée au projet, en cas de demandes multiples**

2. **Avis sur le projet scientifique**

Le projet contribue aux priorités scientifiques du LISAH en matière de conception et d'évaluation des pratiques culturales et des modes de gestion paysagère pour l'adaptation de l'agriculture aux changements globaux et à l'évolution de la disponibilité en eau que ces changements entrainent. Le sujet de thèse inscrit ces enjeux dans la viticulture et les paysages viticoles qui constituent des objets d'étude privilégiés des unités proposantes. Le travail proposé valorise la plateforme OpenFLUID et s'appuie sur l'observatoire OMERE. Cette demande de thèse va contribuer à renforcer les collaborations du LISAH avec des équipes INRA d'agronomes et de chercheurs spécialistes des processus d'innovation en agriculture, collaborations absolument nécessaires pour traiter les questions de définition, d'adaptation et d'évaluation des paysages cultivés face enjeux environnementaux, climatiques et de production agricole. Aussi je donne un avis favorable à cette demande de co-financement de thèse faite auprès du département EA et le MP ACCAF.

3. **Avis sur le candidat (si connu au moment du dépôt du projet)**

Date et nom du DU
2 octobre 2017, Jérôme Molénat, DU de l'UMR Lisah

Avis du directeur de l'unité

1. **Priorité accordée au projet, en cas de demandes multiples**

   Projet de thèse prioritaire auquel Laure Hossard de l'UMR innovation donnera tout son appui.

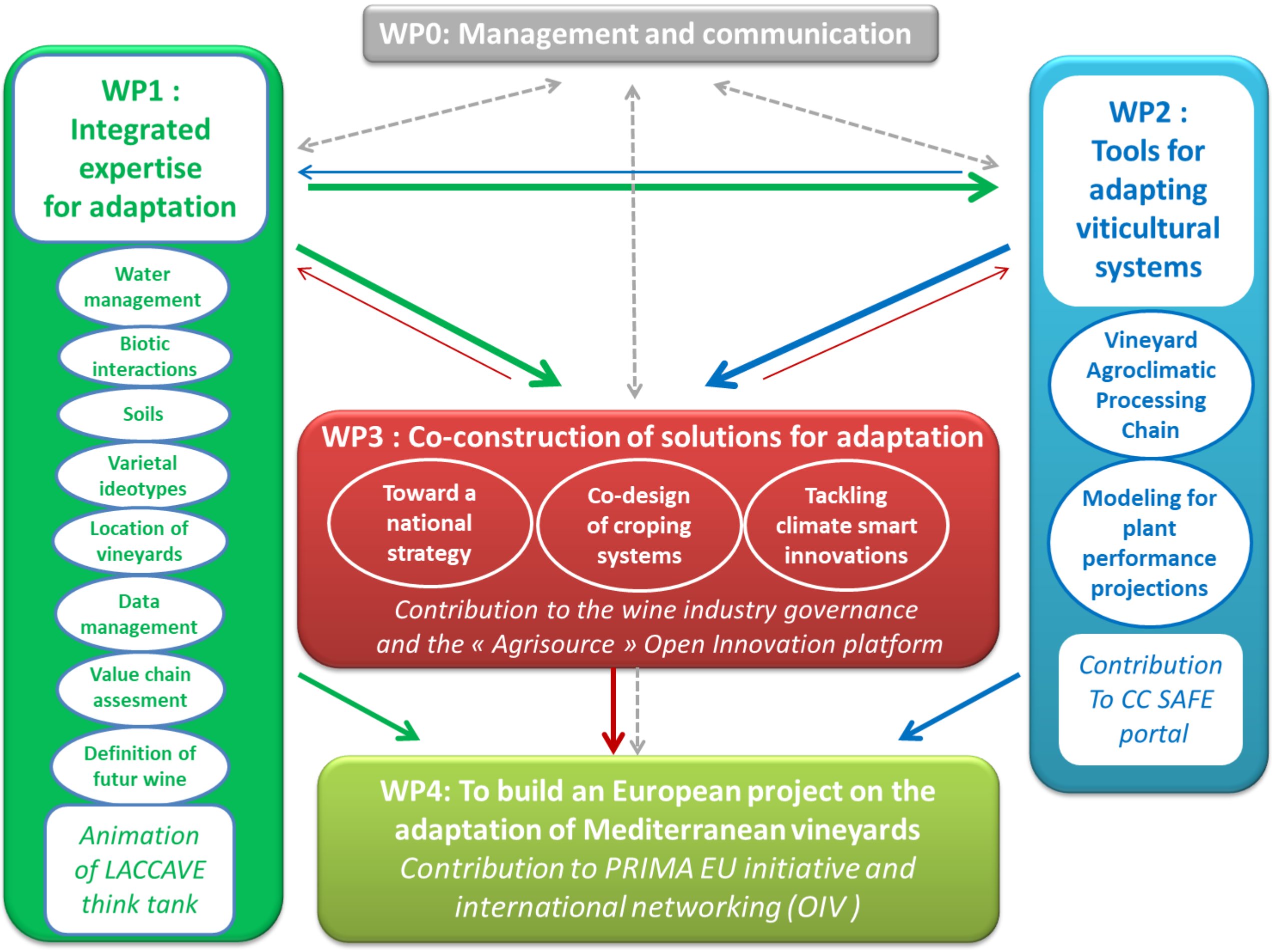
2. **Avis sur le projet scientifique**

Avis très favorable. Projet exemplaire dans sa construction collective en phase avec approche du MP ACCAF.

3. **Avis sur le candidat (si connu au moment du dépôt du projet)**

Date et nom du DU
02 octobre 2017, Jean Marc Touzard, DUA UMR Innovation

Annex 2 : Work flow of LACCAVE 2.21



Annex 3 **Milestones and deliverables**

WP and task	Milestones	Deliverables
WP0		
Organising the steering comittee	M1	
Organising the international advisory board	M1	
Data management plan	M1>M4	D1
Funding plan and procedure	M1>M4	D2
Communication plan	M1>M4	D3
Launching meeting	M4	
Report of the 1st meeting	M6	D4
Web site maintenance	monthly	D5
Annual financial plan	M5, M17, M29	D6
Steering committee meeting and reports	M3, M7, M13, M19, M25, M31	D7
Annual project meeting	M16, M28	
Communication activities	All through the project	D8
Data management activities	M3, M7, M13, M19, M25, M31	D9
Annual meeting reporting	M18, M30	D10, D11
Annual reports for ACCAF	M7, M19, M31	D12, D13, D14
Final report to ACCAF	M36	D15
ClimWine2021 organisation	M20>M34	
ClimWine 2021	M34	D16
ClimWine Proceedings	M36	D17
WP1		
Definition of topic objectives	M0	D18
Annual Meeting of topic groups and reports	M4, M16, M28	D19-topic nb, D20, D21
Workshops and training sessions on specific issues (one per topic) with reports	M7> M34	D22-topic nb
One Master student per topic with report	M18 or M30	D23-topic nb
At least :one production per topic (book, literature review, position papers, leaflets, scientific papers, teaching units)	M24 > M36	D24-topic nb
Methods for heterogeneous data management	M24	D25
Traits and methods for breeding	M24	D26
Varieties to evaluate	M24	D27
Definition of priorities for WP4	M7	
WP2		
Workshop to define the set of indicators	M1>M12	D28
Workshop to identify a list of	M1>M12	D29

submodels		
Coupling submodels with STICS	M12>M24	D30
Collecting data set and recommendations for new data sets	M12>M24	D31
Spatial computation of indicators	M12>M24	D32
Simulations with future climatic conditions with submodels coupled with STICS	M24>M36	D33
Four Master students and reports	M8>M14, M20>M26, M31>M36	D34, D35, D36, D37
WP3		
Meetings of the national group	M1>M12	
National Action Plan	M12	D38
Report/article about industry governance regarding CC	M24	D39
Methodological framework for designing climate-smart vine growing systems	M4>M12	D40
Identification of climate change constraints and available technical levers	M7>M18	D41
Scenario of technical changes in 3 case studies	M12>M24	D42
Ex-ante assessment of contrasted management scenarios with indicators of resilience and water balance models	M24>M36	D43
Ph-D defense and manuscript	M40	D44
Scientific articles	M24 and M30	D45
Implementation of the Open Innovation Platform	M1> M24	D46
Technical leaflets describing innovations	M4>M24	D47
Innovation workshop	M36	D48
WP4		
Contact with potential participants and list of partners	M1>M7	D49
Short missions with reports	M1>M10	D50
Workshop for project construction – Initial draft	M4 and M6	D51
Proposal writing and submission	M5>M10	D52
Report about adaptation to climate change in the Mediterranean vineyards	M15	D53
Launching of the project	M24	D54