Méta-programme ACCAF
AMI 2011

Méta-programme Adaptation au Changement Climatique de l'Agriculture et de la Forêt - MP ACCAF -

Appel à Manifestation d'intention 2011

Le projet complet devra être envoyé à l'adresse accaf@inra.fr Avant le 15/09/2011

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Méta-programme ACCAF
AMI 2011

META PROGRAMME ACCAF
COMPLETE PROJECT

Acronym of the project :	LACCAVE
Title of the project :	Long term impacts and adaptations to Climate Change in Viticulture and Enology

Coordinator

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Axes relevant to the proposal

☐Axis 1. Assessment and management of the medium-term risks and opportunities associated with climate variability and extreme weather

x Axis 2. Regionalised and sectoral projections and scenarios of the long-term impacts of climate change

x Axis 3. Long-term adaptation options

Length ☐ 24 months ☐ 36 months x 48 months

Keywords:

Climate change, grapevine, wine, viticulture, adaptation strategies, terroir, modelling, innovation, landscape, spatial organization, wine market, inter-regional competition, economic evaluation, quality, foresight study, capacity building, France

Abstracts: (1000 characters in arial 11)

Taking into account the economic importance of grape growing and wine industry in France, the specificities of viticulture with regard to climate change, technical innovation and special links, and the necessity of an multidisciplinary and global approach, the present proposal LACCAVE will investigate long-term climate change adaptation strategies and innovations for viticulture and wine production in France. LACCAVE objectives are 1)- to build modelling tools that predict the impact of climate change on viticulture, wine production and wine quality at regional level, 2)- to build and integrate the knowledge gained from different levels of study (climatic, biological, agronomical, environmental, economic and sociological) into models and management tools allowing to develop innovations, 3)- to propose adaptation scenarios and to evaluate their economic, sociological and environmental consequences. LACCAVE is based on the structuration and organization of the ongoing and new research activities developed by 22 teams with many different skills from 7 INRA departments.

Involved Teams (the first partner is the leader team)

Partner N°	Type (UMR, UR,...) and number of the unit	Acronym and name of the unit	INRA Research center	First name of the scientific leader of the team	Last name	email adress	Main research Field
1	UMR 1287	EGFV: Ecophysiology and Functional Genomic of Grapevine	Bordeaux	Nathalie	Ollat	ollat@bordeaux.inra.fr	Ecophysiology, Genomics and Genetics – Determinism of berry quality under changing environment
2	UMR 951	Innovation	Montpellier	Jean Marc	Touzard	touzard@supagro.inra.fr	Innovation, Economics and Sociology
3	UMR 6554	Laboratoire COSTEL	Rennes	Hervé	Quénol	herve.quenol@uhb.fr	Climatology
4	UE 1117	UVV : Grape and Wine Experimental Unit	Angers	Gérard	Barbeau	barbeau@angers.inra.fr	Terroir studies
5	UMR 1131	SVQV : Santé de la Vigne et Qualité du Vin	Colmar	Eric	Duchêne	duchene@colmar.inra.fr	Genetic, grapevine breeding
6	UMR 1330	ALISS : Alimentation et Sciences Sociales	Paris	Eric	Giraud-Héraud	giraud@ivry.inra.fr	Economics

7	**UMR 759**	**LEPSE: Laboratoire d'Etude des Plantes sous Stress Environnementaux**	**Montpellier**	**Thierry**	**Simonneau**	**simonnea@supagro.inra.fr**	**Control of plant growth and transpiration efficiency under water deficit and high temperature**
8	**USC 1320**	**GAIA : Gouvernance des Coopératives des Territoires, de l'Environnement et des Entreprises Agricoles**	**Bordeaux**	**Maryline**	**Filippi**	**m-filippi@enitab.fr**	**Economics and management**
9	**UMR 1334**	**AGAP : Amélioration génétique et adaptation des plantes méditerranéennes et tropicales**	**Montpellier**	**This**	**Patrice**	**this@supagro.inra.fr**	**Genetics, grapevine diversity and adaptation**
10	**UMR 1221**	**LISAH : Laboratoire d'études des interactions sol-agrosystème-hydrosystème**	**Montpellier**	**Philippe**	**Lagacherie**	**lagache@supagro.inra.fr**	**Soil Science hydrology Landscape modelling**
11	**UE 1057**	**Domaine expérimental de Vassal**	**Montpellier**	**Genna**	**Blaise**	**genna@supagro.inra.fr**	**Genetic ressource conservation**
12	**UMR 1048**	**SADAPT :**	**Paris**	**Geneviève**	**Teil**	**genevieve.teil@agroparistech.fr**	**Sociology Pragmatic sociology**

13	UMR 1219	Oenologie	Bordeaux	Philippe	Darriet	philippe.darriet@oenologie.u-bordeaux2.fr	Enology, biochemistry of aroma compounds
14	UE 0999	Pech-Rouge	Montpellier	Hernan	Ojeda	ojeda@supagro.inra.fr	Viticulture, Ecophysiology, Oenology, Biotechnology
15	UMR 1230	SYSTEM	Montpellier	Christian	Gary	gary@supagro.inra.fr	Agronomy
16	UE 1086	Experimental Unit of Bordeaux	Bordeaux	Dominique	Forget	forget@bordeaux.inra.fr	Wine production Integrated management
17	UMR 1083	Sciences for Oenology	Montpellier	Jean-Marie	Sablayrolles	sablayrolles@supagro.inra.fr	Enology, Biochemistry of polyphenolic compounds Microbiology
18	UMR 729	MISTEA: Mathématiques, Informatique et Statistiques pour l'Environnement et l'Agronomie	Montpellier	Pascal	Neveu	pn@supagro.inra.fr	Data and knowledge management, functional statistics
19	UMR 1110	MOISA : Marchés, Organisation, institutions et stratégies d'acteurs	Montpellier	Etienne	Montaigne	montaigne@supagro.inra.fr	Agrifood chain Economics
20	US 1116	AGROCLIM	Avignon	Iñaki	Garcia de Cortazar-	igarcia@avignon.inra.fr	Climatic and phenological

					Atauri		**data base – Crop models**
21	**UMR 1065**	**SAVE : Santé de l'agrosystème viticole**	**Bordeaux**	**Calonnec**	**Agnès**	**calonnec@bordeaux.inra.fr**	**Epidemiology, population genetics, integrated pest management**
22	**UMR 1208**	**IATE**	**Montpellier**	**Buche**	**Patrice**	**patrice.buche@supagro.inra.fr**	**Data and knowledge management**

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

P1	**Dai Z.W., Ollat N., Gomes E., Decroocq S., Tandonnet J.P., Bordenave L., Pieri P., Hilbert G., Kappel C., Van Leeuween C., Vivin P. and Delrot S**., 2011. Ecophysiological, genetic and molecular causes of variation in grape berry weight and composition. American Journal of Enology and Viticulture, 2011, doi: 10.5344/ajev.2011.10116 . **Dai Z.W., Vivin P., Robert T**., Milin S., Li S.H., Génard M., 2009. Model-based analysis of sugar accumulation in response to source-sink ratio and water supply in grape (Vitis vinifera) berries. Functional Plant Biology 36(6), 527-540. **Guillaumie S**., Mzid R., Mechin V., **Leon C., Hichri I., Destrac Irvine A., Trossat Magnin C., Delrot S., Lauvergeat V.,** 2010. The grape transcription factor WRKY2 influences lignin pathway and xylem development in tobacco. Plant Molecular Biology, 72 (1-2) : 215-234.**Pieri P.**, 2010. Modelling radiative balance in a row-crop canopy. Row–soil surface net radiation partition. Ecological Modelling, 221 : 791-801. **Marguerit E**., Boury C., Manicki A., **Donnart M.,** Butterlin G., Némorin A., Wiedemann-Merdinoglu S., Merdinoglu D., **Ollat N., Decroocq S.**, 2009. Genetic dissection of sex determinism, inflorescence morphology and downy mildew resistance in grapevine. Theoretical and Applied Genetics 118(7), 1261-1278. **Parker A**., Garcia De Cortazar Atauri I., **Van Leeuwen C**. and Chuine I., 2011. A general phenological model to characterise the timing of flowering and veraison of Vitis vinifera L. Aust. J. Grape Wine Res., 17, in press.
P2	**Chiffoleau Y., Touzard J.-M., 2011**. Analysing the relational structure of localized agrifood systems. *Agriculture and Human Values*. Vol 28, forthcoming **Barbier J.M., Bellon S., 2010.** Les transitions technologiques vers la protection intégrée et l'agriculture biologique en cultures pérennes. In « Le temps des SYAL. Techniques, vivres et territoires » ; J. Muchnik et C. de Sainte Marie eds ; éditions QUAE France ; pp 171-210. **Le Gal P.-Y., Mérot A., Moulin C.-H. Navarrete M., Wery J., 2009.** A modelling framework to support farmers in designing agricultural production systems. *Environmental Modelling & Software* , 25 (2) : 258-268 **Touzard J.-M., Coehlo A., Hannin H., 2008**. Les stratégies des coopératives vinicoles : Une analyse comparée à l'échelle internationale, *Bulletin de l'OIV*, vol 81, n°929-930-931, p. 381-404. **Chiffoleau Y, Dreyfus F, Stofer R, Touzard J.-M., 2007**. Networks, innovation and performance : evidence from clusters of wine co-operatives, In *Vertical Markets and Cooperative Hierarchies,* Karantinis K., Nilsson J. (eds), Copenhagen, Springer, p. 37-62
P3	Bonnefoy C., **Quénol H.**, Planchon O. et Barbeau G., 2010 : Températures et indices bioclimatiques dans le vignoble du Val de Loire dans un contexte de changement climatique. EchoGéo [En ligne], numéro 14 | 2010, http://echogeo.revues.org/12146. Briche E., **Quénol H.** et Beltrando G., 2011 : Changement climatique dans le vignoble champenois. L'année 2003, préfigure-t-elle les prévisions des modèles numériques pour le XXIe siècle ? L'Espace Géographique, 2/11, 164-175. Bonnardot V., Carey V., Madelin M., Cautenet S. and **Quénol H.**, 2011: Using atmospheric and statistical models to understand local climate and assess spatial temperature variability at fine scale over the Stellenbosch wine district, South Africa. International Journal of Vine and Wine Sciences. (soumis). **Quénol H.** and Beltrando G., 2008: Impact of a new railway line embankment (Mediterranean TGV) on the frequency of spring frosts in a fruit-growing area of the Durance Valley (south of France). Meteorological Applications, **15/3**, 389-398. **Quénol H**., Maciel A., Monteiro A. et Beltrando G., 2007 : Variabilidade espacial do gelo primaveril nos vinhedos do Vinho Verde (Portugal), Geografia, jan/avr 2007, **32/1**, 5−27.
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P6	Gatti, S., **Giraud-Héraud, E**., Mili, S. (2003), "Wine in the Old World : New Risks and Opportunities", 2003, *FrancoAngeli* (ed.), Milan, 240p. Chambolle, C., **Giraud-Héraud, E.** (2005), "Certification of Origin as a non-tariff barrier", *Review of International Economics*, 13 (3), pp 461-471. **Lecocq, S.**, T. Magnac, M.-C. Pichery et M. Visser (2005) "The Impact of Information on Wine Auction Prices: Results of an Experiment" *Annales d'Economie et de Statistique*, vol. 77, pp. 37-57. **Combris, P., Bazoche, P., Giraud-Héraud, E.**, Issanchou, S. (2009), "Food choices: What do we learn from combining sensory and economics experiments?", *Food Quality and Preference* , 20, pp 550-557. **Chevet, J.-M., Lecocq**, **S.**, M. Visser, M. (2011) "Climate, Grapevine Phenology, Wine Production and Prices: Pauillac (1800-2009)" *American Economic Review: Papers & Proceedings*, vol. 101, pp. 142-146.
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P10	Lebon E, **Dumas V**, Pieri P, Schultz HR (2003) Modelling the seasonal dynamics of the soil water balance of vineyards. Functional Plant Biology 60: 699-710 **Biarnès, A.; Bailly, J. & Boissieux, Y**. (2009), 'Identifying indicators of the spatial variation of agricultural practices by a tree partitioning method: the case of weed control practices in a vine growing catchment', Agricultural Systems 99(2-3), 105-116. **Galleguillos ,M., Jacob ,F., Prévot, L., French, A., Lagacherie, P**., 2011.Comparison of two temperature differencing methods to estimate daily evapotranspiration over a Mediterranean vineyard watershed from ASTER data Remote sensing of Environment, 115, 1326-1340 **Guix-Hébrard, N.; Voltz, M.; Trambouze, W.; Garnier, F**.; Gaudillere, J. & **Lagacherie, P**. (2007), 'Influence of watertable depths on the variation of grapevine water deficits at the landscape scale', European Journal of Agronomy 27, 187-196. **Lagacherie, P,. Rabotin, M., Colin, F., Moussa, R., Voltz. M.** (2010), Geo-MHYDAS: A landscape discretization tool for distributed hydrological modeling of cultivated areas, Computers & Geosciences, 36(8), 1021-1032. **Raclot, D.; Le Bissonnais, Y.; Louchart, X.; Andrieux, P.; Moussa, R. & Voltz, M**. (2009), 'Soil tillage and scale effects on erosion from fields to catchment in a Mediterranean vineyard area.', Agriculture, Ecosystems

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P13	**Schuttler A**., Gruber B.R., Lafontaine M., Stoll M., **Thibon C**. , Schultz H.R. **, Rauhut D., Darriet P.** 2011. Influence of environmental stress on secondary metabolite composition of *Vitis vinifera* var. Riesling grapes in a cool climate region – water status and sun exposure. Oeno 2011, 9^{e} Symposium International d’œnologie, 15-17 Juin, Bordeaux, Dunod ed. **Zott, K., Claisse, O., Lucas, P., Coulon, J., Lonvaud-Funel, A.**, 2010. Masneuf-Pomarede, I.Characterization of the yeast ecosystem in grape must and wine using real-time PCR, Food Microbiology 27 (5), 559-567. **Thibon, C., Dubourdieu, D., Darriet, P., Tominaga**, T. 2009. Impact of noble rot on the aroma precursor of 3-sulfanylhexanol content in *Vitis vinifera* L. cv sauvignon blanc and semillon grape juice. Food Chemistry 114 (4), 1359-1364. **Thibon, C; Shinkaruk, S; Tominaga, T**, et al., 2008, Analysis of the diastereoisomers of the cysteinylated aroma precursor of 3-sulfanylhexanol in *Vitis vinifera* grape must by gas chromatography coupled with ion trap tandem mass spectrometry, *J. Chromatogr. A,* 1183, (1-2), 150-157. **Pons, A., Lavigne V., Frerot E., Darriet Ph., Dubourdieu D**., 2008. Identification of volatile compounds responsible for prune aroma in prematurely aged red wines J. Agric. Food Chem., 56, 5285–5290.
P14	**Ojeda H**., Mestre Sanchis F., Corbacho L., Bouquet A., Carbonneau A. 2010. Reduction of cost and emissions in vineyards by the use of low-input technologies adapted to productions of good quality wines: genotypes resistant to fungal diseases and minimal pruning –zero pruning- system. *Progrès Agricole et Viticole*, 2010, N°21-22: 431-440. Etchebarne F., **Ojeda H**., Hunter JJ. 2010. Leaf:Fruit Ratio and Vine Water Status Effects on Grenache Noir (*Vitis vinifera*/ L.) Berry Composition: Water, Sugar, Organic Acids and Cations. S. Afr. J. Enol. Vitic. 31 (2): 106-115. Prieto J., Lebon E., **Ojeda H.** 2010. Stomatal behaviour of different grapevine cultivars in response to soil water status and air water vapour pressure deficit. *J. Int. Sci. Vigne Vin*. 44 (1): 9-20. Geraudie V., Roger JM., **Ojeda H**. 2010. Development of a tool allowing the prediction of grape maturity using near infrared spectroscopy. Australian and New Zealand Grapegrower and Winemaker, 557a: 10-16. Etchebarne F., **Ojeda H**., Deloire A. 2009. Influence of water status on mineral composition of berries in Grenache Noir (*Vitis vinifera* L). Vitis 48 (2): 63–68.
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Teams skills and complementarity

The present consortium gathers a wide range of expertise summarized below (P= partner) :

Genetic and plant breeding P1, P5, P9, P11
Ecophysiology and plant pathology: P1, P5, P7, P14, P21
Agronomy: P1, P4, P5, P7, P10, P14, P15, P16
Enology: P1, P13, P14, 16, P17
Climatology: P3, P1, P20
Modelling at different levels: from plant to systems : P1, P3, P7, P10, P15, P18, P20, P21
System studies : P10, P15
Terroir and landscape studies: P1, P4, P10, P12
Economics and management: P2, P6, P8, P19
Sociology and innovations: P2, P12
Statistics, mathematics and informatics, data base construction and management: P7, P10, P18, P20, P22

In the new version of the project, UMR Eco&Sols left the consortium because grapevine was not in its scientific priorities and was asked to focuse on other species. According to the reviewer's comments UMR SAVE has joined the project to include a crop protection expertise. Additionnally UMR IATE has joined the project to improve the data-management skills and cooperate with UMR MISTEA to WP6.

FUNDING

Please fill in the table enclosed with the details of the funding requested and report here the total amount : 450 000 €

Scientific justification of financial means : detail here the costs of equipment and subcontracting		
Equipment costs		
P4	Climatic measurement devices and sensors (WP1)	8 000 €
P7	Licor 6400 Gas Exchange Analyzer (WP2) to assess leaf photosynthesis and stomatal conductance. Co-funding has been requested in the 'EQUIPEX program'.	10 000 €
P20	Computers and climatic sensors for weather stations	4000 €
Subcontracting costs		
P5	Terpenol analyses by TwistAroma company (WP2)	12 000 €
P6	External office to organize the participation of consumers (1 per year, WP5)	8 000 €
P8	External office to organize the participation of consumers (1 per year, WP5), translation work	11 000 €
P12	Survey and 2 sessions with focus groups (WP1 and WP4)	15 500 €

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

Team	**Funder** **Note : These projects are partly related to LACCAVE**	**Amount**
P1	ANR + CTPS + Aquitaine Region	200 000 €
P4	Project GICC Teradclim	45 000 €
P7	ANR + CTPS + DISP'EAU	325 000 €
P9	ANR	300 000 €
P10		170 000 €
P13	CIVB	20 000 €
P17	UE (2008-2012)	697 000 €

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

Team	Funder Note : these projects are partly related to LACCAVE	Amount
P1	CIVB (WP1) Vitinext (WP2/WP3) Equipex Eve (WP2/WP3) KBBE (WP2)	140 000 € Under preparation 900 000 € (for a mobile vineyard rain shelter) Under preparation
P7	ANR (WP2)	167 000 €
P9	ANR (Investissements d'avenir, Vitinext) + INRA (MP selection génomique)	Under preparation
P17	ANR (Investissements d'avenir, Vitinext)	Under preparation
P20	ACCAF Pherpheclim ACCAF CAQ40	36 500 € 10 000 €

Thesis and post-doctoral contracts

It was decided to provide a description of all the theses necessary to implement the project. The strategy of co-funding is also presented. The subject **T1** will receive the grant from ACCAF.

THESIS : Complete description of the subject – 1 page max

Scientific objectives

T1: « Evolution of the characteristics of wine-related to Climate Change : consumers and producers can adapt ?»

The aim of this Ph-D is to analyze the effects of Climate Change on wine consumer behavior and consequently the adaptation of the wine producers, according to their regional location and to their involvement in marketing chains. The thesis will precise which characteristics of the wine, linked to climate change, can have economic consequences on the wine industry. The work will also contribute to the AOC issue, questioning the economic impact of geographical delimitations, control of varieties and yields, the role of union and interprofessions, etc. It will assess the range of producer possible strategies, as well as the economic influence of marketing managers (in cooperatives, private firms, distributors, etc.). Taking into account the response of consumers to changes in intrinsic characteristics of the wine (ie the sensory characteristics) or to extrinsic characteristics (labelling, indication of origin, references to landscape….). The first stage of the work will establish credible scenarios of evolution of sensory characteristics of wines both for agronomic or economic reasons. It could also contribute to question the evolution of the AOP system in order to confront these scenarios in the evaluation of consumers and producers.

This thesis is linked to **WP5**, connecting different tasks (5.1, 5.2, 5.3), and will provide key information and assessment to **WP7**.

Methods

The thesis will first focus on the downstream market, by implementing an experimental economic device. We propose to perform two kinds of works, corresponding to the two parts of the thesis. The first work would be based on experimental markets, assessing how consumers “willingness to pay” depends on their evaluation of the intrinsic and extrinsic characteristics of wine. The challenge is to define possible wine in the context of climate change scenarios, and to decompose the willingness to pay according to the different wine characteristics, that will be treated by econometric methodology We propose to focus on one issue little explored in the economic literature: 'stable preferences' (analysis of the consequences of changing consumer tastes). Setting up experimental markets will be applying at least in the Aquitaine region. The second part of the thesis will analyse the strategies of producers by mobilizing the results obtained in the first part (consumer demand). The challenge is to provide micro-economic models referring to the theory of product differentiation and international competition. It will also be possible to formalize the upply of these markets (vertical models in theory of industrial organization) and to understand the cost-benefit calculation of the investors taking into account technological choices and the evolving preferences of the consumers.

Name of the supervisor	Maryline Filippi and Eric Giraud-Héraud
Date of beginning	September 2012
Co-funder	Région Aquitaine (sous réserve d’acceptation)
Ecole doctorale de rattachement	Many possibilities either in Paris via Agro Paris-tech or Polytechnic School of Paris either in Bordeaux ED n°42 of the Bordeaux University)

THESIS : Complete description of the subject – 1 page max

Scientific objectives

T2: Development of an applied methodology for climate change studies at the scale of the viticultural terroirs. Integration of human activities under multiple constraints for the production of scenarios of adaptation (WP1 and WP4).

The general circulation models are not adapted to local scales and do not give accurate results regarding the evolution of meso-climates. The main objective of the thesis is to develop a methodology for a spatial modelling of climate adapted to fine scales (viticultural terroir units / landscape), that integrates human activities (cultural practices, land use policy, landscape management, …) in order to proceed to an adapted simulation of local climates and propose answers to the future consequences of climate change.

The thesis is targeted to link WP1 (partners 3 and 4) and WP4 (partners 10 and 12).

Methods

The thesis involves directly partners 3 and 4 that have previously developed basic knowledge and skills on CC in the framework of the ANR Terviclim project (http://terviclim.in2p3.fr/). This project is conducted in two pilot sites of the Mid-Loire Valley (Anjou – Coteaux du Layon for white wines; Saumur for red wines).

Pilot sites are already partially equipped with met stations and on-site climatic sensors. Vineyards are monitored for grapevine phenological stages and berry composition according to mesoclimatic conditions. Human activities will be assessed through surveys and inquiries. The thesis main steps are :

- Acquisition of met and agricultural data at fine scales (terroirs and landscape) in two sub-basins of the Mid-Loire Valley
- Meso-scale climatic modelling based on IPCC scenarios (A2, A1B and B1) generated at an 8 km resolution.
- Integration of human activities (agricultural practices, land management …) thanks to a Multi-agents platform.
- Proposal of scenarios of adaptation for viticulture in the Mid-Loire Valley
- Test of the validity of the method for other vineyards

Name of the supervisor	Aziz Ballouche, University of Angers, Hervé Quénol, CNRS Rennes
Date of beginning	January 2012
Co-funders	INTERLOIRE (for thesis current and lab expenses) + SAD (requested)
Ecole doctorale de rattachement	DEGEST

THESIS : Complete description of the subject – 1 page max

Scientific objectives

T3: Physiological and genetic determinism of water saving strategies in grafted grapevine and their relationship with carbon acquisition and growth (WP2)

Current collaborative projects between Partners 1, 7 and 9 reveal large genetic variations in transpirational water losses and C acquisition for growth in populations of grapevines. Both processes are generally tightly coupled, making water use efficiency (growth to transpiration ratio) hardly modifiable. However, our original exploration of physiological and genetic determinants on rootstocks on the one hand and grafts on the other hand showed that some processes and associated genomic regions can be independently manipulated. Specifically, we detected a range of water saving strategies originating in scions or rootstocks that varied from highly- to non-conservative behavior associated with different biological controls of transpiration. The objective of the thesis is 1/ to dissect which mechanism underlines this variation in water saving strategies, 2/ to what extent it is associated with variation in growth responses to drought and 3/ whether grafting may be optimized to improve water use efficiency under drought conditions and fluctuating evaporative demand.

Special attention will be paid to the water-stress induced hormone abscisic acid (ABA) which is well known to induce stomatal closure and reduction in water losses. Grafting will be used as an original tool to decipher the origin of ABA in roots or shoots which has been recently questioned. Side-effects of ABA on aquaporins activities and consequences on water uptake and water transfer capacities (root growth, maintenance of xylem conductivity, perivascular permeability) will be evaluated under drought conditions. This work will also provide important information for the implementation of WP3, task3.

Methods

2012 (prior to Thesis) : Characterization and selection of contrasted progenies (about 10) from pre-existing crosses (between rootstocks with common scion and between scions with common rootstock). Criterions used for selection : 1/ ABA production and sensing; 2/ contrasted responses of growth and transpiration to soil drying. (end of ongoing ANR project “VITSEC”).
2013 : exploration of physiological responses of the selected panel : ABA production and metabolism; hydraulic conductivity and response to ABA, stomatal sensitivity. ABA will be varied endogenously (drought) or artificially (on intact plants or detached organs fed with artificial ABA) (Montpellier)
Reciprocal grafting between selected rootstocks and scions (Bordeaux) : about 50 combinations.
2014 : exploration of physiological responses on reciprocal grafts in pots (long term effects of different capacities to accumulate ABA). Water use and growth under two watering regimes (Bordeaux and Montpellier phenotyping platforms as replications).
2015 : physiological bases of the coupling between water use and growth (osmotic adjustment and turgor in growing shoots; Montpellier pressure probe); stomatal control of photosynthesis.
Model coupling for water transfer capacities, ABA production, stomatal and growth responses.
Back analysis of databases (under construction in the ANR project “VITSEC”) using the model.

Name of the supervisor	Thierry Simonneau (P7) + Nathalie Ollat (P1)
Date of beginning	Oct 2012
Co-funder	Expected : INRA-EA ½ + GAP ½
Ecole doctorale de rattachement	SIBAGHE

THESIS : Complete description of the subject – 1 page max

Scientific objectives

T4: Development of a new method to extract complex information (WP6)

A new method to extract information from text and tables of heterogeneous data sources available on the Web (bibliographical sources, surveys, …) will be designed and prototyped. This method and associated prototype will be helpful to strengthen the international linkages of the project in terms of data and knowledge management. It will be used to integrate in the Information System (IS) of the metaprogram existing information about the research activities, especially in California, South Africa and Australia on grape and wine production under water limited and high temperature regimes.

Methods

The design of this new method will be based on several subdomains of knowledge engineering. The knowledge of the application domain (Climate Change impacts in Viticulture and Enology) will be modelized in an ontological and terminogical resource (OTR). Guided by this OTR, the extraction and the representation of the information from text and tables of heterogeneous data sources will be based on: (1) natural language processing methods to define lexico-syntatic and semantic patterns to identify relevant information in the text, (2) data table annotation methods to identify relevant information in data tables, (3) fuzzy set and possibility theories to represent and query imprecise data (intervals of values, mean and standard deviation, …) previously extracted from the data sources.

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Name of the supervisor	Patrice Buche
Date of beginning	September 2012
Co-funder	Expected: INRA CEPIA and MIA departments
Ecole doctorale de rattachement	I2S (Montpellier 2 University)

THESIS : Complete description of the subject – 1 page max

Scientific objectives

T5: The role of research and innovation in the capacity building for vineyards adaptation to climatic changes (WP7)

I

"Innovation" is presented as a key issue for the adaptation of vineyards to the climatic change, questioning the institutions dedicated to research, education and technical advice in the wine sector. Research in Innovation Economics considers the role of these institutions, trough the notion of "knowledge system" or "system of innovation" (SI), extending the analysis to networks that connect actors of these institutions to innovating actors in an industry or a region. Recent works reveal that the nature and form of these network influence economic growth or performances, including in the case of the wine industry of the "new world". Nevertheless, no study has recently assessed the role of innovation and science in the French wine industry, neither evaluated the evolution and impacts of these institutions. The aims of this Ph-D is to characterize the structure and evolution of French wine SI, and assess the economic effect on regional vineyards, specifically on their capacity to adapt to climatic change. The assumption is that specific forms of SI can influence this capacity and can reinforce the competition and differentiation between the wine regions. The Ph-D will fully contribute to the WP7 (work 7.2).

Methods

The Ph-D will develop two contrasted approaches of the SI of the French wine industry, and wine regions :
i) an interactionist and bottom-up approach, taking into account relations, actors and institutions involved in concrete changes observed in the vineyards. ;
ii) an institutional and top-down approach, assessing the evolution of the set of institutions formally dedicated to research, education, training and innovation transfer in the wine industry
These two approaches mobilize institutional analysis, networks analysis .and economic evaluation on both public and private organizations, selecting the 6 main French wine regions. This thesis will thus benefit from the networking allowed by LACCAVE project, and on the other way will provide strategic information and assessment for INRA research management oriented to the wine industry.

Name of the supervisor	Jean-Marc Touzard
Date of beginning	September 2012
Co-funder	Expected: INRA SAD and Montpellier SupAgro (or Ministry of Research)
Ecole doctorale de rattachement	EDEG (Montpellier I University)

Description of the project

1. Context

State of the art and scientific issue

Wine grapes (*Vitis vinifera*) are constrained to a narrow climatic range and consequently are especially sensitive to climate change (CC), with potential effects on yield, quality and economic viability (Jones et al. 2005). Since grapevine has been cultivated, specific growing regions were established, whose climatic conditions played a decisive role in the development of typical wines from specific varieties and cultural practices (Schultz et al. 2010). Together with other environmental characteristics, climate traits were used over time to delimitate practically and legally these regions or "terroirs". In France, the Appellation system went further adding regulations for practices and varieties to the legal definition of wine regions. Among other agricultural crops, viticulture has developed very specific and codified relationships with geographical spaces and technologies, which make it emblematic. **This is the reason why viticulture for wine production appears to be a "model agricultural system" allowing to question both the impacts of climate change and the implementation of adaptation strategies.**

Many reports (Schultz 2000, CLIMATOR project, Garcia de Cortazar Atauri 2006, Pieri 2010) show that the major impact of CC on grapevine would affect phenology. Because of the rise in temperature, an advance of 20 to 40 days for any stage of development can be forecasted, with some new regions in the North of France becoming suitable for viticulture. Hydric comfort of plants would be reduced, with negative impacts mainly in the South of France. Ripening would occur under much warmer conditions than today, with major impacts on berry content and its suitability to elaborate the current types of wines (Duchêne et al. 2010). Additionally, variability is expected to increase, and plant-pathogen interactions will be altered (Pangga et al. 2011). All these challenges will necessitate adaptations from vine growers, wine producers, consumers and policy makers. **So far, very few studies have investigated the capacity of the wine industry to adapt to climate change (Holland et al. 2010).**

Most experts underline the complexity of the issue of CC at physical, biological, technical, social, economic and cultural levels, especially for viticulture and wine production (Jones et al. 2010). Large variations in climatic conditions do exist inside viticultural areas, as a result of geomorphology, land cover and proximity of main water bodies and urban areas (Bois et al. 2008). Environmental parameters (temperature, water, CO2, soil mineral composition) will likely interact. Their combined effects on the numerous variety/rootstock combinations are difficult to predict, especially for fruit composition. Adaptation of technical practices and plant material will be crucial (van Leeuwen et al. 2007). Relocalization of vineyards would also represent an alternative. The adaptive capacity of the wine industry will be influenced by a number of factors among economic, sociological and legal ones, and adaptive strategies will differ among wine regions. **Therefore a global approach is clearly needed to propose effective solutions of adaptation, based on the combination of technical innovation, localization strategies and institutional changes**. Nevertheless, and especially in France, research dealing with these issues remains scattered, disciplinary focused and does not integrate the full complexity of the problem.

Taking into account the economic importance of grape growing and wine industry in France (Bastian, 2008) and the specificities of viticulture in relationship to climate change,

considering this activity as a model for both biological and social sciences, noting the dispersion of studies potentially involved, **LACCAVE will investigate long term adaptation strategies to climate change for viticulture and wine production in France**. Its main objective will be to elaborate scenarios of adaptation at different regional levels, taking into account strategies that combine technical innovations, new spatial organization and institutional changes. For each aspect, the specific knowledge will be produced and integrated into models which will be used for the evaluation of different innovation strategies. The conditions needed to implement these innovations, and the benefits and costs of the proposed scenarios and combination of innovations will be analysed in terms of economic competitiveness as well as social and environmental aspects. Recommendations will be made to policy makers, actors of the wine industry, and for future research orientations.

Relevance to the adaptation of agriculture and forest to climate change

Agriculture will support most of the impacts of climatic change. As a consequence, major efforts must be done in order to adapt this human activity, while taking into account its diversity. According to the results of ARP ADAGE, it will be highly necessary to observe, experiment and model the coupled evolution of ecosystems and human societies. To facilitate adaptation, five main strategies can be developed: a better knowledge of CC impacts at a regional level, and of the vulnerability of the ecosystem; the improvement of the capacity of the agriculture to face high climate variability, the identification of actions which will be in agreement with other challenges, the development of adaptive innovations, the release of specific gouvernance strategies for territories and natural resources.
The LACCAVE project meets the research priorities defined in order to face the challenge of adapting viticulture to climate change. Indeed, it will aim to develop **modelling tools** allowing to predict the climatic conditions at various space scales and to **analyse their impacts on the viticultural agro-systems** (from the plant to the vineyard, taking into account the interactions with pathogenic organisms), **on the wine making processes** (from the grapes and their microflora to the wine) and **on the marketing chains** (from the first sale to the final consumption). Based on these studies, **innovative practices** will be further developed in various directions (cultural and oenological practices, water management, plant material choices). However, taking into account the specificities of the French viticulture, i.e. the importance of the historical, socio-economic and institutional dimensions, of the professional governance of this industry, of the regulation policies, LACCAVE considers these aspects as central to answer the questions. **Actors, both professionals and consumers, and their involvement in the adaptive processes will represent important research objects and issues of LACCAVE**. This project will largely deal with the multidisciplinary approach required to release efficient adaptive scenarios and solutions.

Potential structuring impact for INRA

LACCAVE involves 22 UMR, UR, UE or USC of INRA, associated to 7 research departments of INRA (GAP, EA, SPE, CEPIA, SAD, SAE2, MIA). The teams are located in 6 different regions, 5 of them being particularly well known for their wines (Alsace, Bordeaux, Côtes du Rhône, Languedoc-Roussillon, Val de Loire). Most of the teams belong to regional poles dedicated totally or partly to vine and wine studies as the Institut des Sciences de la Vigne et du Vin (Bordeaux), Institut des Hautes Etudes de la Vigne et du Vin (Montpellier), IFR QUASAV (Angers). These poles associate Universities or High Schools, and are strongly supported by grower associations, wine companies and regional institutions. **The LACCAVE project represents a unique opportunity to build and structure a national research consortium, dedicated to CC in viticulture, but considering also regional particularities.** This national consortium will work in collaboration with professional and extension institutions. The national thematic group about “adaptation to CC of the French viticulture”, coordinated by l’Institut Francais de la Vigne et du Vin, will be a natural partner.

Finally **the LACCAVE consortium will represent a strong component of the GIS (Groupement d'Intérêt Scientifique)** which is under construction in France for Viticulture in order to strengthen the links between research, extension bodies, training institutions and professional organisations. LACCAVE will be a conceptual frame for the partners to answer to funding calls at the national or international levels.

Relevance to the call and the axes and originality: The proposal meets several requirements of the call, mainly in the axis 2 and 3. Some aspects may also be relevant to axe 1, especially those taking into account short term adaptive innovations as oenological or irrigation techniques. LACCAVE aims at developing regional projections of the impacts of CC and at investigating adaptive strategies for viticulture on the long range.
Although most wine countries throughout the world conduct research activities on the impacts of CC, we are not aware of any other national structuring project that aims to develop a global approach in order to define adaptive strategies. The strength and the originality of the LACCAVE project lay mainly on the **true interdisciplinary approach**. In this project, adaptation to CC is not only considered as a biological and a technical issue, but as a global issue where the socio-economic aspects are major. The changes, the perception of changes, the ability to change and to participate to the adaptive process, the acceptability of innovations will be analysed from different points of view, from the consumers, through the producers to the scientific community. Different kinds of technical innovations will be studied. Considering the strong links between French viticulture and terroirs, adaptation will also be considered at different space levels. The research activities will result in the construction of several adaptive scenarios which should finally support decision making processes at the different levels of the French wine industry.

2. Technical and scientific description of the project

Scientific aims

The objectives of LACCAVE are 1)- to build an analytical framework and modelling tools to explore the impact of CC on viticulture and wine production at regional level, 2)- to build and integrate the knowledge from different levels of study into models and management tools in order to develop and support innovations enlarging vinegrower adaptation capacities, 3)- to propose adaptation scenarios and to evaluate their economic, sociological and environmental consequences. The proposal is based on the structuration and organization of the ongoing and new research activities developed by INRA and associated teams on the adaptation of French viticulture to climate change. The major added value of the proposal is to share knowledge, research facilities (experimental ones, model units, surveys, data bases) and to develop new links and research projects between teams with various scientific skills. This will allow LACCAVE to design solutions and recommendations for adaptation of viticulture and wine industry to CC. **LACCAVE represents an opportunity to unify the research offer in order to respond to the societal and political demands on these issues.**

Methodologies

LACCAVE combines collective learning tools, aiming **at building interdisciplinary knowledge**, with a set of **more disciplinary oriented research methods**. The progressive building of collective knowledge relies first on a systemic approach connecting both characterization of CC at regional levels and definition of strategic options, with the functioning of viticultural agro-systems, wine making process and wine marketing chains (schema 1, annex 1). **Methods of group intelligence** will also provide shared assessment

on various kinds of information, either coming from other research programs or directly generated by LACCAVE works. **An interdisciplinary information system** (database management) will thus be developed in the frame of the project (specific workpackage). Finally, **a step by step foresight exercise** (scenarios building) will play a crucial role in the interdisciplinary improvement, giving a concrete common goal to all the LACCAVE members.
Behind this collective and interdisciplinary learning process, focused works will be developed to produce new knowledge, to propose new modeling or to assess selected innovations and scenarios. The methodologies used in these works are related to disciplinary approaches: **observations and sociological surveys (eg on current perception of CC), experimentations in greenhouses, vineyards and cellars, phenotypic analysis, experimental economics and econometrics, climate, plant and agro-system modeling, impact analyses, participatory focus groups**…Cross presentations of these specific works and methods could also contribute to the networking and collective knowledge building within the LACCAVE project.

Main stages of the project

Interdisciplinary activities and specific works have been organized in 8 "WorkPackages" (WPs) related in a functional way, according to the schema 2 presented in Annex 2. Beyond the coordination of the project (WP0), 4 WPs are fully dedicated to interdisciplinary stages of the project: sharing and structuring the current knowledge on CC and the possible impacts on the wine sociotechnical systems (WP1); multidimensional evaluation of CC innovations in different vineyards (WP4); database management (WP6); co-construction of adaptation scenarios through foresight exercise (WP7). 3 WPs are centered on more disciplinary works: physiological and genetic bases of grapevine adaptive responses to CC (WP2); oenological, agronomic and plant material innovations (WP3); economic strategies facing CC in the wine industry (WP5). Scientific activities developed in these 8 WPs are successively presented below. A detailed description of the calendar and deliverables is attached in Annex 3.

WP0: Coordination and management of the project. *Coordinators* : N. OLLAT and J-M TOUZARD, with a coordination board involving the different WP coordinators. An international scientific board will be named (cf international aspects).

- The *main coordinators* will be in charge of the general coordination of the project and of the management of the coordination and international scientific boards. They will be in charge to provide the partners with **some deontological rules** (collaboration between partners for additional fundings and publications) and with **collaborative working tools** (WIKI) for the project. They will take care of **the relationships with the official institutions** (ACCAF coordination and INRA) and with **the professional bodies**. They will be responsible of the **visibility** of the project. A **public website** could be developed in coordination with the INRA and ACCAF policies.
- The *coordination board* will be in charge of **the scientific management** of the project and of the **organisation of the main meetings** with all the partners, including the final meeting as an international workshop. This board will be in charge of **reporting and of publishing the collective scientific outcomes of the project** under the supervision of the coordinators. It will be in charge of **the relationships with the other structuring projects** at national levels.

Three general meetings with all the partners will be organised within the duration of the project (beginning, end of year 2, final meeting).The coordination board will meet annually. A report will be released annually.
***Deliverables*:** collaborative working tools, annual reports, organisation of an international workshop with a proceeding book, organisation of meetings with professionals, project Website, general scientific publications about the collective scientific outcomes.

WP1: Characterisation and perception of Climate Change

Coordinators: H. QUENOL (P3), G. BARBEAU (P4) and N. OLLAT (P1)
Partners involved: 1-1 and 1-4: all, 1-2: P2, P4, P12, 1-3: P1, P3, P4, P10, P12, P14, P20, P21

Great variations in climatic conditions do exist inside viticultural areas, as a result of geomorphology, land cover and proximity of main water bodies and urban areas. This means that climate change will not impact in the same way various locations inside a winegrowing area. Hence, climate change must be studied at a very fine scale. Until now, very little research is dedicated to the issue of the effects of climate change at a local scale.

WP1 aims at elaborating the required basic knowledge and climatic information at vineyard or terroir level to further study adaptation to CC. Various objectives are targeted: i) the development of a methodology for measurements (both meteorological and agronomical) at fine scales, ii) downscaling the spatial modelling of climate, iii) taking into account the current knowledge, practices and issues expressed by actors in the wine industry, about CC and its potential effects on the production systems and products quality, including the development and evolution of pests and diseases, and the berry microbial ecosystem.

1.1. State of the art. *CC global vs local. Links between climate / terroirs / grapevine physiology and wine quality. Impacts on pest and disease development. Elaboration of a common scientific basis of knowledge at these local scales for all the scientists involved in the project.*
1.2 Evaluation of the perception of CC by the regional/local wine industry *and identification of the emerging practices/strategies taking into account this issue as well as those that would be readily acceptable.*
1.3 Modelling / predicting CC impacts on vineyards and terroirs *in various regions: Val de Loire, Bordeaux, Languedoc-Roussillon (in the frame of ANR TERVICLIM).*
1.4 Formalizing the issues, constraints, and hypotheses set by CC
Deliverables : meeting and workshop reports, scientific papers, reviews of literature, reports on actor facing CC, climate predictions at the different scale levels, reports on issues and hypotheses. Data for data base implementation.

WP2: Physiological and genetic bases of grapevine response and adaptation.

Coordinators : P. VIVIN (P1), E. LEBON (P7) and P. DARRIET (P13)
Partners involved : P1, P5, P7, P9, P11, P13, P16, P17, P20

Besides the resolution of methodological bottlenecks, WP2 aims at investigating physiological and genetic mechanisms underlying the phenotypic responses and adaptation of grapevine to multiple abiotic stresses (either natural or imposed). Our approaches on plant development and growth will combine field and greenhouse phenotypic analysis of various genotypes with process-based models for phenology (see ACCAF Pherpheclim), root-to-shoot biomass allocation, yield, berry composition (primary and secondary metabolites : polyphenols, volatile and non volatile aroma compounds), and wine quality. One ultimate goal is to simulate performances of genotypes and reverse models to guide breeding or plant management choices as a function of targeted climatic conditions. The specific objectives of WP2 are:

2.1 Development and networking of experimental set up and methodologies for accurate and ***high-throughput phenotyping***.
2.2 Analysis of ***genetic variability for adaptive responses*** of varieties and rootstocks to environmental variations according to different climatic scenarios (high temperature and CO_2, drought). A Ph-D work will be dedicated to this task (subject T3).
2.3 Analysis of the ***effects of grape adaptive responses*** to environmental variations ***on composition and organoleptic characteristics of wine***.

2.4 ***Integration of information in process-based models*** to predict the effects of climate change.
Deliverables : phenotyping tools for aerial and root development, databases and process-based models for grape phenology and water relationships in combination with carbon allocation, characterization of scion and rootstock varieties, knowledge on the links between grape and wine traits, biochemical markers for grape composition assessment, patterns of microflora evolution

WP3 : Exploring and testing putative innovation techniques for a specific wine quality

Coordinators : H. OJEDA (P14) and P. THIS (P9)
Partners involved: P1, P4, P5, P7, P9, P10, P13, P14, P15, P16, P17

Based on WP2 results, WP3 aims at exploring innovative and sustainable systems ensuring high wine quality, sustainable production, profitability, environmental quality, resource conservation and quality of life. The range of investigated techniques in the vineyard and the cellar will provide adaptation methods at short, medium and long term scale. Available plant material and new plant material will be considered. The conditions of acceptability of these innovations will be taken into account in different wine regions through links with WP1, WP4 and WP7.

3.1. New enological practices and technologies for the improvement of wine quality
Innovative technological treatments or new enological practices, as electro-separative methods, could be developed in order to primarily correct some defects in the chemical and sensorial properties of wines (higher astringency and alcohol contents, decrease of fresh and exuberant aromas, higher pH values, and risks of increase in the salt contents of wines). The implementation of technologies based on controlled extraction and separation can lead to the development of wines more oriented and defined in terms of composition, sensory quality and with increased chemical and physical stabilities. It is also a prerequisite to identify and define the technological routes for the expression of the quality potential of new vine varieties. Innovative approaches at the various steps of winemaking by adapting technology to both the characteristics of the grapes and the desired characteristics of wines will include the use of specific sensors in course of development at INRA. Several approaches, linked to industrial partnership, have been initiated in this direction.
3.2 New management practices to control water use efficiency and cluster microclimate: irrigation, use of new water resources, soil management, training systems. Climate change will generate an important drought which will affect the quality of grapes and wines, principally in southern Europe. This situation calls for an evolutionary adaptation of cultural practices. New training systems controlling light interception by the foliage and cluster exposure could be considered. Irrigation is also a key issue. In a context of reduced water availability, the development of new technology to improve efficiency in water use, news soil-crop systems and the assessment of new sources of water as recycled water from sewage treatments has to be considered.
3.3 Valorization of genetic diversity for the selection of varieties and rootstocks for late ripening, low sugar, high acidity, tolerance to drought and high temperature. This task will be coordinated with the general approach developed within Vitinext project and with other works developed in ANR projects Vitsec and Duravitis. The main aims within the LACCAVE project will be to 1- evaluate the genetic variability (*V. vinifera* varieties, Vitis accessions, foreign rootstocks) at phenotypic and molecular level and 2- to integrate the knowledge collected in WP2 about phenology, sugar accumulation, drought and temperature tolerance to develop breeding schemes for these traits (in relation with the SelGen metaprogramme).
Deliverables: new enological practices, new sensors, improved training systems and water management practices, characterization of plant material, breeding schemes

WP4: Explore and evaluate CC innovations and spatial reconfigurations in vineyard areas *Coordinators*: P. LAGACHERIE (P10), G. TEIL (P12) and G. BARBEAU (P4)
Partners involved : P2, P3, P4, P10, P12, P15, P16, P20

WP4 aims at i) evaluating the introduction of the technical innovations issued from WP3 and the within-vineyard relocation of vine parcels for their ability to ensure the social and economic efficiency of wine production in farms and wineries while providing ecosystem services such as the protection of soil and water resources ii) assessing the acceptability and the appropriation of these adaptation schemes by the vinegrowers, according to the type of wine production. These two objectives need to be addressed at the landscape (or terroir) scale since it corresponds to the size of the entities considered (farm, catchments). To avoid too many experimental costs, the research will be focused on well-documented areas that have been studied by the partners for many years: Roujan and Peyne Catchments in Languedoc, AOC Chaume et Saumur-Champigny in Val de Loire. This WP will be supported by a Ph-D work (subject T2).

4.1 Building scenarii of vineyard landscape including climate change constraints and adaptations (technical innovations and spatial reconfigurations). The proposed approach is two-fold. First we will deliver a limited set of narrative CC adaptation scenarii for the two considered study areas by i) synthetizing WP 1.4, WP3 and WP7.2. results and ii) contrasting this scientists view with the actor views collected through focus groups. Second, these narrative scenarii will be converted into spatially and temporally explicit scenarii at scales compatible with the application of the evaluation approach (see further). This will be done by coupling downscaled CC data (WP1), digital maps of the impacting landscape features and data on vinegrowers actions and decisions.
4.2 Evaluating the impact of adaptation schemes on vine production (quantity and quality) and on water and soil resources of vineyard catchments. Different evaluation approaches will be undertaken in the two study regions. In Languedoc an “analytical” multicriteria evaluation (vine production + ecosystem services) of the above produced scenari will be conducted. This will use an integrated modelling approach that will couple physically-based models that represent together the relevant landscape processes. In Val de Loire the evaluation will be more focused on the conservation/evolution of the typicity linked to the terroir through the prediction of changes in grapevines phenological stages, dates of harvest, grape quality and wine typicality.
4.3 Contrasting actors and scientific views and assessing the acceptability of the CC adaptation scenario*:* The way actors shape their activities does not always simply fit with the scientific analytical framing. This sub-task will further the co-construction work started in WP1.2. by enlarging the focus from a rather technical view in WP1&3 to a more global understanding of the wine making and wine selling activity addressing namely quality, terroir and environmental issues. The work will firstly ground upon a socio-technical multi-actor enquiry (extensive interviews) of on-going changes and adaptations performed by the actors. It will be followed by participatory assessment (focus group) of vineyard transformations, adaptations and innovations.
Deliverables*:* scenarii of adaptation at vineyard scales; digital maps of spatial allocations for vineyards, new practices, risks, adaptation scenario, indicators of environmental impacts; surveys and reports.

WP5: Economic competition and exploration of new strategies to cope with CC
Coordinators : E. GIRAUD-HERAUD (P6) and M. FILIPPI (P8); *Partners involved* : P2, P6, P8, P19

WP5 aims at evaluating the effects of CC i) on producers and consumers strategies within wine marketing chains, ii) on the competition between wine regions and iii) on the regulation

of the wine industry. CC is supposed to modify the links between wine quality and its geographical origin, questioning whether consumers could adapt their preferences to these evolutions. CC will also differently impact production costs and yields, according to vinegrowers location. Consequentially, the conditions of competition between firms and between regional vineyards could be strongly affected, leading to question the European wine regulation Because assessing all economic impacts of CC and their feedbacks on strategies is not realistic, WP5 will focus on key points: Consumers perception on putative quality changes; strategic reactions of producers in contrasted wine regions and wine chains; implication on European wine regulation, specifically on the geographical indication system. Assumptions and results will be also specified along the interactions with the foresight study (WP7), taking into account the 4 previous strategic options mentioned.
The research will mobilize methods coming from applied economics, experimental economics and structural econometrics. Different French and European wine regions will be selected, according to contrasted expected impacts of the CC, and to the choices made by WP1 and WP4. Information on consumer behaviors will be generated by our own experimental device, and, if possible, repeated in order to test their stability. Vineyard structural and economic data will be given by 2010 agricultural census and by FranceAgrimer Agency. Normative models, in the field of the Industrial Organization Theory, will thus be elaborated in order to assess the strategic positioning of wine firms among the value chain, from the production step to the retailing step (model of strategic sourcing). This WP will be the core of the Ph-D work supported by ACCAF (cf thesis description, T1).

5.1 Evolution of consumer behavior, facing expected new types of wines *(according to WP2, WP3 suggestions) and possible evolution of the wine regions. This work relies on experimental economics, testing willingness to pay of consumers groups, according to the wine quality expected changes induced by CC.*
5.2 Wine producers and company's location strategies at regional and international levels . This task tries to understand how producers take into account the evolutions of wine quality perception by consumers, and their own cost of adaptation to new climatic and technological conditions.
5.3 Competition between regional vineyards at European level*, including institutional aspects (interaction with WP7), coordination of actors and value chain management. The specific role of "regional interprofession" (lever of change) will be assessed and questioned* by using applied economic models, adapted from previous research.
5.4 Impact of CC on the wine regulation, focusing on the Geographical Indications System (complementarity with WP1 and WP4 inquiries on "terroir" perceptions). Economic impacts will be assessed according to different institutional changes in the AOP/IGP system. This exploring work (Master these) will mobilize institutional economics and associate INAO (National Institute of Official quality labels).
Delivrables*:* one Ph-D thesis, two master theses, articles in economic review (JWR…), report and recommendations to INAO, internal notes dedicated to WP7,

WP6. Data management and analyses for the viticulture and wine production

Coordinator : P. NEVEU (P18) and P. BUCHE (P22), *Partners involved* : all

WP6 aims at gathering different kinds of existing information related to the wine sector through the development of an integrated Information System (IS). Data will be gathered, organized and stored by using computational methods of integration which allow the formalization and structuration of correspondence through a mediation system based on ontologies. This system will allow to abstract the specific implementations of existing databases and to integrate knowledge and to improve data analysis. Beyond the state of the art, a new method to extract information from text and tables of heterogeneous data sources available on the Web (bibliographical sources, surveys, …) will be designed and prototyped.

Extraction patterns of relevant information used in this new method will be defined in the ontologies of the mediation system. This method and associated prototype will be helpful to strengthen the international linkages of the project. It will be used to integrate existing information about the research activities, notably in California, South Africa and Australia on grape and wine production under water limited and high temperature regimes. For statistical analysis and interpretation of these integrated data, we will use methods such as curve clustering, statistics for functional data and bayesian models. This WP will be supported by a pH-D work (T4).

6.1 Definition and design of knowledge and databases models
6.2 Construction of an integrated information system (SI) for wine sector for existing data and data generated within the project
6.3 Statistical analysis and interpretation of integrated data collected during the project
Deliverables : analysis of existing databases, design of models for integrated data and knowledge, development of these models, including a specific prototype to extract information of data sources; Specific methods and tools will be developed to allow data interpretation.

WP7: Co-construction of adaptation scenarios facing CC.

Coordinators : J-M TOUZARD and N.OLLAT. Partners involved : all

WP7 aims at building and evaluating adaptation scenarios for French wine regions, leading to provide recommendations for research activities and policy makers.
A step by step foresight methodology will be experimented through iterative exchanges with other WPs. During the building period of the LACCAVE project, four strategic scenarios (by 2050) have been yet elaborated, taking into account contrasted combinations between technical innovations, spatial strategies and institutional changes:
i) conservative strategy, controlling innovations and maintaining current zoning;
ii) implementation of radical innovations (new varieties, irrigation, new oenological techniques…) in order to keep the vineyard location and the use of geographical indication
iii) opportunity of “terroirs moves” following the “climatic frontier”;
iv) liberalization of the wine regulation, giving power to downstream marketing firms (sourcing in several vineyards).
These four scenarios will be given to all WPs as starting strategic proposals that will be discussed, evaluated, completed and specified during the WP7 working period. The foresight exercise will be carried out through annual workshops (generally coupled to LACCAVE general meetings) and by a dedicated committee, animated by INRA engineer. Systemic approach will be used, taking advantage from WP1 results and from previous INRA foresight exercises on the wine sector (collaboration with INRA “foresight mission” and FranceAgrimer). Impacts of both climatic scenarios and strategic scenarios will be assessed according to a set of “change levers” covering the different steps of the wine productive and marketing system, from the varietal plantation to the consumer’s practices. Results from the different WPs, including biological (WP2), technical (WP3 and WP4) and socio-economic approaches (WP4 and WP5), will contribute to explain and evaluate specific levers and interactions in the system. Final scenarios will describe and question different regional vineyard evolutions.
Resilience and adaptation capacity of the wine regions (considered as wine clusters) will be also questioned in WP7, focusing on institutions and networks that connect research to technical and economic actors of the wine industry. Based on both specific surveys and observation of focus groups, Institutional and network analysis will provide key information on the role of innovation and research in CC adaptation (Ph-D allocated to the project T5).

During the final year, recommendations to policy makers and actors of the wine sectors will be formulated through participatory sessions and synthesis coming from the foresight exercise. Thus fours tasks are considered in WP7:

7.1 Foresight Exercise building CC adaptation scenarios for wine regions;
7.2 Assessment of the CC adaptation capacity building in wine regions, role of research and Innovation Systems.
7.3 Identification of key issues for further research activities
7.4 Recommendations to policy makers (legal framework, innovation policy, landscape management, Wine CMO) and actors of the wine industry. Deliverables: successive methodological notes at each step of the foresight exercise, final report and collective article presenting the foresight method and the scenarios, PhD on the role of research and innovation in adaptative strategy facing CC, operational publications (review and webpages) explaining the scenarios to actors of the wine industry, collective report presenting key issue for INRA research agenda

Complete expected results (including strategy for innovation and valorization)

Knowledge	- Shared knowledge among the partners about CC impacts on viticulture and wine making - Definition of a common set of hypotheses, scientific issues and constraint for adaptation - On the effects of environment on grapevine biology and their consequences on wine quality, - On the biological mechanisms underlying vine adaptative strategies - On the consequences of various adaptation strategies at vineyard levels - On the conditions of acceptability of innovations and alternative adaptive strategies by actors - On the economical consequences at estate and institutional levels
Tools	- Definition of common protocols and devices for experimental work in the vineyard - Phenotyping tools for canopy, grapes and roots. Biochemical markers for wine quality - Ecophysiological models at plant level to assess of genotype x environment interactions - Vineyard models to assess adaptive strategies at the vineyard area scale. - Integrated Information System for viticulture and wine production
Technical innovations	- Oenological techniques : electro-separative methods, new technological routes, sensors - Cultural practices : irrigation techniques using new water sources, training systems, soil management - Plant material : evaluation of the potential scions and rootstocks not grown yet in France
Recommen-dations	- for INRA : to define priorities for further research direction - for to the wine industry organizations : guide of choice for adaptive strategies - for policy and decision makers : how to facilitate adaptation of viticulture ?
Networking	- Unique network with 22 INRA laboratories, predicted linkages with professional and extension bodies (GIS) - International network construction
Valorization	- Scientific and technical publications at the project scale or for specific actions within WPs - Meetings with professional and extension bodies at different steps of the project

Links with other on-going projects or actions: The proposal is linked to several national on-going projects which support largely the research activities included in the structuration: ANRs TERVICLIM, VITSEC, DURAVITIS, CTPS “Phenotyping”, SACCESS, BIOCOMON, ORE OMERE, Gessol SP3A, etc. This proposal is linked to 2 other programs submitted to ACCAF: PERPHECLIM and CAQ40. Delegates of LACCAVE will participate to these projects. Other projects will be submitted soon to support phenotyping infrastructures and breeding activities described in WP2 and WP3 (Grand Emprunt Call: VITINEXT, Equipex EVE). Bordeaux teams are partners of the Labex COTE. The international links are considered in the next section.

Added Value of this project toward others funded projects involving team(s) of the consortium: LACCAVE added value will mainly be the **strong multidisciplinary approach**. This

approach will provide a unique opportunity to gather and put together the knowledge, the results, the expertise collected in other projects characterized by a more disciplinary approach. If most of the experimental work will be funded by other sources, the network established within LACCAVE will help **to share data and results**, to build new **collaborations**, then to improve the efficiency of the scientific work. The project results from **a true co-construction process**. Despite the difficulties, it will improve the perception of the participants for complex issues and develop an open-minded consideration of adaptation. Based on the analyses of scenario, considering all the different strategies for adaptation, LACCAVE increases the chance **to provide efficient recommendations and solutions**.

3. International aspect

Climate change is a global issue and most wine countries will have to deal with this challenge. Moreover, in some countries, climatic conditions are currently those which are forecasted for France within the XXIst century. In Europe and in the other important countries (USA, Australia, South Australia, Chile, Argentina), some researches have been developed for at least a decade, mainly to address the question of the impact of climate change on wine quality, and the prediction of the suitability of vine growing areas during the XXIst century. Spanish project named Démeter, gathering 22 research laboratories and 26 private companies has been implemented from 2009 to 2011. The aims of this project was to develop strategies/methods of viticulture and winemaking to mitigate CC effects and to study the application of new technologies improving the efficiency of the resulting processes

An important aspect of LACCAVE aims at modeling climatic conditions at the regional and sub-regional levels. **This task is part of the international project GICC-TERADCLIM** run by Hervé Quénol (P3). P4 is also collaborating to this international project. TERADCLIM is based on a partnership between 11 countries throughout the world. The LACCAVE project will benefit from this existing international network and will contribute to reinforce it.
At the European level, partners are collaborating to several projects as KBBE-CAFÉ (Computer-aided food processes for control engineering for UMR SPO) and KBBE-SOLINSA (Innovation in Agriculture Knowledge System, UMR Innovations). Following the COST858 network, an EU call on viticulture has been released (KBBE.2012.1.2-04: Vineyard agronomic management and breeding for improved grape quality to reinforce competitiveness of the winegrowing sector). P1 and P7 will contribute to a proposal named INNOVINE. Most partners have already developed bilateral collaborations with international laboratories working on climate change issues, as the Research Center Geisenheim (Germany), the University of Pampelune (Spain), the University of Bologna (Italy), the INRB (Portugal), Christchurch University (New Zealand), INTA Mendoza (Argentina), EPAMIG (Brazil), etc....

Because international expertise and experiences, the LACCAVE project aims at fully integrate this French initiative within the international research activities on the subject. On the bases of the TERADCLIM project, LACCAVE could actively participate to the construction of an international network dealing with the adaptation of the wine industry to CC. Therefore the LACCAVE partners have decided to constitute **an international scientific board.** Pr G. Jones (Oregon U., USA), Dr V. Bonnardot (Stellenbosh U. South Africa), Dr J. Tonietto (Embrapa, Brazil), Pr H. Schultz (Geisenheim R.C., Germany), Pr F. Zamora (Tarragone U., Spain) have already accepted to be part of this board. This board will provide expertise and advises to the project, and participates to the elaboration of international collaborations. This committee will be invited to participate to the initial meeting, mid-term

and final meetings. This final meeting will be organized in the form of **an international conference on CC in viticulture** under the frame of the GiESCO (International Group of Experts about Grapevine and Wine Systems for the Cooperation www.giesco.org).
Climatic Change being one of the OIV (Office International de la Vigne et du Vin) priorities, the LACCAVE project will develop strong links with this organization. It will be based on the already existing contribution of individual partners.
The LACCAVE project will build linkages with the Démeter Spanish project in order to share experiences and to develop European collaborations. Industrial perspectives for the outcomes of the project have to be considered in the frame of INRA and EU policies (as KIC Climat for example).

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

Considering the size of the project and the number of partners, it will be a challenge to manage it, mainly on the scientific point of view. It will be a challenge to build an active network in which each partner has the feeling to participate to the whole project and not only to one WP. It will be a challenge to develop the collaborations outside of the existing ones. It will be a challenge to put all the results together to improve the scientific and collective added value of the project. Consequently we consider that the project would benefit from additional competences for scientific project engineering and management. Specific skills for communications towards different publics would be helpful.

On a more focused point of view, we considered that additional competences in mathematical aspects of modeling would be very valuable.

Answer to reviewers' comments

The reviewers of the LACCAVE proposal pointed out two major weaknesses for the project and gave four directions of improvements. We have taken these recommendations into account in the new version of the project as described thereafter

1- **Administrative burden**: the number of the partners will indeed represent a significant administrative burden. In the new version, WP0 (the management WP) was further described to explain how we plan to achieve the management of the project. A coordination board will be created with the WP leaders. This board will be in charge of the scientific life of the project. The main coordinators of the project will provide the partners with collaborative working tools (WIKI) in order to improve the administrative and scientific exchanges between the partners.

2- **Attractibility for alternative fundings and students** (Ph-D and post-doctoral): the LACCAVE is mainly considered as a frame of coordination and structuration for the national research dedicated to the Adaptation of Viticulture to Climate Change. This project and coordination will support further application for fundings. Despite ACCAF decided to support only half a grant for a Ph-D student, we decided to provide in the new version a detailed description of all the Ph-D subjects which would be necessary. A strategy to apply for fundings for these Ph-D from the INRA departements has been established in a collaborative way among the partners. Moreover, several partners of the project are currently participating to the writing of alternative fundings proposals (Grand Emprunt call: Equipex EVE, VITINEXT; KBBE). Regional institutional bodies have been or will be contacted. Finally, it has been discussed to elaborate a proposal to the call of Ministry of Agriculture (innovation and partnership) in collaboration with extension service and professional partners.

3- **Crop protection expertise**: an additional partner (P21, UMR SAVE) with a large expertise in grapevine pathology and crop protection has been included in the project. It will mainly participate to the WP1 in order to lead an extended and systemic analysis about the impact of the CC on the pathosystem of the grapevine. This analysis will support the definition of research priorities within this field and be the start point for new studies.

4- **Wine quality**: we agree with the reviewers that the wine quality aspects did not appear clearly in the first version of the project, although they were naturally behind every aspect of the proposal. In the new version, a new task has been defined in WP2, in order to analyse the consequences of the modified grape composition due to CC on the final wine quality. In WP3, the enological innovation task has been enlarged and described with more details. Finally the wine quality appears now as a key element for the sociological (WP4) and economical studies (WP5) developed in the project.

5- **International linkages**: in the new version we provide more details about the international linkages already existing between some partners of the LACCAVE project and international teams, especially the TERRADCLIM project and many bilateral cooperation projects. We have decided to associate to LACCAVE, some international experts in a frame of a scientific board. Together with these experts, we will work on the development and improvement of international linkages.

6- **Economic analysis**: an important work has been performed by the leaders of WP5 to improve the economic analysis section, in order it may answer in a more specific way to the CC issue. The half-grant provided by the Metaprogramm ACCAF will be dedicated to this section.

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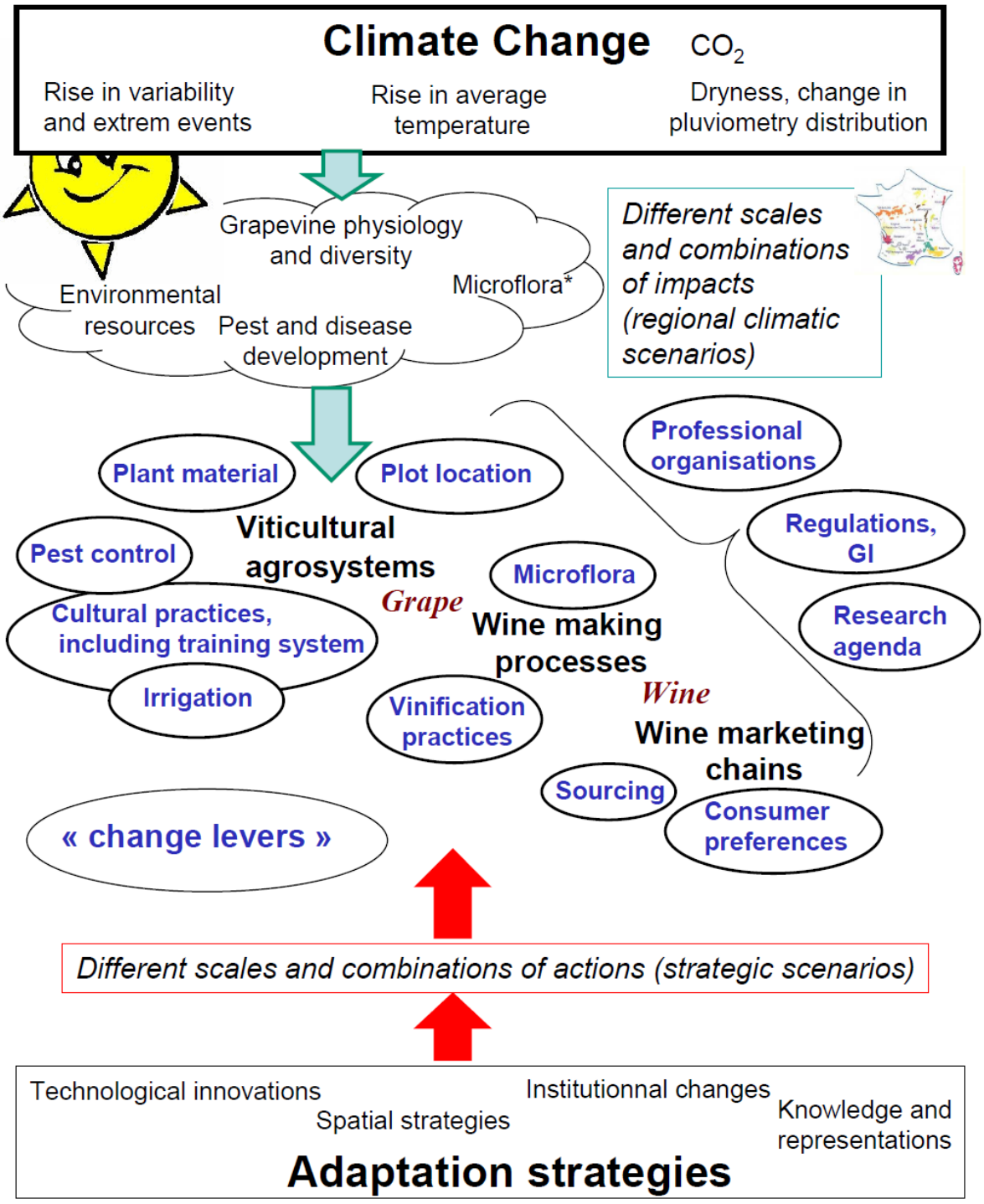
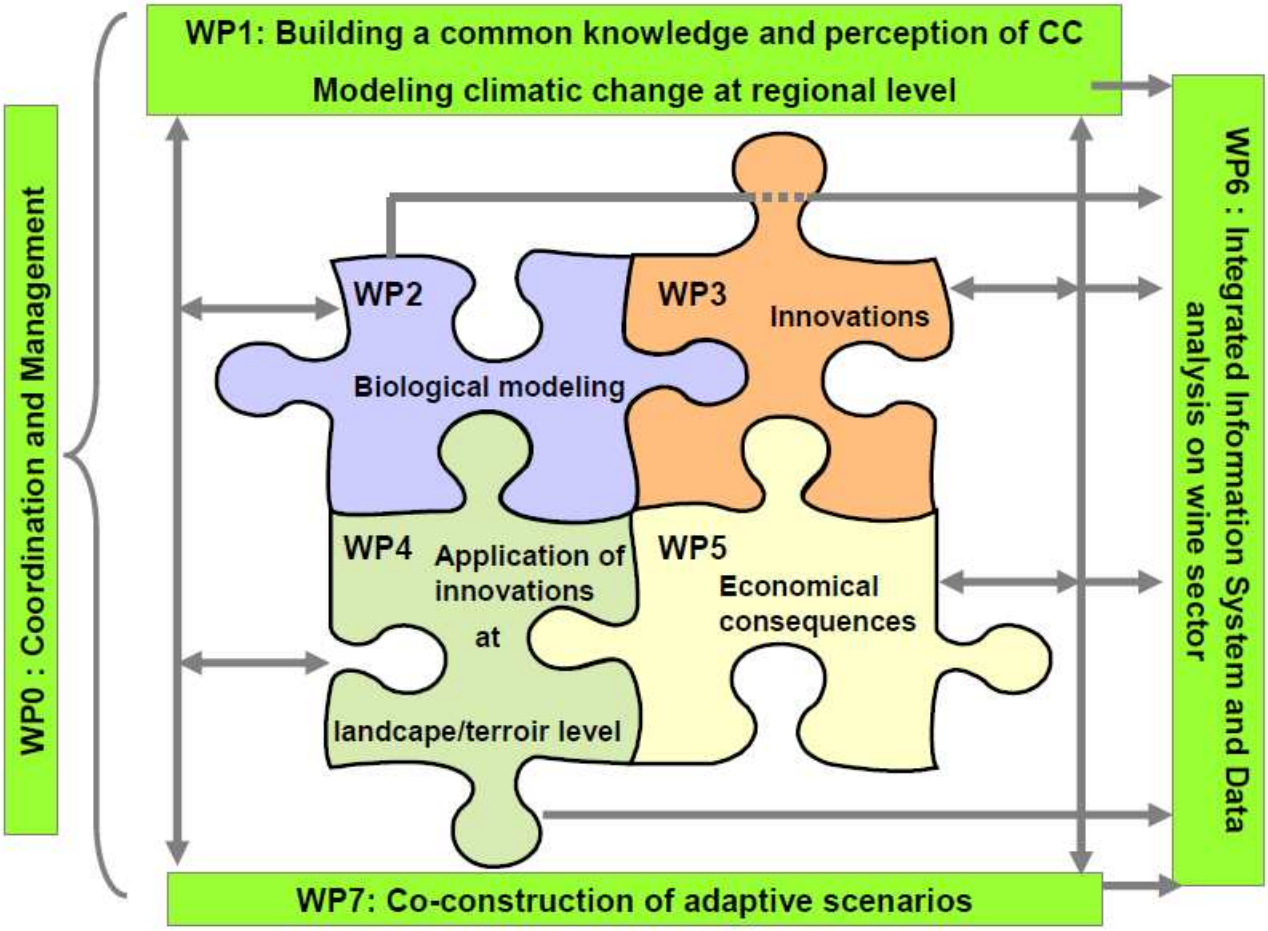
Systemic analysis of the Adaptation of French Viticulture and Wine Industry to Climate Change



* Only grape microflora will be considered in the project. Soil microflora is also a very important issue but won't be taken into account

Functional chart of WPs in the project



Detailed calendar of actions and deliverables listed for each WP

In order to simplify the presentation, it was chosen to list actions and deliverables by WP. Common outcomes for all the partners and the WP are listed under the mention “who ?: all the partners”, mainly in WP0, WP1, WP6 and WP7. Collaborations between WPs have also been mentioned.

WP coordination meetings will be organised by the WP leaders at regular intervals during the project. These meetings have not been mentioned in the following calendar.

WP0	**From Month 0 to 48**	**Who ?**	**Month**	**Action (A) Deliverable (D)**
	Preparation of the general meetings	P1 et P2	0, 22	A1, A5
	General meetings, including international scientific members.	All the partners	2, 25	A2, A6
	Implementation of deontological rules and collaborative working tools	P1 et P2	6	D1
	Launching of the LACCAVE Web site	P1 and P2	12	D2
	Visibility of the project : Presentation of the project and its outcomes in front of institutions and professional representatives	P1 and P2	0-48	A3
	Reporting for the general meetings	Coordination board	6, 27	D3, D5
	Coordination board meeting	“	2, 12, 25, 36	A2, A4, A6, A8
	Annual scientific reporting	“	15, 27, 39	D4, D6, D7
	Organisation of the international workshop	Coordination board	30-45	A7
	Final meeting and international workshop	“	45	A9
	Final report of the project	“	48	D8
	Proceedings of the final workshop release	“	48	A9

WP1	From Month 1 to 36	Who ?	Month	Action (A) Deliverable (D)
	Contribution to the scientific reporting of the project	WP1 leaders	15, 30, 39, 48	D4, D6, D7, D8
WP 1-1	First general meeting Sharing knowledge between the partners	All the partners	2	A2
	Workshop to define common set of protocols and devices to measure the climate and vine response at local states	All the partners	6	A10
	Scientific proceedings of the first general meeting	All the partners	12	D9
	Litterature reviews as scientific publications	According to the discussions during A2	12	D10
	Booklet release for common protocols and devices (technical paper)	WP1 leaders	13	D11
WP 1-2	Field inquiries on the perception of CC	P12	1 - 26	A11
	Workshop with professional delegates about the a priori acceptability of innovations techniques	WP1 leaders, P1 and P2	18	A12
	Report and scientific publication on actors facing CC and its impacts	P12	36	D12
WP1-3	2007 IPPC scenarios downscaled at the level of vineyards and terroirs in constrated climatic regions and impact studies at various levels of the vine ecosystem : pest and disease, phenology, grape ripening and quality, land use (Ph-D T2)	P1, P3, P4, P10, P12, P14, P20, P21	1 - 24	A13
	Release of the scenarios and impact studies	P1, P3, P4, P10, P12, P14, P20, P21	24	D13
	Workshop on the downscaling and modelling process and the accuracy of the prediction	P1, P3, P20	24	A14
	Workshop report on downscaling and modelling	P1, P3, P20	27	D14
WP1-4	Formalizing the issues, constraints and hypotheses set by CC	All the partners	24-36	A15
	Second general meeting to launch the WP1-4	All the partners	25	A6
	Computation of results obtained from WP1, WP2 and WP3	All the partners	25-32	A16
	On-line data-base with project results	All	32	D15
	Scientific Report about “the issues, constraints and hypotheses”	WP1 leaders, P1, P2	30	D16
	Regional workshops with professional delegates about issues, constraints and hypothesis	WP1 leaders, P1, P2	32-34	D17
	Final report for WP1	WP1 leaders, P1, P2	36	D18

WP2	From Month 1 to 48	Who ?	Month	Action (A) Deliverable (D)
	Contribution to the scientific reporting of the project	WP2 leaders	15, 30, 39, 48	D4, D6, D7, D8
WP2-1	Inventory of existing non destructive phenotyping tools for canopy development, berry composition and root development and experimental set-up	P7, P1, P4	1-12	A16
	Workshop to define common set of protocols and devices to measure the climate and vine response at local states	All the partners	6	A10
	Propose and test efficient non destructive phenotyping tools based on fluorescence and IR sensors, thermography and hyperspectral imaging in order to monitor canopy development and berry composition.	P7, P14, P16	36	D19
	Development of high-throughput non-invasive tools for phenotyping root traits for a large number of rootstock genotypes	P1	1-36	A17
	Set-up and scientific publication for phenotyping root traits	P1	36	D20
WP2-2	Analysis and modeling of the physiological and genetic determinism of water saving strategies (iso/anisohydric) in grafted grapevine and their relationships with carbon acquisition and growth (Ph-D T3)	P1, P7	9-45	A18
	Exploring genetic variability of high temperatures effects on fruit components, including flavonoids and terpenoids biosynthesis in grape berries.	P1, P5, P9, P13, P17	1-36	A19
	Scientific publications on the genetic variability of high temperatures effects on fruit components, including flavonoids and terpenoids biosynthesis in grape berries.	P1, P5, P9, P13, P17	36	D21
	Manuscript release and defence of the Ph-D work for T3	P1, P7	45	D22
WP2-3	Producing knowledge on the effects of grape adaptative responses to environmental changes on must fermentability, wine organoleptic characteristics, and wine aging potential using sensorial analysis and microvinification methods.	P13, P4, P17	1-36	A20
	Analyse the effect of vine water stress on the aromatic composition of musts and wines	P1, P13, P14, P17		A21
	Scientific publications	P13, P4, P17	36	D23
WP2-4	Development of process-based phenological models and databases for projections of grape phenology under different climate change scenarios.	P1, P5, P20	1-24	A22
	Release of phenological models and databases	P1, P5, P20	24	D24
	Development and networking of new and existing models for phenology, plant growth and development and grape berry composition to simulate future genotype x environment scenarios.	P1, P7	1-48	A23
	Critical analysis of existing models at different plant scales	P1, P7, P20, P21	24	D25
	Internal workshop with WP2 about crop modelling : from individual plants to vineyards	P1, P7, P10, P15, P20, P21	40	A24
	Scientific outcomes of the internal workshop about crop modelling: scientific priorities –	WP2 and WP4 leaders	45	D26
	Release of a framework for an integrated grapevine development models able to simulate future genotype x environment scenarios.	P1, P7, P15,	48	D27

WP3	From Month 1 to 48	Who ?	Month	Action (A) Deliverable (D)
	Contribution to the scientific reporting of the project	WP3 leaders	15, 30, 39, 48	D4, D6, D7, D8
	Contribution to the workshop with professional delegates about the a priori acceptability of innovations techniques	All the partners from WP3	18	A12
	Contribution to WP4-3	All the partners from WP3	22-48	
WP3-1	Assessment of new enological practices and technologies for the improvement of wine quality	P14, P17	1-48	A25
	Choice of the best electro-separative method for decreasing the pH of wines without altering their sensory properties.	P14, P17	18	D28
	Development of a precise combination of different technologies based on controlled extraction and separation steps for the assessment of the skills of new vine varieties.	P13, P14, P17	36	D29
	Development of innovative approaches at the various steps of winemaking for a complete control of the process.	P13, P14, P17	48	D30
WP3-2	Evaluation of irrigation rational use of vines with agricultural and alternative waters	P7, P14, P15	1-24	A26
	Evaluate new tools to improve the efficient use of irrigation water.	P14, P17	1-24	A27
	Release of new tools to improve efficient of irrigation water	P14, P17	24	D31
	Analysis of impacts of alternative irrigation water on the system soil / subsoil / plant / grape / wine.	P14, P15, P17	12-48	A28
	Publications on the impacts of alternative irrigation on vine and wines	P14, P15, P17	48	D32
	Technical publications about new irrigation strategies	P14	48	D33
	Performance characterization of new training systems	P14, P17	1-48	A29
	Behavior characterization of new training systems in terms of bearing, vigor, drought tolerance, disease resistance and quality of grapes and wines.	P14, P17	36	D34
	Economic evaluation of training systems according to different varieties and production targets	P2, P14, P19	48	D35
WP3-3	Characterization of the genetic variability for sugar accumulation, phenology, drought and temperature tolerance of a large set of germplasm	P1, P7, P9, P11, P16	1-48	A30
	Scientific publications about the genetic variability existing for these traits	P1, P7, P9, P11, P16	36, 48	D36
	Proposition of existing scion and rootstock varieties which could be interesting for the future	P1, P5, P9	45	D37
	Framework proposal around the development of new breeding scheme, in relation with WP 2 and in relation with Genomic selection Meta programme	P1, P5, P9, P11 with WP2 leaders	24-48	A31

WP4	From Month 1 to 48	Who ?	Month	Action (A) Delivery (D)
	Contribution to the scientific reporting of the project	WP4 leaders	15, 30, 39, 48	D4, D6, D7, D8
	Contribution to the workshop with professional delegates about the a priori acceptability of innovations techniques	All the partners from WP4	18	A12
WP4-1	Concertation with other WPs and formulation of "scientists" CC scenario for the two study areas	All the partners	9-12	A32
	Enquiries on actor's views on CC adaptation schemes	P4, P12	12-18	A33
	Production of a limited set of narrative CC scenario including different proposal of innovations to face CC	P12	18	D38
	Derivation of spatially and temporally explicit scenario (Languedoc, Val de Loire)	P4, P10, P12, P15	18-21	A34
	Digital maps of spatial allocations of vine and selected innovations + intra annual calendar of vineyard operations	P4, P10, P12, P15	21	D39
WP4-2	Modelling vine physiology and wine quality at the vineyard scale (Val de Loire)	P4, P15	18-36	A35
	Outcomes of the models in terms of phenology , date of harvest, grape composition, wine typicity for different types of wines, at the regional level (Val de Loire)	P3, P4	36	D40
	Modelling environmental features in Val de Loire (thesis T2)	P3, P4	18-36	A36
	Digital mapping of CC associated risks (frost, run-off …) and on-line adaptation scenarios of existing cartography of terroir units.	P4	36	D41
	Integrated modelling in Languedoc-Roussillon	P10, P15	18-36	A37
	Quantified and spatialised indicators of vine production and environmental impacts	P10, P15	36	D42
	Manuscript release and defense of the pH-D work for thesis T2	P3, P4	47	D43
WP4-3	Accessing the acceptability of innovations (in coordination with WP1-2, and WP3)	P2, P12	1-48	A38
	Two batches of interviews	P12	1-21	A39
	Report on vintners facing climate change and impact within their activity tied with wine	P2, P12	21	D44
	Third batch of interviews (non producers)	P12	22-36	A40
	Report: global socio-technical regimes of actions in the wine domain facing climate change	P2, P12	36	D45
	Recruitment of participants in relation with WP3, organisation of the focus group sessions	P2, P12 and partners from WP3	33-48	A41
	Report on general acceptability of climate change adaptation scenario (in coordination with WP7)	P2, P12	48	D46
	Workshop with professional delegates about the outcomes of the project in term of acceptability of innovation	P2, P12 and partners from WP3	45	D47

WP5	From Month 1 to 48	Who ?	Month	Action (A) Deliverable (D)
	Contribution to the scientific reporting of the project	WP5 leaders	15, 30, 39, 48	D4, D6, D7, D8
WP5-1	Evolution of consumer behaviour (Ph-D, T1)	P6, P8,	1-48	
	State of the art - Links between spatial scale and wine quality.	P2, P6, P8, P19	1-12	A42
	Release of the literature review	P2, P6, P8, P19	12	D10
	Definition of credible scenario of sensory characteristics of wines	P6, P8	12-18	A43
	Testing workshop - Analysis of consumer behaviour	P6, P8	12-30	A44
	Analysis of the economical consequences	P6, P8	24-36	A45
	Scientific publications	P6, P8	40	D48
	Ph-D manuscript release and defence	P6, P8	47	D49
WP5-2	Producer location strategies at regional and international levels	P2, P6, P8, P12, P19	12-36	
	Master work on the way producers will take into account the perception by consumers of the new types of wines	P2, P6, P8, P12, P19	13-18	A46
	Release of the master work	P2, P6, P8, P12, P19	18	D50
	Analyses on the way producers will take into account the cost of adaptation to new climatic conditions	P2, P6, P8, P19, P12	25-31	A47
	Data analyses and scientific publications on the subject	P2, P6, P8, P12, P19	31	D51
WP5-3	Competition between regional vineyards at European levels	P2, P8, P12, P19	12-36	A48
	Internal notes to WP7	P2, P8, P12, P19	24, 36	D52
WP5-4	Impact of CC on wine regulation	P2, P8, P12, P19	24-40	A49
	Master work	P2, P8, P12, P19	25-31	A50
	Release of the Master work	P2, P8, P12, P19	31	D53
	Reports and recommendations to INAO	P2, P8, P12, P19	40	D54

WP6	From Month 1 to 48	Who ?	Month	Action (A) Deliverable (D)
	Contribution to the scientific reporting of the project	WP6 leaders	15, 30, 39, 48	D4, D6, D7, D8
WP6-1	Definition and design of knowledge and databases models	P18, P22 with all the partners	1-15	A51
	Inquiries about the existing databases among the partners	P18, P22	1-12	A52
	Release of models	P18, P22	15	D55
WP6-2	Construction of an integrated information system	P18, P22	9-48	A53
	Design of a new method and prototype to extract information from text and tables of heterogenous data sources (thesis T4)	P22	9-46	A54
	Release of the Integrated information system for wine sector for existing data and data generated within the project	P18, P22	24	D56
	Manuscript release and defence of the Ph-D work for thesis T4	P18	47	D57
WP6-3	Statistical analyses of integrated data	P22 with all the partners	13-48	A55
	Internal workshop in order to collect the needs of the partners, what kind of methods can be applied and to build more specific collaborations	P22 with all the partners	18	A56
	Report of the internal workshop about statistical analyses	P22	24	D58
	Statistical analyses and interpretation of integrated data collected during the project	P22 with all the partners	39	D59

WP7	From Month 1 to 48	Who ?	Month	Action (A) Deliverable (D)
	Contribution to the scientific reporting of the project	WP7 leaders	15, 30, 39, 48	D4, D6, D7, D8
	Official report on the adaptation scenarios for the institutional organizations and policy makers	WP7 leaders	48	D60
	Official report for INRA about research issues and priorities	WP7 leaders	48	D61
WP7-1	Building CC adaptation scenarios for wine regions	P2 with WP7 committee	1-48	A57
	Preparation of the WP7 sessions during the general project meetings	P2 with WP7 committee	1, 20, 40	A58
	WP7 sessions (general project meetings)	All the partners	2, 25, 45	A59
	WP7 committee meetings: analyses and integration of the results	P2 with WP7 committee	9, 15, 26, 45	A60
	Methodological report about the adaptation scenarios approach	P2, P19	24	D62
	Successive evaluations on strategic scenarios (definition, impact, conditions)	P2 with WP7 committee	3, 26, 47	D63
	WP7 Committee meetings reports	P2	10, 16, 27, 47	D64
	Redaction of final scenarios and impact assessment	P2, P19	36-48	D65
WP7-2	Assessment of the CC adaptation capacity building, role of research and innovation systems (thesis T5)	P2	9-45	A61
	Litterature review and definition of the method	P2	9-15	A62
	Conceptual publication	P2	15	D66
	Institutional assessment of regional vs sectorial organizations	P2	15-21	A63
	Scientific publication on the characterization of the wine “system of innovation” in the main wine region	P2	21	D67
	Relational inquiries in 3 vineyards	P2	18-30	A64
	Report presenting the innovation networks – Methodological article	P2	30	D68
	Testing the impacts of the relational data on adaptation strategies to CC	P2	30-45	A65
	Manuscript release and PhD defence – Scientific publication	P2	45	D69
WP7-3	Consulting WPs on new research issues	WP leaders	30-36	A66
	Internal reports about scientific issues	WP7 leaders	36	D70
	Synthesis of result confrontation to the scenarios	WP leaders	36-48	A67
WP7-4	Consulting WPs on operational results	WP leaders	30-36	A69
	Internal reports about operational results	WP7 leaders	36	D71
	Synthesis of the operational result confrontation to the scenarios		33-46	A70
	Articles in technical review	P2	48	D72