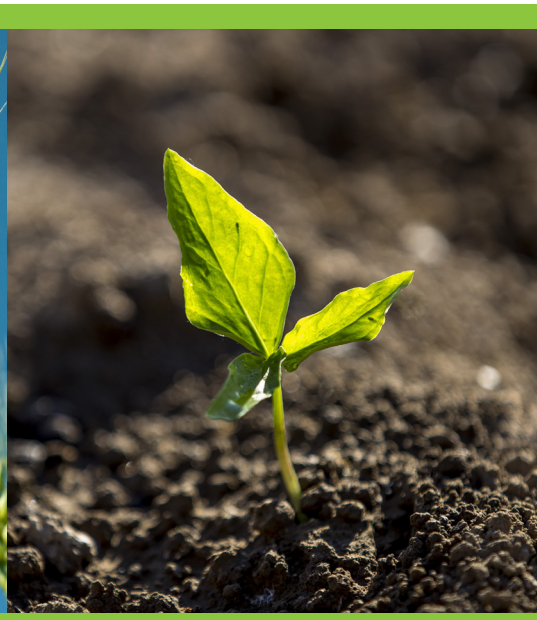
FACCEJPI

Agriculture, Food Security and Climate Change





Synthesis of the valorisation survey FACCE-JPI funded projects

MACSUR, ERA-NET PLUS and Multi-partner call on GHG mitigation

2017

www.faccejpi.com

Acknowledgments

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The Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI) aims to tackle the grand societal challenges related to sustainable agricultural development and food security in the face of climate change that cannot be solved solely on the national level.

FACCE has developed a valorisation strategy, with the aim to show impact on the global societal challenge and feed in to policy and evidence-based decision making. The first step in this valorisation strategy will be a series of workshops gathering together researchers and stakeholders and giving rise to policy and practice briefs. The first pilot workshop on climate will be on 22 March 2017.

To prepare the valorisation workshops and highlight the key achievements of FACCE-JPI projects, project coordinators were asked to reply to a survey on three main issues: **key scientific, key policy-relevant and key practical findings / innovative solutions.**

We will use further in the text three icons when addressing these issues for separate projects:


Key scientific outcomes


Key policy-relevant findings /outputs


Key practical findings / innovative solutions

Regarding key policy-relevant findings, two major climate related policies were identified to which FACCE-JPI funded research could contribute: **1) EU Climate and energy package action and COP21 follow-up and 2) Common Agricultural Policy (CAP) and CAP 2020+.**

For the first pilot valorisation workshop on climate we invited projects from the three most advanced climate related actions: **MACSUR, the ERA-NET Plus on Climate Smart Agriculture** (11 funded projects) and the **Multi-partner Call on Agricultural Greenhouse Gas Research** (11 funded projects). Therefore below you can find the main results from the valorisation survey for these actions/projects.

The valorisation survey was sent to all the projects coordinators in October 2016. From 22 projects and the MACSUR Knowledge Hub (KH), we got responses from 18 projects and from MACSUR (General KH results, specific for CropM and LiveM).

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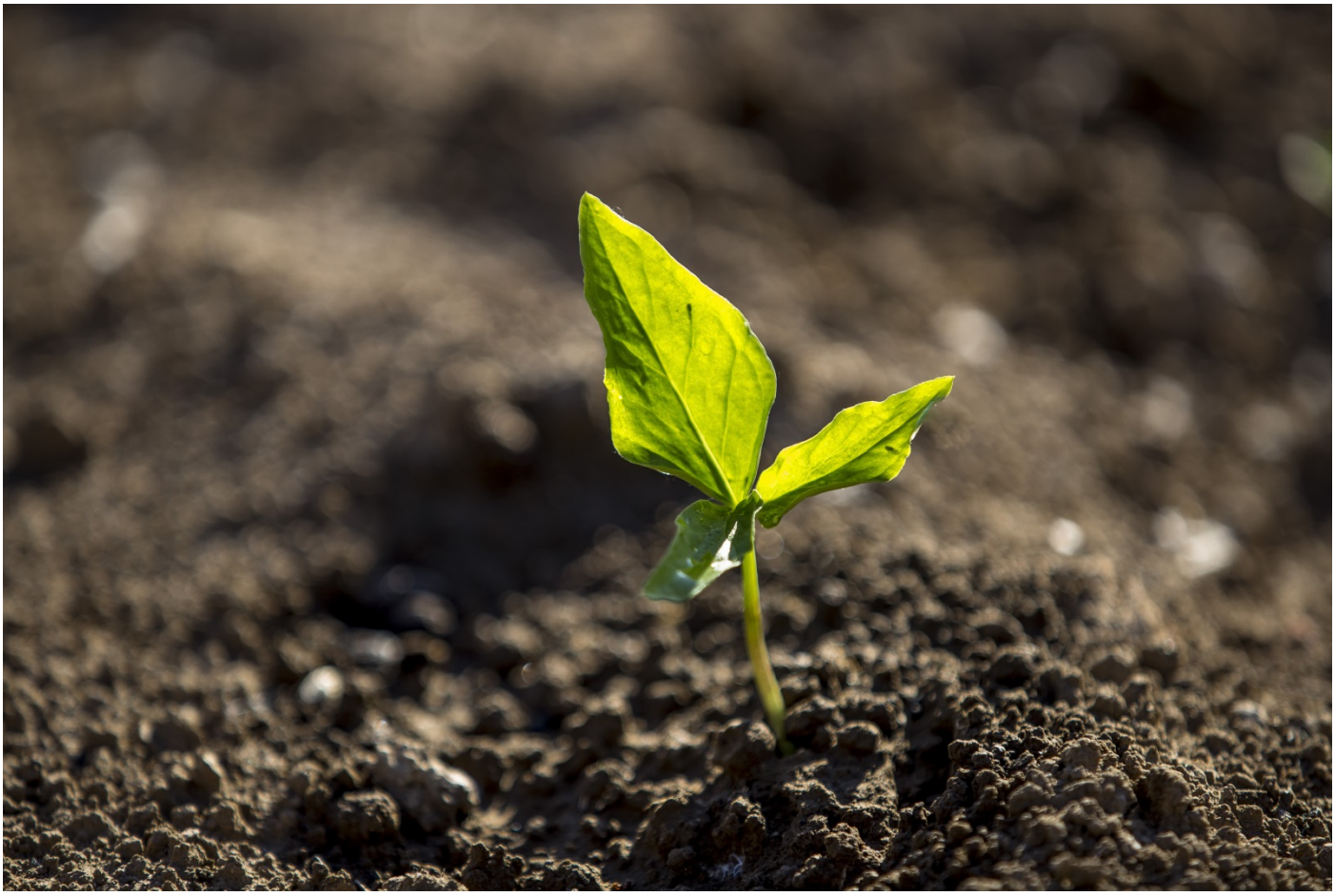
FACCE-JPI Knowledge Hub on Modelling the Impacts of Climate Change on Food Security (MACSUR)[1]

MACSUR is the pilot FACCE-JPI action, which started in June 2012 for 3 years (MACSUR1). It was extended for a further 2 years (MACSUR2) until May 2017. Further extension of MACSUR3 is under consideration. MACSUR addresses the modelling of impacts of climate change on European agriculture and food security and the reduction of uncertainties in climate change scenarios. MACSUR consists of 3 coordinated and integrated networks on 1) crops (**Crop M**); 2) grasslands and livestock (**Live M**) and 3) economics and trade (**Trade M**).

MACSUR has a unique position in assessing risks and opportunities for agriculture and food security due to climate change. It is a unique agricultural system modelling community with top subject matter specialists covering the majority of relevant disciplines (crop science/agronomy, livestock, farming, agricultural markets and trade) to both generate information to feed societal debates on climate, agricultural and land use policies, and achieve scientific excellence.



[1] www.macsur.eu

MACSUR members conduct research aimed at improving the modelling of European agriculture with climate change for food security. The improvement of individual models can increase the certainty of model-based impact assessments and allow more practical, i.e. smaller, model ensembles to be used effectively. Going beyond single crop species, MACSUR initiated the first model inter-comparison on crop rotations. Continuous simulation of multi-year crop rotation yields outperformed single-year simulation.

MACSUR has extended the concept of crop model comparisons and ensemble modelling to grassland production. Different grassland models capture features of specific grasslands so that care must be taken in the choice of models. Livestock models are even more diverse than grassland models so that comparisons of models, approaches and research gaps was a great step towards improvement of livestock modelling in integrated crop-livestock-socioeconomic model systems. Having good livestock models is necessary for assessing the effectiveness of climate change mitigation measures in agriculture.

Farms are a business and therefore farmers must balance climate change effects on crops and livestock with other constraints and opportunities. Socio-economic analyses of regional case studies by use of models indicate the impacts of climate change in their context with policy, economy and environment. Thus, one case study[2] shows that changes in farm income under climate change is higher when adaptation policies are in place. However, increasing productivity from climate change leads to deteriorating environmental conditions such as declining plant species richness and landscape appearance. It has to be balanced by mitigation and adaptation policies taking into account effects from the considerable spatial heterogeneity.

Publications: 391 journal articles and book chapters, 247 books and technical reports.

The results from MACSUR research formed part of the scientific bedrock of the COP21 agreement in Paris in 2015. MACSUR made the significant European agricultural contribution to the IPCC and UNFCCC work. MACSUR members also contribute directly to policy documents as authors, e.g. the IPCC's 5th assessment report's chapter on food security or the EEA Report on climate change, impacts and vulnerability in Europe (January 2017). LiveM also has a unique focus at the farm-scale, and they are presently putting together a synthesis of MACSUR findings relevant for small-holders (SHs) at the farm-level.

Within LiveM, three recent position papers (one looking across modelling of ruminant systems in Europe, one focusing on grassland modelling, and one focusing on livestock health and pathogen modelling) set out the priorities for developing the modelling capacity to tackle the issues that are the focus of these policies. These are intended to help policymakers and funders understand the strengths and uses of current tools and what they need in order to contribute more. Just two examples of how LiveM activities can support policy-relevant research include contributions to regional case studies working with regional stakeholders across Europe and new approaches to stakeholder engagement in modelling.

Improved agricultural models contribute to alerting policymakers, farm advisors and farmers to likely future trends, both threats and opportunities.

Research is closest to marketable innovation for breeding companies, where MACSUR models can guide breeders in the selection of future varieties/breeds.

[2] Conclusion from a case-study for the Austrian region Mostviertel

FACCE ERA-NET Plus on Climate Smart Agriculture: Adaptation of Agricultural Systems in Europe[3]

Projects were to address one or more of the four areas highlighted as key to advancing research in this area: i) genetics and breeding of animals and plants to increase resilience to climate change, ii) pests and diseases linked to climate and posing significant risks, iii) adaptive management of water and soil resources and iv) options for adapting agricultural systems.

Among the 11 selected projects two concern **organic soils**, two concern **livestock** (one on breeding, one on housing), one concerns **pests** and the rest concern **different plants and crops (barley, rice, Brassica, grasslands, cropping systems)**.

The ERA-NET Plus mid-term meeting will take place on 21st March 2017, back-to-back with valorisation workshop.

We received responses from 9 projects coordinators (of 11 projects).

[3] https://www.faccejpi.com/Research-Themes-and-Achievements/Climate-Change-Adaptation/ERA-NET-Plus-on-Climate-Smart-Agriculture

GreenRice[4]: Sustainable and environmental friendly rice cultivation systems in Europe

	GreenRice contributes to adaptation to climate change by defining a water-saving cropping system for rice with expected reduction of methane emissions as a short term option. On a medium-term perspective, using advanced breeding methodology such as genomic selection, the project will develop varieties adapted to alternate wetting and drying system (AWDS) that carry the right combination of tolerance to abiotic stresses, resistance to emerging pest (root knot nematode) and disease (blast) and response to root colonization by Arbuscular Mycorrhizal Fungi (AMF) which will be needed in the new cropping system. AWDS will, then, represent an alternative scenario that can be proposed to stakeholders in the partner countries but also, more broadly, to the other European rice growing countries such as Portugal, Greece, Romania, Bulgaria or Hungary. GreenRice contributes to greenhouse gas mitigation by shifting from a system that is a significant source of methane but contributes to carbon sequestration by taking CO2 from the atmosphere to a system that drastically decreases methane emission. The effect of AWDS on N_2O, presently unclear, will have to be assessed. GreenRice contributes to assessing and reducing trade-offs between food supply, biodiversity and ecosystem services. *Publications: 1 poster + 1 conference paper+ dissemination to stakeholders (3 in France, 1 – Italy, 1-Spain)*
	The GreenRice project contributes to EU policy on climate change through the expected reduction of GHG emission and water savings in a context of complex agro-ecosystems. It fits well with the three priority areas of the Common Agriculture Policy ("biodiversity and the preservation and development of natural farming systems", water management and use" and "dealing with climate change") as described in the "Agriculture and the environment" policy area (http://ec.europa.eu/agriculture/envir/index_en.htm).
	GreenRice will identify varieties that maintain their productivity under AWDS (alternate wetting and drying system) through whole genome association mapping of a large panel of temperate varieties, using genomic selection to predict the values of additional breeding lines. Traits determining adaptation to AWDS will be investigated. An extensive gene expression study will identify the root types and genes important in transport process and the degree to which they are affected by AWDS. The results obtained will be disseminated to local stakeholders (primarily farmers and natural park authorities) and to the scientific community.

[4] There is also other project named "GreenRice": Greenhouse gas emissions from paddy rice soils under alternative irrigation management, under Multipartner call on GHG mitigation

GRASSLANDSCAPE: Bridging landscape genomics and quantitative genetics for a regional adaptation of European grasslands to climate change

	GRASSLANSCAPE used an innovative methodological frame (landscape genomics) to screen the natural diversity of a grassland species (perennial ryegrass) in order to discover genetic variability involved in environmental adaptation, and more specifically in climatic adaptation. Association models between genomic polymorphisms and environmental variations are presently used to map the spatial distribution of genomic markers linked to adaptive diversity in present climatic conditions and to foresee possible shifts in the spatial range fitting these markers in the context of several climate change scenarios based on the four Representative Concentration Pathways of IPCC AR5. Based on these results, allelic profiles of perennial ryegrass will be defined that are expected to provide climatic adaptation at regional scale over Europe under the future climatic conditions foreseen by climate models. *Publications: 1 article, 1 conference paper, 3 posters.*
	Grasslandscape contributes to strengthen any policy including the concern to maintain or increase grassland acreages in the EU. Since the 1990s, there has been an increasing concern about the need to stabilise the EU permanent grassland acreage. There has also been a focus on the interest of increasing the acreage of temporary meadows even if their benefit on environment and soil protection is smaller than that of permanent grasslands. Since 1992, CAP reforms have incited farmers to maintain grasslands through demands of cross-compliance mandatory to obtain direct payments from CAP pillar 1 and through encouragements provided by agri-environmental measures (AEM) promoted by CAP pillar 2. The last CAP reform for the period 2014-2020 has again reinforced demands and encouragements to farmers for environmental protection and for maintaining grasslands.
	In GRASSLANSCAPE project a number of genetic pools will be designed mixing different natural populations. These genetic pools will be the basis to initiate breeding programmes aiming to deliver improved populations adapted to future regional climates. These improved populations will enable to restore grasslands degraded by future climatic disruptions.

SYBRACLIM: Securing yield stability of Brassica crops in changing climate conditions

	SYBRACLIM involves genetic, genomic and molecular analyses of Europe's primary Brassica oilseed crop, to increase resilience to abiotic stress factors triggered by climate change. One of the best examples of the potential impact of SYBRACLIM results is the analysis of pod shattering in response to high temperature. Recent results from the SYBRACLIM project showed that increasing temperature by a few degrees C leads to a doubling of shattering, suggesting that average losses could increase to 40% in the field. Measures that lead to an improvement in pod shattering resistance under high temperatures can not only lead to an increase in grain yield but also to increase the income of farmers. The innovative character of the project with a multi-layered multidisciplinary approach, consisting of modern phenotyping, genetic, transcriptomic and modelling studies will help to assess the impact of climate change on agricultural production and ensure punctual adaptations of agricultural production systems. *Publications: 2 peer-reviewed articles.*
	SYBRACLIM will significantly contribute to the development of climate adapted and flexible oilseed rape cultivars due to the uncovering of new physiological strategies and mechanisms as well as genetic components involved in drought and high temperature resistance in Brassica crops, and their role in crop yield stability. SYBRACLIM will also help to assess the effects of climate change on plant-based production. As a result a forecast of possible risks associated with climate change and provision of measures that can be initiated in time will be defined and therefore agricultural production systems can be adapted at an early stage to prevent crop losses.
	Results from SYBRACLIM can be directly used in the selection process and integrated in commercial breeding programs for the establishment of stable cultivars which can cope with climate change. SYBRACLIM findings will contribute to the development of tools to improve the adaptability of oilseed Brassica crops to the current scenario of climate change and the global warming associated with it. ISICROP statistical modelling framework is being developed that could help to find the correlations between oilseed rape yield and climate variables at different periods of the growing season of the crop by using newer regression techniques that were more powerful than classical ones in identifying the important climate variables contributing to the oilseed rape yield, as well as in accurate prediction of the yields.

Genomite: New generation sustainable tools to control emerging mite pests under climate change

	The project Genomite focuses on understanding the interactions between spider mite *(Tetranychus urticae/T.evansi)*, their host plants and climate change combining genomics, metabolomics and computer modeling approaches to understand the impact of climate change on this major cosmopolitan chelicerate pest. The results revealed that drought stress caused by climate change may have a profound impact on proliferation and economic crop damages caused by these pests. Spider mite population modeling under different climate scenarios and latitude-microenvironment studies (Stavrinidis et al. unpublished), revealed that the spider mite ecological niche will expand with climate change, especially expanding northwards Europe representing an increasing threat to crop security. Cumulatively the research provides novel data on spider mite expansion, interaction with plant stress caused by climate change and reveals novel molecular mechanisms that mites use to suppress plant defense response. These data will be critical for the development of novel sustainable management strategies aided by novel protocols developed by this project. *Publications: 40 articles mainly in peer-reviewed journals.*
	The project is still at too early a stage to provide concrete measures for the pest management. However, it is clear that reduction of drought stress has a potential to reduce spider mite damage and reduce their populations. Also, growing stress-resistant varieties appears to be an alternative strategy that will reduce pest populations. The target(s) of spider mite injected proteins that manipulate plant defense need to be evaluated as potential breeding targets for plants that can resist spider mite damage. Experiments in progress will reveal metabolite profiles of plants attacked by spider mites as a potential source of plant molecules toxic to spider mites, providing potential plant-based pesticides coming from edible plants.

OptiBarn: Optimized animal-specific barn climatization facing temperature rise and increased climate variability

	The OptiBarn target is to develop region-specific, sustainable adaptation strategies for dairy housing, focusing on an optimised climatisation of naturally ventilated buildings. Appropriate construction methods and management of the buildings can improve the thermal control, provided that precise identification of factors affecting the thermal control capacity of the buildings under practical farm conditions is undertaken. In this context, indicators for an optimisation of livestock buildings under climate change will be developed in OptiBarn by: (i) Barn-specific assessment of the influence of outdoor climate on the indoor conditions, (ii) Region-specific risk analysis on how often extreme weather situations will occur, (iii) Monitoring animal-individual stress responses to the indoor conditions, (iv) Development of engineering solutions. (v) Modelling tools to assess environmental and economic cross effects of adaptation alternatives. Optibarn in close cooperation with MACSUR identifies challenges for modelling livestock health. The key findings are propagated to farm scale modelling to assess emissions and economic impacts of climate change for the dairy sector. Uncertainties attributed to climate change scenarios, resulting from sampling strategies (due to nonstationary, inhomogeneous conditions inside the buildings) and related to the animal individual responses are compiled. This is the base to improve risk assessments and to support the development of regional, sustainable adaptation strategies for the dairy sector, thus contributing to agricultural resilience and promoting the future availability of high quality dairy products. *Publications: 5 articles, 2 conference papers, 1 poster.*
	OptiBarn project can contribute to the aim of a 20% cut in greenhouse gas emissions. Furthermore, improvements in the monitoring and evaluation of microclimatic conditions in dairy barns facilitate a targeted use of fans or sprinklers in naturally ventilated dairy barns and thereby can contribute to the improvement of energy efficiency. OptiBarn addresses two of the key objectives of CAP: viable food production and the sustainable management of natural resources and climate action by supporting the development of guidelines of dairy housing in naturally ventilated barns in Europe. These studies facilitate recommendations on sampling strategies and parameters for the evaluation of the housing. Moreover, objective heat stress parameters are explored which take into account the uncertainties in evaluating microclimatic parameters and individual animal parameters.
	The results of OptiBarn are intended to stimulate new concepts of building and ventilation design. Moreover, recommendations for the monitoring of crucial variables to implement smart ventilation and management concepts that minimize the impact of climate change on dairy production are provided. Building up on the OptiBarn studies smart control systems can be designed in such a way that in the future the cows' can actively regulate the microclimatic conditions in the barn.

CAOS: Climate-Smart Agriculture on Organic Soils

	The CAOS project aims to generate the knowledge to design climate smart agricultural systems for organic soils adapted to the diverse regional conditions of Europe. CAOS will provide and distribute evidence that climate smart management improves yield stability and quality as well as resilience to climate change while providing strong GHG mitigation and improved soil and water quality. Study regions represent typical land use systems and unique challenges in six regions in Europe with a large share of organic soils drained for agriculture. In each study region, on-farm evidence of past climate smart management is synthesized, including farm surveys and expert knowledge. In four study regions, field experiments are conducted with innovative climate smart management options comprising active water management (van den Akker et al., 2012), soil management (sand addition) (Berglund & Berglund, 2016), and wetness-tolerant species for bioenergy use (Kandel et al., 2013). *Publications: 1 peer-reviewed article, 8 conference papers, 1 other publication.*
	CAOS project's results will be very relevant for the development and evaluation of mitigation strategies especially in the land use, land-use change and forestry (LULUCF) sector, the analysis of policy options and identification of potential caveats. In the partner countries, GHG emissions from organic soils are a major contribution to the GHG budget from agricultural activities, and need to be targeted to reach the EU emission reduction targets. As part of the non-emission trading sector, agriculture should contribute to reducing GHG emissions by 16% in 2005-2020. This includes N2O from farmed organic soils. The EU Decision No 529/2013/EU (European Parliament and Council, 2013) sets accounting rules on greenhouse gas emissions and removals resulting from activities relating to LULUCF, including "cropland management", "grazing land management" and "wetland drainage and re-wetting, which refers to CO_2 and CH_4 from farmed organic soils. The member states will need to report on plans for mitigation measures and report progress in accomplishing the planned measures. In this context, CAOS will offer scientific and practical evidence basis to implement activities for GHG mitigation on hotspot areas in the short term and will provide the scientific basis towards climate smart management including both adaptation and mitigation. CAOS results will be highly relevant to develop options to integrate mitigation options for agriculture in the Common Agricultural Policy after 2020. The task "Policy Analysis" within the work package "Agro-economic evidence of climate smart farming under different political conditions" of the project is specifically designed to evaluate options to integrate climate-smart management of organic soils into the CAP. The policy analysis comprises the potential support of adapted management by the CAP and the potential support of the implementation of climate smart management by the existing European legal framework (e.g. ELER) in the different European regions. The policy analysis includes feedback from the survey, regional and European stakeholder workshop. Based on these results, the aim is to identify barriers and options to use the current agricultural policy and its instruments to extend the implementation of innovative management techniques. Furthermore, carbon footprints, labels and carbon markets are analysed. Based on the analysis of existing successful systems, suitable policy instruments will be designed that act on the most urgent barriers, costs and legal constraints.
	Overarching objective of CAOS project is to implement innovative climate smart management options for organic soils. The feasibility and implications for production are tested by on-farm water and soil management experiments addressing country-specific challenges regarding soil properties and agro-economic circumstances. Understanding of the water and soil management techniques will be improved. It will be developed and applied an improved coupled hydrological and crop growth model. Optimal management strategies increasing the synergies between adaptation, mitigation and agro-economic indicators will be identified.

CINDERELLA: Comparative analysis, INtegration anD ExemplaRy implEmentation of cLimate smart LAnd use practices on organic soils: Progressing paludicultures after centuries of peatland destruction and neglect

	CINDERELLA compares plant species and genotypes with respect to growth rate, nitrogen allocation, gas exchange (Tho et al. 2016), and biomass characteristics (Gianini et al. 2016) in order to identify the most productive and best adapted ones for various site conditions and to develop recommendations for their cultivation and use. The project has assessed the area potential for paludiculture in the respective countries, has implemented demonstration sites and organized several field days in the participating countries to provide information and raise awareness amongst stakeholders, and for taking samples to fill the joint database. The political and administrative boundary conditions have been analysed, and Ministries for Agriculture of the participating countries have been asked to optimize framework conditions for paludiculture implementation. *25 publications, from which: 3 conference papers, 3 book chapters, 4 policy related/technical documents*
	The CINDERELLA project contributes to both climate change mitigation and adaptation by restoring evaporative cooling, pollution control, flood mitigation and water retention. Reducing greenhouse gas emissions is an essential aim and consequence of peatland rewetting while reducing ecosystem damage. Framework conditions for CAP-payments are still not satisfactory and have to be optimized: including making paludicultures such as reed and cattail eligible for direct payments, phasing out of subsidies for drainage based peatland agriculture, and adapting agri-climate-environmental schemes, e.g. remunerating high water levels in agriculturally used peatlands. A transformation of grasslands into permanent paludicultures (e.g. cultivation of peatmoss, reed, cattail) should not be treated as ploughing up of grassland, i.e. should not need establishing compensatory new grassland.
	CINDERELA project will provide recommendations for site-specific, optimal agricultural use on peat soils, give an overview on productive species, provenances and breeds to be used in paludiculture, quantify GHG fluxes, C sequestration and nutrient retention. The project will provide specific recommendations how to start and maintain paludiculture farmlands concerning site suitability, initial soil treatment, optimal water level regimes, weed control, nutrient supply, sowing and planting techniques, optimal plant densities, harvest regimes and techniques, and possible applications (energy, food, fodder, material use).

MODCARBOSTRESS: Improving models and plant phenotyping pipelines for a smart agriculture under abiotic stress combination and elevated CO_2

	MODCARBOSTRESS questions and tests possible improvements of crop models by (i) evaluating some of the assumptions on which they are based (in particular in relation to the role of carbon and photosynthesis on growth), (ii) improving formalisms, (iii) testing these improvements using field experiments where stresses are combined and (iv) evaluating their impact on predictions of European food production. The project aims at delivering to simple, low cost, principles and solutions for manipulating combined stresses, including elevated CO_2, in experimental set-ups. A final outcome of the project will be to propose model improvements and to run them against climate model projections for Europe. Two crop species, bread wheat (Triticum aestivum L.) and oilseed rape (Brassica napus L.), are used but the project intends to revisit crop model rationales in a species independent manner. The results could serve as a basis for the improvement of models also on other species. Project gathers 7 European groups who bring their skills in modeling and knowledge of the plant function under stressful conditions.
	By improving crop models, MODCARBOSTRESS contributes to paving the way to large scale simulations of crop production in Europe for the next decades. Simulations associating improved models and a variety of cropping systems and climate scenarios could be relevant to policy makers involved in the set-up of CAP by encouraging both productive and climate resilient solutions, in terms of varieties, species, rotations, cropping systems.
	MODCARBOSTRESS project will provide improvements on models that will be readily translated into improvement of predictions by model ensembles that are more and more used for accurate prediction of crop production in future climate. This avenue will be used to set-up decision-making tools from the farmers to the policy makers.

Climate Cafe: Climate Change Adaptability of cropping and Farming systems for Europe

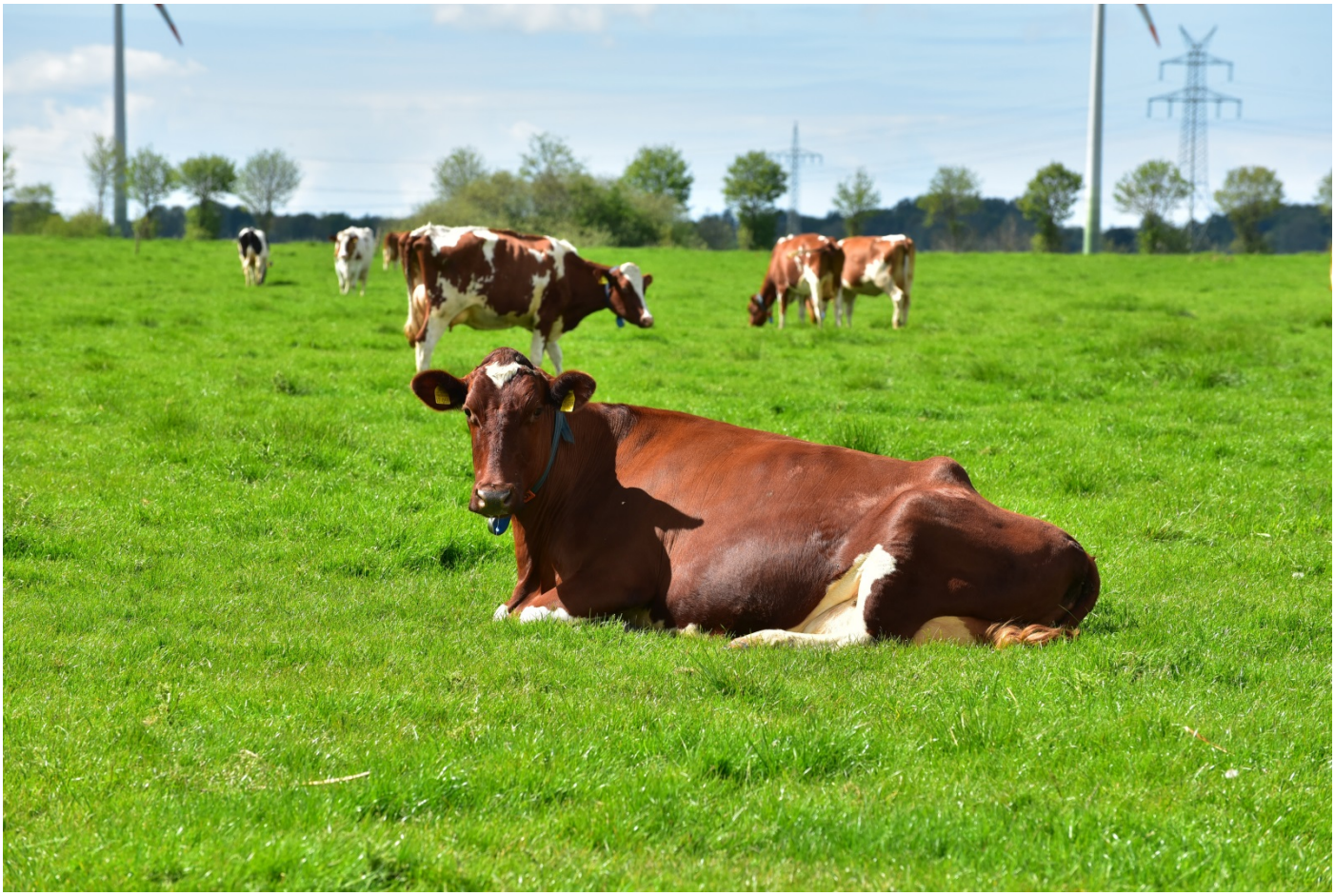
	Climate-CAFÉ focuses on increasing the “adaptive capacity” of arable and forage crops to climate change (CC). The project will use an interdisciplinary approach to evaluate traditional and more novel regional adaptation and mitigation strategies along a North-South climate gradient in the EU and propose new farming system designs for adaptation to CC. The evaluation includes synergies and trade-offs between strategies using different scales and indicators for IPCC scenarios up to 2100. The expected final results of the Climate-CAFE project are: i) an overview of possible effects of CC (scenarios of IPCC until 2100) on the current European cropping systems, ii) an overview of potential CC adaptation measures in accordance with farm constraints, iii) simulation of adaptation measures and their ranking in terms of efficiency and costs for the worst scenario of IPCC predictions until 2100. This work is considering a wide range of EU countries representing a North-South climate gradient in Europe based on the 10 Adaptation Pilots designed in the Climate-CAFÉ project.
	Relevance and possible contributions to the European Adaptation strategy.

Multi-partner Call on Agricultural Greenhouse Gas (GHG) Mitigation[5]

Among the 11 projects funded, the majority address **specific mitigation measures** (biochar, grass-fungal endophyte symbiosis, nutrition-related strategies, alternative irrigation of paddy rice, livestock – crop interactions, rumen microbiome). Two others aim to assess **the effectiveness of mitigation measures** and **one focuses on increasing the adoption of such options.** Finally, one project aims to set up **a whole farm GHG estimation and environmental diagnostics platform** and **one looks at C and N models to assess management options for mitigation.**

We received responses to the valorisation survey from 7 projects coordinators (11 altogether).

As for this action, projects' partners come also from outside Europe, including the USA and New Zealand, therefore the scientists are less aware about European policy needs. Nevertheless some possible contributions to climate-related policies are proposed below.



[5] https://www.faccejpi.com/Research-Themes-and-Achievements/GHG-Mitigation/multi-partners-call

CN-MIP: C and N Models Intercomparison and Improvement to assess management options for GHG mitigation in agrosystems worldwide (coordinated by INRA, France, with 10 other partners)

	With the support of the Global Research Alliance on agricultural greenhouse gases (GRA) and ADEME in France, the CN-MIP project took part in a major international scientific study which coordinated several projects, most of which are under the FACCE-JPI umbrella, in an area that concerns increasingly public action for national GHG inventories and soil carbon: crop and pasture modeling. A coordinated action of unprecedented scale (24 models, 16 models for croplands, 12 models for grasslands and 4 models for both, 45 teams from 11 countries) focuses on benchmarking and evaluation of simulations models using data from 10 international sites over 4 continents. It was shown that the median of a set of several models is a robust predictor of grain yields (wheat, maize and rice), of N_2O emissions and of soil carbon storage for crops and temperate grasslands from contrasting sites. It was also found that none of the models had superior performance under any circumstance to that of other models. This exercise has improved the models structure and parameterization and has extended their range of validity. *Publications and events: 2 peer-reviewed articles in preparation, 1 peer-reviewed article published, 1 book chapter, 5 oral communications, 4 scientific seminars during the course of the CN-MIP project (between them one with Models4Pasture project, and other – with Models4Pasture, MAGGNET et CometGlobal projects)*
	This work has several implications at a range of scales (local, regional, global) including improvement of national inventories from IPCC Tier 1 or 2 methods to Tier 3 methods (leveraging a set of models or a meta-model) (more details are provided). A second ongoing step is concerning the evaluation of climate change mitigation and adaptation options (changes in agricultural practices) by an ensemble of simulation models in response to countries commitments for climate negotiations. Finally, this work contributes to the international research program 4 per 1000, by evaluating the performance of soil C models to predict evolution of soil C stocks in response to agricultural practices.
	Improved models can be used to predict yields (maize, wheat, rice) and grassland productivity, and in particular the response of agro-systems to climate change (temperature, precipitation, atmospheric CO_2 concentration). The models will be used during the year 2017 to test mitigation options and their effects on productivity, N_2O emissions and soil carbon on a large scale (across all 10 sites' conditions). The mitigation options tested will primarily concern reduced fertilization, irrigation management, abandonment or reduction of tillage, and grassland intensity of pasture. The results should guide the implementation of mitigation options at regional level, taking into account the pedoclimatic conditions and agricultural systems.

Designchar4food: Enhancing both soil carbon sequestration and fertility while reducing soil greenhouse gas emissions through designer biochar application (coordinated by the United States Department of Agriculture-Agriculture Research Service with 5 other partners)

	Designchar4food's overreaching goal is to provide scientific data that establishes the baseline for "designer biochars". In this context, designer biochars are tailored with specific properties to alleviate soil deficiencies (e.g., low pH, poor nutrient levels, etc.) and to reduce nitrogen (N) losses via denitrification as N_2O (30 publications to date). The project initially started with 3 partnering countries (US, Spain and Germany) and has since grown to a collaborative network of 30 countries. In so doing, the project has leveraged the resources of this project to further the impact of the results and research. *Publications and other achievements:* *30 publications, more than 15 presentations in conferences, 3 trade publication articles, 8 students/post-docs that received partial support through this project*
	The Designchar4food results can contribute to the policies in increasing knowledge on the mitigation potential of biochar for reducing GHG emissions from agricultural operations.
	Designchar4food project's practical application of results entails refined designer biochar production guidelines that minimise losses of N via leaching and greenhouse gas formation. This designer biochar can be produced from a variety of agricultural and horticultural waste products. This could be a "win-win" scenario for producers and stakeholders because a waste product now has a value.

Endogas: Manipulating Grass - Fungal Endophyte Symbioses to Reduce Greenhouse Gas Emissions and Increase Soil Carbon Sequestration in Grasslands of Finland, Spain, and the United States **(coordinated by the University of Kentucky, USA, with 2 other partners)**

	The project is quantifying whether endophyte infection (Epichloë spp.) reduces GHG flux in tall fescue pasture of the USA, perennial ryegrass pasture in NZ, and meadow fescue pasture in Finland. In addition, they are quantifying endophyte effects on soil C sequestration for tall fescue, meadow fescue, and red fescue in multiple locations in Europe (two sites in Finland, one site in Spain, and one site in the Faroe Islands) as well as one site in the USA. Project results will inform whether this existing forage agronomic practice (manipulating grass-endophyte symbioses) has potential to help mitigate future climate change (10 publications in peer-reviewed journals). A unique database will be constructed and will be made publicly available on a project website, in an effort to facilitate and promote additional international work and analyses evaluating grass-endophyte effects on belowground processes. *Publications: 10 in peer-reviewed journals*
	Endogas results could be relevant to CAP 2020+ as perennial grass systems are often more environmentally friendly than row crop agriculture and the grass-endophyte systems of this project are located in most of the EU – so the results should be directly relevant to this group working on CAP as a relatively achievable and low-cost way to potentially gain some environmental benefits from animal production systems.
	If the ENDOGAS project finds significant differences between endophyte-infected and endophyte-free stands, it could mean that policy-makers should consider endophyte infection status as a means through which agricultural cool season grass pastures could help mitigate future climate change and meet reductions in agricultural GHG flux targets.

GLOBAL NETWORK: Global network for the development and maintenance of nutrition-related strategies for mitigation of methane and nitrous oxide emissions from ruminant livestock

(coordinated by Pennsylvania State University with 5 other partners)

	Ruminant husbandry is a major source of anthropogenic greenhouse gases (GHG). There is a large body of nutrition-related GHG and ammonia (NH_3) mitigation data. These data, however, are not well organized. The GLOBAL NETWORK will accumulate, analyze, and systematize these existing resources. The goals of this project are to: (1) Create, update, and expand animal and feed databases for mitigation of enteric methane (CH_4); (2) Gain understanding of the contribution of genetic and microbial factors to variation in enteric CH_4 production, digestion, and nutrient utilization; (3) Validate markers of enteric methanogenesis for the development and monitoring of CH_4 mitigation strategies in ruminants; (4) Create, update, and expand a database of mitigation strategies aimed at improving dietary N utilization and lowering N excretion and NH_3 and nitrous oxide (N_2O) emissions from manure; (5) Develop Standard Operating Procedures (SOP) and guidelines for conducting and assessing data from in vitro and in vivo studies designed to evaluate nutritional strategies for mitigation of CH_4, NH_3, and N_2O emissions; (6) Develop new and evaluate existing models for predicting CH_4 emission and N excretions under various nutritional, animal, and farm management scenarios; and (7) Identify and recommend CH_4, NH_3, and N_2O mitigation technologies that are practical and feasible for the specific conditions of livestock production systems in the consortium countries. Project's activities are integrated with the activities of the "Network and Database on Feed and Nutrition in Relation to Greenhouse Gas Emissions" (FNN), which is part of the Livestock Research Group of the Global Research Alliance (GRA). Work on the mitigation databases is almost completed and the team produced two review papers summarizing information regarding in vitro and in vivo methane measurement procedures.
	The GLOBAL NETWORK project will fill important knowledge gaps and provide the much needed expert recommendations for future research priorities, methodologies and science-based GHG mitigation solutions to government and non-governmental organizations, advisory/extension networks, and the ruminant livestock sector.

GreenRice: Greenhouse gas emissions from paddy rice soils under alternative irrigation management (coordinated by Ghent University, Belgium, with 3 other partners)

	GreenRice project's main objective is to translate new knowledge generated in the project on specific effects of alternative irrigation management (AIM) on GHG emissions in floodplain soils into the world's most widely used biogeochemical model, DNDC (DeNitrification DeComposition). The GreenRice project is evaluating the impact of reduced water use on the global warming potential of rice-based cropping systems. Part of the work applies to temperate irrigated paddy rice production. On the basis of field-experimental monitoring sets (Italy and Bangladesh), the project results are improving a biogeochemical simulation model (DNDC-rice). It is foreseen that the updated DNDC-rice model would be an improved instrument to perform larger scale scenario analysis of impact of agricultural management on paddy soil greenhouse gas emissions. *Publications: 10 in peer-reviewed journals, 3 – other publications (in Italian).*
	There will be a significant role for carbon sequestration and GHG mitigation in the next 20 to 30 years and it will be essential to accurately monitor these to estimate their role in closing the GHG emission gap. By the IPCC AFOLU (Agriculture, Forestry and Other Land Use) guidelines, reporting countries can choose between different tiers in estimating changes in C pools and GHG fluxes. At the ambitious so-called 'Tier 3 methods', higher order methods are used, like biogeochemical models. GreenRice will contribute to the improvement of models and as such to the accuracy of national GHG accounting.
	Within soil biogeochemistry and management, DNDC is well known and is probably the world's most widely used biogeochemical model. The project will open up generated datasets of the experiments to other modelers which will expand the impact of GreenRice even further beyond the already considerable community of DNDC-users. Scenario analysis by these updated models will be crucial in decision making support to mitigate GHG to meet expected future needs for adaptation to water shortage for food security.

MAGGNET: Quantifying Greenhouse Gas Mitigation Effectiveness through the GRA Croplands Greenhouse Gas Network (cordinated by the USDA Agricultural Research Service, USA, with 6 other partners)

	MAGGnet seeks to provide a platform for the inventory and analysis of agricultural GHG mitigation research throughout the world, with involvement from 46 Global Research Alliance (GRA) member countries. In 2012, a greenhouse gas (GHG) research network referred to as MAGGnet (Managing Agricultural Greenhouse Gases Network) was established within the Croplands Research Group of the Global Research Alliance on Agricultural Greenhouse Gases (GRA). To date, metadata from 315 experimental studies in 20 countries have been compiled using a standardized spreadsheet. Most studies were completed (74%) and conducted within a 1-3 year duration (68%). Soil carbon and nitrous oxide emissions were measured in over 80% of the studies. Among plant variables, grain yield was assessed across studies most frequently (56%), followed by stover (35%), and root (9%) biomass. MAGGnet has contributed to modeling efforts and has spurred other research groups in the GRA to collect experimental site metadata using an adapted spreadsheet. With continued growth and investment, MAGGnet will leverage limited-resource investments by any one country to produce an inclusive, globally-shared meta-database focused on the science of GHG mitigation (Liebig et al., 2016). *One publications published by now.*
	MAGGnet was used in January 2014 to help identify experimental sites for potential inclusion in an international model intercomparison exercise coordinated by the GRA Soil Carbon-Nitrogen Modeling cross-cutting team (Ehrhardt et al. 2015). This ambitious exercise, involving 28 models used in 11 countries, seeks to quantify prediction accuracy among models for estimates of crop yield, grassland dry-matter production, N_2O emission, net CO_2 exchange, and soil C stocks.

RumenStability: Understanding the development and control of stability in the rumen microbiome as a basis for new strategies to reduce methanogenesis (coordinated by TEAGASC, Ireland, and including 8 other partners)

	The project will identify and exploit long-term effects of short-duration dietary treatments on methane production, rumen function and responses to methane mitigation interventions at a later stage. There will be a focus on manipulations in early life, when the rumen community is developing, but also work on other diet transitions. The idea is to reduce the cost and effort of mitigation strategies by reducing the duration and/or quantity of treatment required and/or to increase the size of responses if treatments have to be reapplied. Whilst earlier studies with young ruminants have used potent anti-methanogenic compounds, this work focuses on the residual effects of some of the dramatic diet transitions experienced on-farm, including weaning and transitions to grazing or high-density finishing diets. This project addresses effects of management history on the interaction between the host and its microbiome and on methane production. The ability to identify differences between animals makes the work highly complementary to existing programs on the effects of host genetics/genomics on methane production. The long-term nature of these studies (manipulations in young animals affecting responses in adults) means that there are relatively few results at this stage. The expectation is that this set of studies will provide information about: inter-individual methane variation (genetic or epigenetic), how feeding level of calves and the metabolic status of cows influence methane production and nutritional additives which might be of interest to apply early in life to mitigate rumen methanogenesis. *Publications: 3 peer-reviewed articles, 8 conference papers.*
	Results from Rumenstability can show that the methane yield of dairy cows changes throughout lactation and depends on the extent of fat mobilisation in early lactation. These results should be considered when current and future attempts are undertaken to identify/select animals for different methane yields. When doing so, selection for low methane yield of dairy cows may bear the risk of compromising metabolic health.
	The Rumenstability project will provide more information on potential application of novel nutritional strategies to reduce emissions. However, the results will need to be tested at farm level and maybe across different production systems. The expectation from results is that this set of studies will provide information for application in animal breeding, in the provision of nutrition advice and for application by feed companies. There will be both environmental (reduced GHG emissions) and economic (increased performance and profitability) benefits from this project.

Insights and proposals from the synthesis of valorisation survey results

Targeted stakeholders: mainly policy makers and farmers / farm advisors might be interested by results from these projects. Also breeding and agri-food companies might be concerned. Some projects are very active in involving stakeholders and sometimes they are partners in the projects (MACSUR, ERA-NET Plus GreenRice, CAOS projects)

Scale of the projects: some of the projects are related to a small farm scale (ERA-NET Plus GreenRice project), some are considering regional/European dimension (MACSUR, ERA-NET Plus CAOS) or global scale (Multi-partner call: GLOBAL NETWORK, MAGGnet, CN-MIP)

Links between presented projects: some projects have already established links/cooperate together. MACSUR has links with ERA NET Plus: SYBRACLIM, OptiBarn, MODCARBOSTRESS. Eranet Plus GreenRice project has interactions with GreenRice project from Multi-partner call. CN-MIP has links with Models4Pastures, MAGGnet and CometGlobal projects. There are also links to the Global Research Alliance (GRA) of several projects (GLOBAL NETWORK, MAGGnet, CN-MIP projects).

The projects could be classified according to specific policy questions/main themes they target:

- Adaptation and resilience of European agriculture to climate change and impacts in the context of the European Adaptation strategy[6], including climate-proofing of the CAP
- Carbon sequestration in soils to contribute to meeting the 1.5/2 degree targets (including negative emissions)
- Mitigation/the potential contribution of the agriculture sector to decrease GHG emissions in crop and livestock production.

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[6] https://ec.europa.eu/clima/sites/clima/files/docs/eu_strategy_en.pdf