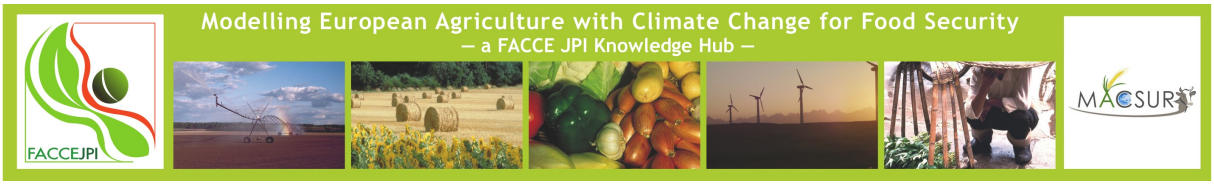

FACCE-MACSUR

Overview of case studies

Martin Köchy*[1], Jason Jorgenson[2], Katharina Braunmiller[1],
and the contact persons of the case studies

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Instrument:	Joint Programming Initiative
Topic:	Agriculture, Food Security, and Climate Change
Project:	Modelling European Agriculture with Climate Change for Food Security (FACCE-MACSUR)
Start date of project:	1 June 2012
Duration:	36 months
Theme, Work Package:	Hub 1, CropM 6
Deliverable reference num.:	D-H2.1, D-C6.1
Deliverable lead partner:	Thünen Institute, James Hutton Institute, and LEI
Due date of deliverable:	month 36
Submission date:	20YY-07-23
Confidential till:	–

Revision	Changes	Date
1.0	Web release	2014-01-30
2.0	Report	2015-07-23

Abstract
MACSUR comprises 18 regional case studies for analysing the effects of climate change on agriculture with integrated inter-disciplinary models. Three case studies in Finland, Austria, and Italy have been selected as pilot studies because of their advancement in integration and representation of European farming systems and regions.

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Introduction

MACSUR comprises case studies from many independent projects. Regional case studies are an important type of case studies. Regional case studies allow a simultaneous and interlinked development of a common conceptual framework of actual models and model links to assist policy makers and actors in the agri-food chain in identifying effective and efficient adaptation and mitigation measures and potential consequence scenarios, e.g. impact on food yield, quality, nutritive value, disease load etc. in perceived hotspots of climate impacts.

One of the aims of MACSUR is to collect information of the case studies in a standardised way, select those that already show a high level of integration between crop, grassland, livestock, and socio-economic modelling (regional pilot studies). Over time, case studies in MACSUR are expected to develop in a way to allow to answer the questions "**what would be the different contributions of different European adaptation strategies to global food security until 2050 at different scales (farm to EU) while keeping the GHG targets? What investments are necessary? What are the implications?".**

Methods

The MACSUR membership was asked to fill in a structured online questionnaire. From the compiled answers (presented below), the Project Steering Committee selected three pilots studies that already showed a high degree of interconnectedness and inter-disciplinarity and could serve as an example for future studies.

Results

Eighteen regional case studies (East Anglia, UK; England and Wales; Kuyavia-Pomerania (PL); Lublin (PL); Massif Central (FR); Piedmont (IT); (IT); Emilia Romagna (IT); Piacenza-Parma-Emilia·Romagna-Toscana (IT); Central-South Italy; Israel; Northern Savo (FI); Mostviertel (AT); Oristano (IT); Southern Norway; Scotland; Northwest England) were submitted (Fig. 1). The case studies of Northern Savo (Finland), Mostviertel (Austria), and Oristano (Sardinia) were selected as pilot studies representing northern, central and southern Europe.

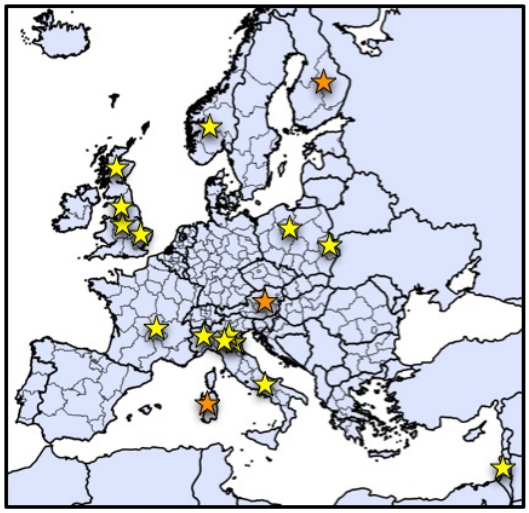


Table 1. Overview of regional pilot studies.

	Northern Europe	Central Europe	Southern Europe
Region name	**Northern Savo (Finland)**	**Mostviertel (Austria)**	**Oristano (Italy)**
Contact persons	Heikki Lehtonen	Martin Schönhart	Pier Paolo Roggero

Farming systems (SEAMLESS typology)

arable/			
cereal	x	x	x
dairy cattle/			
permanent grass			x
temporary grass	x		x
beef and mixed cattle/			
permanent grass		x	
temporary grass	x		
mixed farms/ all land use types		x	

Specific issues the region deals with/will deal with

Northern Europe	Central Europe	Southern Europe
detailed analysis of * drought (or flood) risk for silage grass production: future development, (in)direct costs for farms * increased risk of pests and plant diseases: role of new cultivars, benefits of improved crop protection management vs. Additional costs * economic benefits of higher productivity and resulting production reorganisation (incl. Machinery, logistic benefits due to higher yields) (H.L.) * weather dependence of crop yields (cereals, grass) * GHG emissions of dairy/beef cattle systems, incl. mitigation methods	* intensification of land use (northern region) * land abandonment under changing climate and market conditions (southern region) * focus on climate change impacts on landscape development and biodiversity	* durum wheat cropping systems as monoculture or in rotation with grain legumes * low profitability * decrease in crop area in many regions (increasing imports) * resilience to changes in the world commodity market * few profitable alternative of land use * dairy farming in an intensive cropping system: * high dependence on extra-farm and costly inputs (feeds, fertilizers…) * nitrate vulnerable zone, 30 000 cattle in 5,500 ha * N-pollution of groundwater, P-pollution of surface water * cereals: low profitability; risk of abandonment of farming and land desertification * intensive water use for farming (irrigation water pricing based on full cost recovery - WFD) * decreasing sheep breeding profitability * high and increasing price variability for outputs and some inputs

Regional challenges with regard to climate change

Northern Europe	**Central Europe**	**Southern Europe**
* (summer) drought related problems in crop production (esp. in cereals production) will increase; may be mitigated by breeding efforts * drought causes problems for grasslands, but they may benefit from longer growing period → more attention to crop protection/rotation, and other mitigation measures required * skilled farmers may benefit from longer growing period; benefit needed given high production costs in northern Europe * higher climatic variability and more frequent and severe extreme events (e.g. heat waves, dry spells, heavy rains) during the growing season → increase various abiotic and biotic stresses * if higher volatility of in-/output prices → negative affect on profitability of investments in agriculture (also of those which are necessary due to adaptation + mitigation) * foremost crop production: increased average yields, but higher probability for severe weather conditions in planting period (too wet, too cold) and in harvesting period (too wet to access the fields)	* moderate yield gains expected * extreme weather effects due to arable crops on hilly sites as well high shares of maize in crop rotations	* crop yield stability vs spring drought * farm management in conditions of monoculture with growing climatic and market uncertainty * tillage on heavy soils vs persistent rains constraining seeding dates * grain quality (N) * soil organic C dynamics * increasing maximum temperature particularly in summer→ increased irrigation water requirements * serious drops in farmers' income * drop in milk production, cow's fertility and increased animal mortality related to forecasted increased temperature-humidity index * land abandonment: desertification; loss of production typicalities * increasing maximum temperature particularly in summer → increased irrigation requirements (higher irrigation costs with volumetric pricing of water)

Adaptation measures which are…

… important to this region (O)

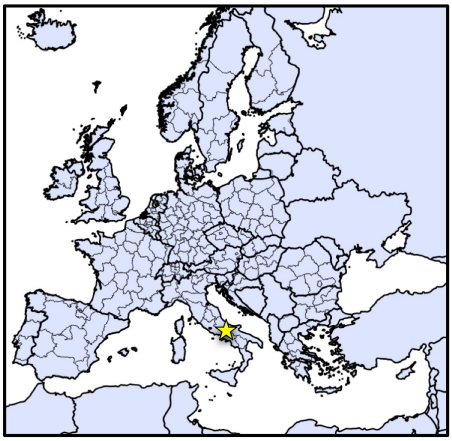
… important to this region AND will be included in the modelling exercise (Ø)

water management	O			O	O	Ø
irrigation	O			Ø	Ø	Ø
drainage	O	O			O	
species/varietal choice	Ø	Ø	Ø	Ø	O	Ø
plant breeding	Ø	Ø		O	O	O
changed planting/sowing days	Ø	Ø	Ø	Ø	Ø	Ø
crop rotation	Ø		Ø	Ø	Ø	Ø
alternative tillage methods		O	Ø	Ø	Ø	O
pest/weed management	Ø		O	O		O
housing of livestock	O	O			Ø	Ø
land consolidation				O		
management of feeding and reproduction of livestock	Ø	Ø	Ø		Ø	Ø
structure and scale of production adjustment	Ø	Ø			Ø	O
crop insurance	O					
exit from agriculture	Ø		Ø	O	O	O
climate alertness	O					O
political regulations at various administrative levels	Ø	Ø		O	O	Ø
others	Ø[1]			O[2]	O[3]	Ø[4]

[1]*overall farm production reorganisation implied by the CC adaptation/mitigation needs*
[2]*introduction of a buffer stock scheme*
[3,4]*- increased local production of forage and feeds*
[3,4]*- reduction of the cattle stocking rate in the district, also by relocating part of the livestock in neighbouring areas to reduce costs (to be assessed through the DSP model)*
[3]*- GHG emissions both from animals and fertilizers*
[3]*- water pollution*
[4]*- role of non food crops (energy, landscape, etc.) against abandonment and desertification*

Acknowledgements

This paper is a contribution to the FACCE MACSUR knowledge hub.



Central South Italy

General information

Name of region	District of Foggia, Puglia, Italy
Contact (general)	Domenico Ventrella
Contact (scenarios)	Pier Paolo Roggero
Location (NUTS code)	ITF4
The three most important farming systems in region (SEAMLESS nomenclature)	• Arable / cereal

Specific issues the region deals with/will deal with

In the Capitanata area, the winter durum wheat (Triticum durum L.) represents the principal cereal crop often grown in rotations with irrigated horticultural species. Among these, processing tomato crop (Lycopersicon aesculentum Mill.) is well represented. In particular, two-years rotation (tomato-wheat) and three-years rotation (tomato-wheat-wheat) are the typical farming rotations of this large productive area. The soil of Capitanata area are typically deep, clay and with montmorillonitic characteristics.The availability of water for irrigation is good and it is managed by a network agency that distributes water for irrigation in a large area of Capitanata. Alternatively, farmers extract water directly from wells obtaining water from deep aquifers up to 2-300 m. Typically the winter wheat is cultivated in rainfall regime in such a way as to exploit the rains of autumn and winter periods. The irrigation is a necessary agronomical practice in order to obtain sustainable productive levels of horticultural crops, characterized by a spring-summer cycle.
The interest of our study is to evaluate winter durum wheat and tomato responses under future climatic scenarios in a space-temporal analysis for significant pedologic and homogeneous areas characterizing the spatial variability of “Capitanata” plain. In this analysis different adaptation strategies to climate change will be evaluated with particular reference to winter duum wheat and tomato. The adaptation strategies will be evaluated and selected on the basis of indicators of crop production and soil fertility.

Regional challenges with regard to climate change

As supported by trend analyses of the last 50 years and by GCM simulations for the next decades, the Mediterranean region has been indicated as a possible hotspot for the decades to come. Climate change over this region is shown to be characterized by both increasing temperatures and by relatively large changes in the frequency of extreme climatic events for both temperature and rainfall. Heat stress frequency and dry spell periods are following a positive trend, whereas the number of frost events is decreasing. The amount of rainfall per event has been shown to be increasing, and changes in the distribution of seasonal rainfall have also been recorded. These trends are expected to have a negative impact on many economic sectors of the region including agriculture, forestry, energy consumption, and tourism. Many crop simulation studies have been conducted on the major crops (soft wheat, maize, potato, rice, etc.), only a few studies have been focussed on typical Mediterranean crops like durum wheat, vegetables, olive, grapevine, etc. These studies generally showed that increasing temperatures shorten the growing season of crops (Guereña et al. 2001; Giannakopoulos et al. 2009; Moriondo et al., 2011a), with a subsequent shorter time for biomass accumulation, thereby also

resulting in a lower yield (Bindi et al., 1996; Ferrise et al., 2011). However, changes in yields were also dependent on crop distribution (e.g. summer and winter crops), crop type (e.g. C3 and C4 plants) and environmental conditions (water and nutrient availability) (Giannakopoulos et al. 2009). Ventrella et al. (2012) in a recent study focused in Capitanata area, showed that the simulations for winter durum wheat showed that, for an expected increase of +2°C, the positive fertilization effect of increasing CO2 concentration on durum wheat yields was greater than the negative effects due to rising temperature and declining rainfall in agreement with the FAR-IPCC report (IPCC, 2007b). Moreover, this behaviour was in agreement with that reported by El Afandi et al (2010), for the middle Egypt area under A2-B2 climate change scenarios. The results of Ventrella et al. (2012) for tomato showed that for both future climate scenarios (i.e. +2°C and +5°C), the positive fertilization effect of increasing CO2 concentration was not sufficient to overcome the negative effects determined by increasing temperature and reducing rainfall. These results also highlighted that summer crops, including tomato, may be strongly affected by climate change that in this very important agricultural area of Italy. The modification of present management strategies (e.g. irrigation scheduling) showed that an increase in the frequency of irrigation treatments (i.e. start the automatic irrigation when soil reached 40 and 60% of crop available water) may reduce the negative effect of climate change on tomato yields. At the same time, however, the results showed that under future climate scenarios tomato yields will be limited more by high temperature than by water availability. In particular, under both future climate scenarios it was predicted that any further addition of water above that provided by the irrigation treatment would not produce any increase in tomato yields since high temperature was the limiting factor shortening both crop cycle and photosynthetic activity.

Important adaptation measures that will be considered in the study

Water management	is important to this region.
Irrigation	is important to this region AND will be included in the modelling exercise.
Drainage	
Species/varietal choice	is important to this region AND may be included in the modelling exercise.
Plant breeding	
Changed planting/sowing days	is important to this region AND will be included in the modelling exercise.
Crop rotations	is important to this region AND will be included in the modelling exercise.
Alternative tillage methods	
Pest/weed management	
Housing of livestock	
Land consolidation	
Management of feeding and reproduction of livestock	
Structure and scale of production adjustment	
Crop insurance	
Exit from agriculture	
Climate alertness	

Political regulations at various administrative levels	
Others	is important to this region.
	We will consider the Nitrogen fertilization as potential agronomical practice for adaptation to climate change

Models, stakeholders, advancement of knowledge

Models used in the study

Socio-economy	Crops	Grassland	Livestock
A4SMOD: Discrete Stochastic Programming Model (territorial and representative farms) Farm Budget Analysis Input Farm structures: FADN, 2010 Agricultural Census Land Use: FADN, 2010 Agricultural Census CORINE Land Cover	DSSAT v 4.5 EPIC v 0810	NONE	NONE

Stakeholders involved in the study

Agro-business or agro food chain

Pasta industrial association (http://www.pasta-unafpa.org/)
Associazione delle industrie del dolce e della pasta http://www.aidepi.it/en/association.html
Confederazione Italiana Agricoltori Puglia, http://www.scianet.it/ciapuglia/
Consorzi di bonifica e Irrigazione (Water Users Associations)
Consorzio di bonifica dell'Oristanese, www.bonificaoristanese.it
Associazione nazionale bonifiche, irrigazione e miglioramenti fondiari (ANBI), www.anbi.it

Administrative bodies or regional or national governments

Ministry of Agricultural Food and Forestry policies www.politicheagricole.it
Agricultural councillorship and agricultural agencies in the following regions: Sardinia, Campania, Puglia, Marche
Farmers Unions of Italy
Italian national research project IC-FAR coordinated by PP Roggero and linking 7 long term field experiments including wheat rotations
Coldiretti www.coldiretti.it
Confagricoltura www.confagricoltura.it
Confederazione Italiana Agricoltori www.cia.it
Farmers organizations at district level (Organizzazione dei produttori)

Contribution to answering the focus question

Food security
Agriculture sustainability
Investments on plant breeding
GHG emissions associated to durum wheat production under Mediterranean conditions
Farm profitability under uncertain climate and market conditions

Further information

The analysis will include aspects related to crop productivity and soil fertility as influenced by higher thermal regimes, modified rainfall distribution, longer growing season due to climate change.
From agronomical point of view, we will take in consideration the optimization of sowing or transplanting time, the nitrogen fertilization, irrigation and crop rotation. In climate scenarios of longer than 20 year span, such practices will be evaluated as potential adaptation strategies to climate change, but at the same time the potential effects as mitigation will be also assessed.

References

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El Afandi G, Khalil FA, Ouda SA (2010) Using irrigation scheduling to increase water productivity of wheat-maize rotation under climate change conditions. Chilean Journal of Agricultural Research 70(3):474-484
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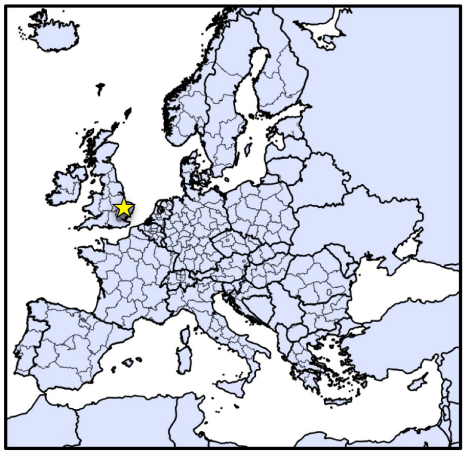
Guereña A, Ruiz-Ramos M, Díaz-Ambrona CH, Conde J, Mínguez MI (2001) Assessment of climate change and agriculture in Spain using climate models. Agron J 93:237–249
IPCC (2007) Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 976 pp.
Moriondo M, Giannakopoulos C, Bindi M (2011) Climate change impact assessment: The role of climate extremes in crop yield simulation. Clim Change 104:679-701
Ventrella D, Charfeddine M, Moriondo M, Rinaldi M, Bindi M (2012) Agronomic Adaptation Strategies under Climate Change for Winter Durum Wheat and Tomato in Southern Italy: Irrigation and Nitrogen Fertilization. Regional Environmental Change 12:407-419

Collaborators

CRA Luisa Giglio, Monia Charfeddine
UNISS Luciano Gutierrez, Luca Doro, Paola Deligios, Giovanna Seddaiu, Luigi Ledda Collaborators
UNITUS Gabriele Dono, Raffaele Cortignani, Luca Giraldo, Graziano Mazzapicchio



East Anglia, UK

General information

Name of region	East Anglia, UK
Contact (general)	Eric Audsley
Contact (scenarios)	Richard Kipling
Location (NUTS code)	UKH
The three most important farming systems in region (SEAMLESS nomenclature)	• Arable / cereal

Specific issues the region deals with/will deal with

Dry area of UK.

Regional challenges with regard to climate change

Lack of rainfall? Suitability for new crops (eg maize, sunflower)

Important adaptation measures that will be considered in the study

Water management	
Irrigation	is important to this region AND will be included in the modelling exercise.
Drainage	
Species/varietal choice	
Plant breeding	
Changed planting/sowing days	is important to this region AND will be included in the modelling exercise.
Crop rotations	is important to this region AND will be included in the modelling exercise.
Alternative tillage methods	
Pest/weed management	
Housing of livestock	
Land consolidation	
Management of feeding and	

reproduction of livestock	
Structure and scale of production adjustment	
Crop insurance	
Exit from agriculture	
Climate alertness	
Political regulations at various administrative levels	
Others	

Models, stakeholders, advancement of knowledge

Models used in the study

Socio-economy	Crops	Grassland	Livestock
REGIS Self-contained.	REGIS uses its own metamdoels derived from the IMPEL crop models. Use soil and climate data	REGIS uses its own metamdoels derived from the IMPEL crop models. Use soil and climate data	Includes a grass for dairy cows land use option. Has own dairy cow feeding and grass grazing and silage making model.

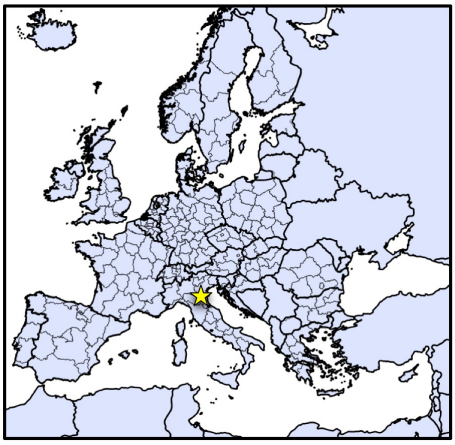
Stakeholders involved in the study

Agro-business or agro food chain
none

Administrative bodies or regional or national governments
none

Contribution to answering the focus question
Can examine effects on crop production parameters such as breeding for yield, technology such as improved irrigation and new crops, and demand adjustment.

Further information
http://www.cranfield.ac.uk/sas/naturalresources/research/projects/regis2.html



Emilia Romagna (IT)

General information

Name of region	Emilia-Romagna, Italy
Contact (general)	Davide Viaggi
Contact (scenarios)	Davide Viaggi
Location (NUTS code)	ITD5
The three most important farming systems in region (SEAMLESS nomenclature)	• Arable / cereal • Horticulture / all land use • Permanent crops / all land use

Specific issues the region deals with/will deal with

Increasing input costs. High price variability. High macro-specialization. Relatively small farm size.

Regional challenges with regard to climate change

Increasing rainfall variability. Increasing frequency of extreme events. Increasing average temperature.

Important adaptation measures that will be considered in the study

Water management	is important to this region AND will be included in the modelling exercise.
Irrigation	is important to this region AND will be included in the modelling exercise.
Drainage	is important to this region.
Species/varietal choice	is important to this region AND will be included in the modelling exercise.
Plant breeding	
Changed planting/sowing days	
Crop rotations	
Alternative tillage methods	is important to this region.
Pest/weed management	is important to this region.
Housing of livestock	
Land consolidation	

Management of feeding and reproduction of livestock	
Structure and scale of production adjustment	
Crop insurance	is important to this region.
Exit from agriculture	is important to this region.
Climate alertness	
Political regulations at various administrative levels	is important to this region AND will be included in the modelling exercise.
Others	

Models, stakeholders, advancement of knowledge

Models used in the study

Socio-economy	Crops	Grassland	Livestock
DYMORA WAter Trading Assessment Model (WATAM) Input: - climatic scenarios - agronomic technical coefficients - water production function - output prices	CRITERIA: soil water balance model (or others to be defined)	None	None

Stakeholders involved in the study

Agro-business or agro food chain

Contacts with Irrigation boards and farmers organisations are already well developed.

Administrative bodies or regional or national governments

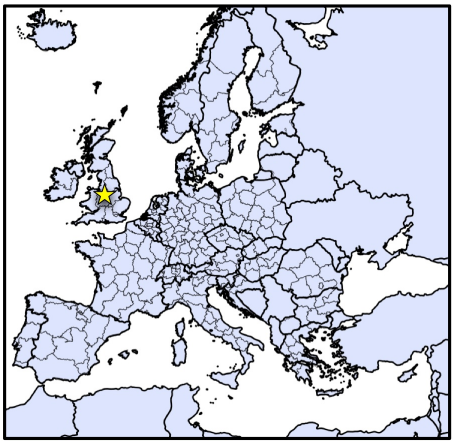
ARPA

Contribution to answering the focus question

Our focus in the formulation of institutions that support the adaptation of farms to climate change. In particular, we have an insight on the water allocation policies. The increasing frequency of extreme events lead to a more uncertain productivity which must be dealt with.

Further information

None.



England & Wales

General information

Name of region	England & Wales, UK
Contact (general)	Eric Audsley
Contact (scenarios)	Richard Kipling
Location (NUTS code)	UK(C-L)
The three most important farming systems in region (SEAMLESS nomenclature)	• Dairy cattle / permanent grass • Beef and mixed cattle / permanent grass • Mixed farms / all land use types

Specific issues the region deals with/will deal with

Future socio-techno-economic scenarios.

Regional challenges with regard to climate change

New crops becoming feasible. Change in suitability for grassland.

Important adaptation measures that will be considered in the study

Water management	
Irrigation	is important to this region AND will be included in the modelling exercise.
Drainage	
Species/varietal choice	
Plant breeding	
Changed planting/sowing days	is important to this region AND will be included in the modelling exercise.
Crop rotations	is important to this region.
Alternative tillage methods	
Pest/weed management	
Housing of livestock	
Land consolidation	
Management of feeding and	

reproduction of livestock	
Structure and scale of production adjustment	
Crop insurance	
Exit from agriculture	
Climate alertness	
Political regulations at various administrative levels	
Others	

Models, stakeholders, advancement of knowledge

Models used in the study

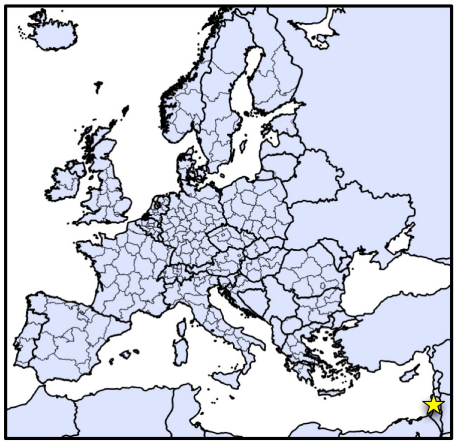
Socio-economy	Crops	Grassland	Livestock
SFARMOD/Future scenarios Production demand - the model then works out the prices of commodities	Has own crop model. Soil and climate data	Has own grass model. Soil and climate data	Has simple dairy cow model of DMIntake and energy and proterin requirements.

Stakeholders involved in the study

Agro-business or agro food chain
none

Administrative bodies or regional or national governments
none

Contribution to answering the focus question
Effect of production parameters (eg breeding) and consumption parameters affecting demand.



Israel

General information

Name of region	Israel
Contact (general)	Iddo Kan
Contact (scenarios)	Ruslana Palatnik
Location (NUTS code)	IL
The three most important farming systems in region (SEAMLESS nomenclature)	• Arable / others • Mixed farms / all land use types • Permanent crops / all land use

Specific issues the region deals with/will deal with

Water scarcity, lack of professional workers, import barriers, environmental negative externalities

Regional challenges with regard to climate change

Reduction in total precipitations, increase in heat waves and damages associated with stormy weather

Important adaptation measures that will be considered in the study

Water management	is important to this region AND will be included in the modelling exercise.
Irrigation	is important to this region AND will be included in the modelling exercise.
Drainage	is important to this region.
Species/varietal choice	is important to this region AND will be included in the modelling exercise.
Plant breeding	is important to this region.
Changed planting/sowing days	is important to this region.
Crop rotations	is important to this region.
Alternative tillage methods	is important to this region.
Pest/weed management	is important to this region.
Housing of livestock	is important to this region.
Land consolidation	is important to this region.

Management of feeding and reproduction of livestock	is important to this region.
Structure and scale of production adjustment	is important to this region.
Crop insurance	is important to this region.
Exit from agriculture	is important to this region.
Climate alertness	is important to this region.
Political regulations at various administrative levels	is important to this region AND will be included in the modelling exercise.
Others	is important to this region AND will be included in the modelling exercise.
	Recycling of wastewater

Models, stakeholders, advancement of knowledge

Models used in the study

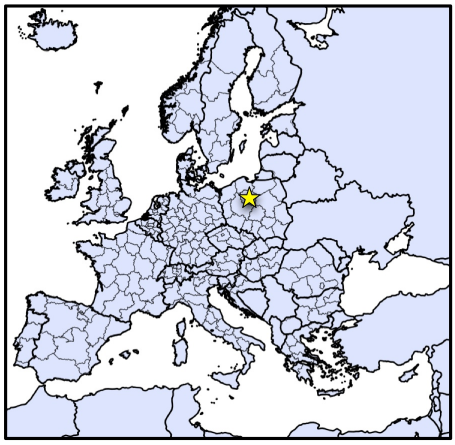
Socio-economy	Crops	Grassland	Livestock
The VALUE (Vegetative Agricultural Land Use Economic) model -- a regional scale positive mathematical programming (PMP) model, which examines adaptation through reallocation of land and water sources among crops, while taking into account salinity conditions. Inputs include water quotas, land allocation and precipitations.	See a model of water and salinity equilibrium in soil-plant-atmosphere : Shani, U., Ben-Gal, A., Tripler, E. and Dudley, L.M. (2007), "Plant Response to the Soil Environment: An Analytical Model Integrating Yield, Water, Soil Type and Salinity," Water Resources Research 43: W08418. doi: 10.1029/2006WR005313.	None	None

Stakeholders involved in the study

Agro-business or agro food chain
None

Administrative bodies or regional or national governments
Ministry of Agriculture and Rural Development.

Contribution to answering the focus question
What are the implications of changes in climate variables (particularly precipitations) on the agricultural sector with respect to farming profits and consumer surplus? How international trade barriers, policies associated with inputs (labor and water infrastructures) affect the agricultural sector under climate change (e.g., profits, shadow values of water and labor constraints).



Kuyavia-Pomerania (PL)

General information

Name of region	Kuyavia-Pomerania (Kujawy & Pomorze), Poland
Contact (general)	Waldemar Bojar
Contact (scenarios)	Waldemar Bojar
Location (NUTS code)	PL61
The three most important farming systems in region (SEAMLESS nomenclature)	• Arable / cereal • Mixed farms / all land use types • Mixed livestock / all land use types

Specific issues the region deals with/will deal with

Kujawy & Pomorze is a very important region about agricultural production in Poland due to essential resources and output in relation to other regions. Deficit of water (below 500 mm and often about 400 mm yearly and still it is decreasing) is a main minimum factor of farming. Poor retention of water, so called small retention is also an important not desired fact for farming.

Regional challenges with regard to climate change

A problem is a low possibility of retention of water for agricultural production needs. So, at sure a challenge for the region is improvement of infrastructure for more effective small retention of water. For Kujawy & Pomorze region there will be also important activities (at CAP or domestic and regional policy level) towards agricultural land consolidation. Some irrigation investments can be also a one of solution to adapt regional agriculture to CC.
Mentioned above activities can increase economic efficiency of farming in surveyed region. Selection of cereals and maize for grain was made because they are very important crops in food supply and demand balance in global, country and regional scale. Those crops are also very important for Kujawy & Pomorze region due to their essential market meanings. Defining owned models, data bases and tools are useful for forecasts creation on climate change impact on future agricultural production according to spatial and subjective scope of analysis. Owned resources of the data and models for research let select cereals and maize for grain as interesting crops for regional pilot study.

Important adaptation measures that will be considered in the study

Water management	is important to this region AND will be included in the modelling exercise.
Irrigation	is important to this region AND will be included in the modelling exercise.
Drainage	
Species/varietal choice	
Plant breeding	is important to this region.

Changed planting/sowing days	is important to this region.
Crop rotations	is important to this region.
Alternative tillage methods	is important to this region.
Pest/weed management	
Housing of livestock	
Land consolidation	is important to this region.
Management of feeding and reproduction of livestock	
Structure and scale of production adjustment	
Crop insurance	is important to this region AND will be included in the modelling exercise.
Exit from agriculture	
Climate alertness	
Political regulations at various administrative levels	is important to this region AND will be included in the modelling exercise.
Others	is important to this region.
	On the base of predicted yields and prices of wheat and maize for grain we will calculate future regional productivity of land for wheat and maize for grain in both surveyed regions based on forecasted output and farm land area in Kujawsko-Pomorskie region taking attention climate changes and their impact on yields in long term perspective (2020, 2030, 2050, (60). Among effects will be slower decrease of productivity of crops influenced by extreme climatic phenomena and especially declining deficit of water reached over better small retention of water, irrigation. Appropriate agricultural policy under CC circumstances and also effective crop insurance will ensure keeping farmer incomes at stabilized level.

Models, stakeholders, advancement of knowledge

Models used in the study

Socio-economy	Crops	Grassland	Livestock
FARM DSS MAGPie - GAMS – baseline climatic scenarios	The UTP Agroclimatic statistical models for setting dependencies	None	None

Models used in the study

Socio-economy	Crops	Grassland	Livestock
Global climatic models which let predict and measure climatic phenomena until 2050, eg. GLOBIOM for forecasted prices and/or input-output gaps MAGNET for regional output using bottom-up strategy from farm to region level FORECASTS OF RAW FOOD MATERIAL PRICE GAP CHANGES in the past and in the future	between yields of selected crops (wheat, corn) and climate change parameters to predict in long term perspectives (2030, 2050) their yields P139 CropM partner models for setting dependencies between yields of selected crops (wheat, corn) and climate change parameters to predict in long term perspectives (2030, 2050) their yields P25 Crop M partner SPACSYS model for setting dependencies between yields of selected crops (wheat, corn) and climate change parameters to predict in long term perspectives (2030, 2050) their yields		

Stakeholders involved in the study

Agro-business or agro food chain

Pomorsko-Kujawski Związek Hodowców Trzody Chlewnej Pomorze & Kujawy Pig Breeders Association http://bazy.ngo.pl/search/info.asp?id=35176
Kujawsko-Pomorski Związek Hodowców Bydła Kujawy & Pomorze Cattle Breeders Association http://www.krs-online.com.pl/kujawsko-pomorski-zwiazek-hodowcow-bydla-krs-86051.html

Administrative bodies or regional or national governments

http://www.bydgoszcz.uw.gov.pl/en/ (http://www.bydgoszcz.uw.gov.pl/pl/wydzial-srodowiska-rolnictwa-i-rozwoju-wsi.html)
http://bip.lublin.uw.gov.pl/

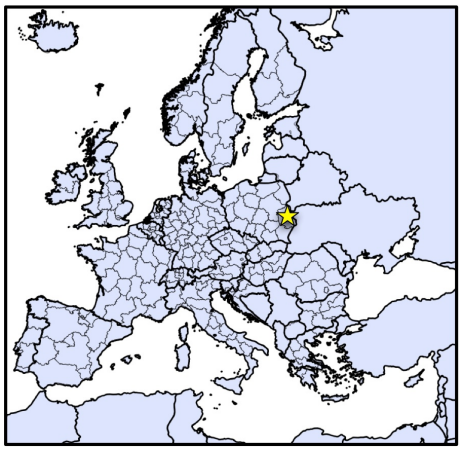
Contribution to answering the focus question

Calculation of the future farm incomes influenced by changes in productivity of wheat and maize for grain with consideration of expected changes of their yields because of precipitation changes, different (CAP) policy instruments usage, plantation insurance usage and irrigation/small retention treatment in long term perspective (biological and technological progress is constant in forecasted period) 2020, 2030, 2050(60). This way will be produced different variants of scenarios showing also expected levels of productivity of surveyed regions about wheat and maize for grain what can have influence on food security keeping in Europe. Projections of parameters of baseline scenarios (GAMP) into farm level will be also possible over comparison of models based on regional empirical data and global models.

Further information

1. BANK DANYCH LOKALNYCH (LOCAL DATA BASE) GUS www.stat.gov.pl/bdl
2. Bojar W. Studium wyboru maszyn w gospodarstwach rolniczych w świetle rozwoju systemów wspomagania decyzji (Study on farm machinery selection at farms in a view of Decision Support Systems development). Rozprawy nr 114. Akademia Techniczno-Rolnicza w Bydgoszczy. 2005.
3. Bojar W. Unification of the data and the knowledge bases At national and the EU level being a challenge facing agriculture In the knowledge societies [In:] 3rd International Conference on Information Technology in Business, Warsaw Agricultural University, 2006. p. 21-29.
4. Czarnecka M., Koźmiński C., Michalska B. Climatic risks for plant cultivation in Poland. Acta Agrophisica 169 (1) Monografie, 2009, 78-97.
5. http://www.fwie.eco.pl
6. Gocht, A. W.Britz and M. Adenäur, Farm level policy scenario analysis. IPTS, 2011.
7. Kuchar L. Application of mathematical methods for crop yield estimation under changing climatic conditions. Acta Agrophisica 169 (1) Monografie, 2009, 52-62.
8. Leśny J. (red.). Climate change and agriculture in Poland – impacts, mitigation and adaptation measures. Acta Agrophysica, 169, 2009, ss.152.
9. www.lubelskie.pl
10. „Rolnictwo w województwie lubelskim w 2011 roku (Agriculture in Lubelskie Province), GUS, Lublin, 2012.

11. http://www.stat.gov.pl/cps/rde/xbcr/gus/RN_pkb_rachunki_regionalne_2010_notatka.pdf
12. Żarski J., Kuśmierek-Tomaszewska R., Dudek S. Tendencje zmian termicznych okresów rolniczych w rejonie Bydgoszczy. Trends of variation in thermal agricultural seasons in the region of Bydgoszcz. Infrastruktura i Ekologia Terenów Wiejskich, nr 3/I, 2012 7-17.



Lublin (PL)

General information

Name of region	Lublin, Poland
Contact (general)	Cezary Slawinski
Contact (scenarios)	Cezary Slawinski
Location (NUTS code)	PL31
The three most important farming systems in region (SEAMLESS nomenclature)	• Arable / cereal • Mixed farms / all land use types • Mixed livestock / all land use types

Specific issues the region deals with/will deal with

Lublin region is potentially very important due to high quality soils and good natural conditions for agricultural production. Minimum factor is frittered agrarian structure and also poor retention of water.

Regional challenges with regard to climate change

A problem is a low possibility of retention of water for agricultural production needs. So, at sure a challenge for both regions is improvement of infrastructure for more effective small retention of water. For Lublin region there will be also important activities (at CAP or domestic and regional policy level) towards agricultural land consolidation. Some irrigation investments can be also a one of solution to adapt regional agriculture to CC. Mentioned above activities can increase economic efficiency of farming in both surveyed regions. Selection of wheat and maize for grain was made because they are very important crops in food supply and demand balance in global, country and regional scale. Those crops are also very important for Lublin region due to their essential market meanings. Defining owned models, data bases and tools are useful for forecasts creation on climate change impact on future agricultural production according to spatial and subjective scope of analysis. Owned resources of the data and models for research let select wheat and maize for grain as interesting crops for regional pilot study.

Important adaptation measures that will be considered in the study

Water management	is important to this region AND will be included in the modelling exercise.
Irrigation	is important to this region AND will be included in the modelling exercise.
Drainage	
Species/varietal choice	
Plant breeding	is important to this region.

Changed planting/sowing days	is important to this region.
Crop rotations	is important to this region.
Alternative tillage methods	is important to this region.
Pest/weed management	
Housing of livestock	
Land consolidation	is important to this region.
Management of feeding and reproduction of livestock	
Structure and scale of production adjustment	
Crop insurance	is important to this region AND will be included in the modelling exercise.
Exit from agriculture	
Climate alertness	
Political regulations at various administrative levels	is important to this region AND will be included in the modelling exercise.
Others	is important to this region.
	On the base of predicted yields and prices of wheat and maize for grain we will calculate future regional productivity of land for wheat and maize for grain in both surveyed regions based on forecasted output and farm land area in Lubelskie region taking attention climate changes and their impact on yields in long term perspective (2020, 2030, 2050, (60). Among effects will be slower decrease of productivity of crops influenced by extreme climatic phenomena and especially declining deficit of water reached over better small retention of water, irrigation. Appropriate agricultural policy under CC circumstances and also effective crop insurance will ensure keeping farmer incomes at stabilized level.

Models, stakeholders, advancement of knowledge

Models used in the study

Socio-economy	Crops	Grassland	Livestock
FARM DSS MAGPie - GAMS – baseline climatic scenarios	The UTP Agroclimatic statistical models for setting dependencies	None	None

Models used in the study

Socio-economy	Crops	Grassland	Livestock
Global climatic models which let predict and measure climatic phenomena until 2050, eg. GLOBIOM for forecasted prices and/or input-output gaps MAGNET for regional output using bottom-up strategy from farm to region level FORECASTS OF RAW FOOD MATERIAL PRICE GAP CHANGES in the past and in the future	between yields of selected crops (wheat, corn) and climate change parameters to predict in long term perspectives (2030, 2050) their yields P139 CropM partner models for setting dependencies between yields of selected crops (wheat, corn) and climate change parameters to predict in long term perspectives (2030, 2050) their yields P25 Crop M patner SPACSYS model for setting dependencies between yields of selected crops (wheat, corn) and climate change parameters to predict in long term perspectives (2030, 2050) their yields		

Stakeholders involved in the study

Agro-business or agro food chain

Pomorsko-Kujawski Związek Hodowców Trzody Chlewnej Pomorze & Kujawy Pig Breeders Association Address: ul. Hetmańska 28 85-039 Bydgoszcz, Poland http://bazy.ngo.pl/search/info.asp?id=35176 Kujawsko-Pomorski Związek Hodowców Bydła, Bydgoszcz z siedzibą w Mnikowie 1B, powiat nakielski, gmina Nakło n. Notecią 80-120 Minikowo Kujawy & Pomorze Cattle Breeders Association http://www.krs-online.com.pl/kujawsko-pomorski-zwiazek-hodowcow-bydla-krs-86051.html

Administrative bodies or regional or national governments

http://www.bydgoszcz.uw.gov.pl/en/ (http://www.bydgoszcz.uw.gov.pl/pl/wydzial-srodowiska-rolnictwa-i-rozwoju-wsi.html) http://bip.lublin.uw.gov.pl/

Contribution to answering the focus question

Calculation of the future farm incomes influenced by changes in productivity of wheat and maize for grain with consideration of expected changes of their yields because of precipitation changes, different (CAP) policy instruments usage, plantation insurance usage and irrigation/small retention treatment in long term perspective (biological and technological progress is constant in forecasted period) 2020, 2030, 2050(60). This way will be produced different variants of scenarios showing also expected levels of productivity of surveyed regions about wheat and maize for grain what can have influence on food security keeping in Europe. Projections of parameters of baseline scenarios (GAMP) into farm level will be also possible over comparison of models based on regional empirical data and global models.

Further information

1. BANK DANYCH LOKALNYCH (LOCAL DATA BASE) GUS www.stat.gov.pl/bdl
2. Bojar W. Studium wyboru maszyn w gospodarstwach rolniczych w świetle rozwoju systemów wspomagania decyzji (Study on farm machinery selection at farms in a view of Decision Support Systems development). Rozprawy nr 114. Akademia Techniczno-Rolnicza w Bydgoszczy. 2005.
3. Bojar W. Unification of the data and the knowledge bases At national and the EU level being a challenge facing agriculture In the knowledge societies [In:] 3rd International Conference on Information Technology in Business, Warsaw Agricultural University, 2006. p. 21-29.
4. Czarnecka M., Koźmiński C., Michalska B. Climatic risks for plant cultivation in Poland. Acta Agrophisica 169 (1) Monografie, 2009, 78-97.
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7. Kuchar L. Application of mathematical methods for crop yield estimation under changing climatic conditions. Acta Agrophisica 169 (1) Monografie, 2009, 52-62.
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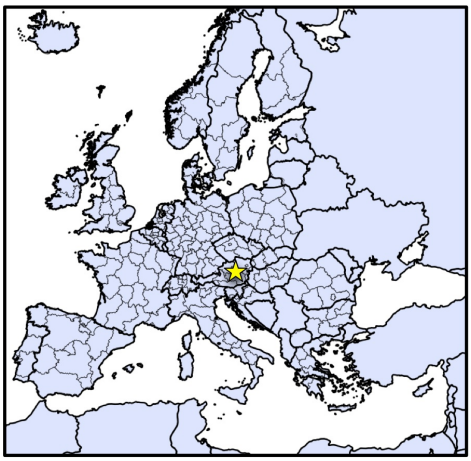
11. http://www.stat.gov.pl/cps/rde/xbcr/gus/RN_pkb_rachunki_regionalne_2010_notatka.pdf
12. Żarski J., Kuśmierek-Tomaszewska R., Dudek S. Tendencje zmian termicznych okresów rolniczych w rejonie Bydgoszczy. Trends of variation in thermal agricultural seasons in the region of Bydgoszcz. Infrastruktura i Ekologia Terenów Wiejskich, nr 3/I, 2012 7-17.



Mostviertel (AT)

General information

Name of region	Mostviertel, Austria
Contact (general)	Martin Schönhart
Contact (scenarios)	Martin Schönhart
Location (NUTS code)	AT121
Farming systems in region (SEAMLESS nomenclature)	• arable/cereal • beef and mixed cattle/permanent grass • mixed farms/all land use types

Specific issues the region deals with/will deal with

We focus on two case study landscapes in the Mostviertel region. One faces intensification of land use (northern region) while the other (southern region) may face land abandonment under changing climate and market conditions. We specifically focus on climate change impacts on landscape development and biodiversity. This all will be analyzed with respect to rural development.

Regional challenges with regard to climate change

According to previous studies, we expect moderate yield gains from climate change. However, important appear extreme weather effects due to arable crops on hilly sites as well high shares of maize in crop rotations.

Important adaptation measures that will be considered in the study

- species/varietal choice
- changed planting/sowing days
- crop rotations
- alternative tillage methods
- management of feeding and reproduction of livestock
- exit from agriculture

Models, stakeholders, advancement of knowledge

Models used in the study

Socio-economy	Crops	Grassland	Livestock
FAMOS, information is needed on socio-economic pathways (developed by the modelling team)	EPIC, CropRota (crop rotation generator), climate change data from statistical model is	EPIC is applied to model changes in grassland yields, complemented by A. Schaumberger's grassland model (LFZ Raumberg-Gumpenstein)	Contained within socio-economic model.

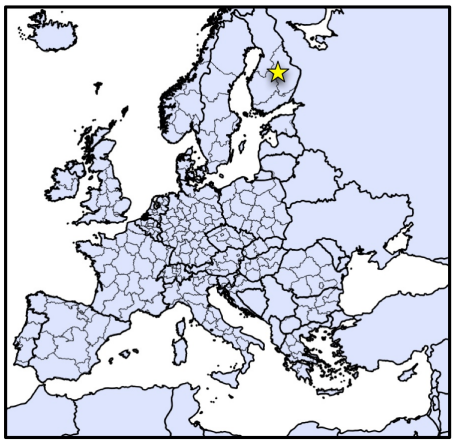
Models used in the study			
Socio-economy	**Crops**	**Grassland**	**Livestock**
	already available		

Stakeholders involved in the study

Agro-business or agro food chain
The group of stakeholders includes agricultural experts such as teachers from agricultural schools, staff from extension services and administration, as well as farmers.

Administrative bodies or regional or national governments
TBD

Contribution to answering the focus question
Our Regional Pilot Study should provide insights into the question whether and how climate change impacts landscape development, land abandonment/intensification, and the biotic environment. These results also allow statements on the development of agricultural productivity (food, resource production) under climate change.



Northern Savo (FI)

General information

Name of region	Northern Savo (Pohjois Savo), Finland
Contact (general)	Heikki Lehtonen
Contact (scenarios)	Heikki Lehtonen
Location (NUTS code)	FI132
Farming systems in region (SEAMLESS nomenclature)	• arable/cereal • dairy cattle/temporary grass • dairy cattle/land independent • beef and mixed cattle/temporary grass

Specific issues the region deals with/will deal with

Grassland fodder production dominate land use in Pohjois-Savo region, while cereals, especially barley, oats and mixed cereals for feed have a strong role in land use as well. Livestock production has a strong role in terms of farm income. Feed production re-organisations, connected to both crop yield changes and other operations of a livestock farm, are the most potential options of producing economic value at least for a number of future climate and market scenarios. Due to the situation of high production costs and uncompetitive agriculture that has prevailed now for many years, we are interested in possibilities of increased domestic feed production productivity at low environmental costs, since that could partly solve the inefficiency problems due to high and increasing production costs at livestock farms in particular. However, productivity gains require necessary investments and changes in inputs and variable costs. Hence we need to identify also market and socio-economic conditions where climate change implications of increased plant disease pressure, more frequent adverse weather conditions, leading to increased production and financial risks inhibit farmers from necessary adaptation and lead to reduced productivity and increased production costs. Increased price fluctuations may increase overall risks at a farm and thus the expected benefits from productivity promoting investments and variable inputs are dependent on expected prices and policy incentives.
More specifically the following themes are under detailed analysis:

1. Drought (or flood) risks for silage grass production, future developments of such risks and their direct and indirect cost implications for farms; we calculate how much the likelihood of severe drought and shortage of silage will increase, and what is the cost of preparing for adverse conditions, necessary to keep the risk at acceptable levels (which depend on the farm orientation and its feeding system). We also evaluate the likely changes in the variability of the quality of silage under different climate conditions since e.g. low protein content implies increased purchased feed costs for a farm (dependent on global cereals and oilseed prices)
2. Increased pressure and impact risk of pests and plant diseases, the role of new cultivars in terms of yield potential and tolerance of multiple stresses– the benefits of improved crop

protection management versus additional costs (esp. cereals farms), dependent on global input and output prices.

3. Economic benefits of higher productivity and resulting production re-organisation, including machinery choices and logistic benefits due to higher yields (especially logistic and roughage storage costs in dairy production).

Regional challenges with regard to climate change

In northern Europe and esp. Finland climate change basically means increased temperature and precipitation (Ruosteenoja et. al. 2011). Increase in temperature is likely to be 1.5-2 times higher in Northern European areas such as Finland than the global average increase in temperature. Winter time precipitation is likely to increase relatively more than then precipitation during the growing season (see, Sloth madsen et al., 2012; Rötter et al., 2013). Taking into account longer growing season and potentially higher biomass production, early summer drought may get even more severe, at least the possibility for drought related problems in crop production, esp. in cereals production may exacerbate. Early summer drought, in combination with intensive daylight in early summer and relatively short yield determination period of seed crops, is traditionally a major yield limiting factor in northern European agriculture. This problem could, at least in principle, be mitigated by plant breeding efforts for seed crops, which may lead to significant increases in potential yields (Peltonen-Sainio et. al. 2009). For grasslands, higher summer time temperatures and possibility for drought may also cause problems, but it is concluded that grass crops may still benefit from longer growing season. However, harvesting of some crops may become more disturbed by heavy rainfalls (which has been a problem also earlier, implying losses in yield quality and volume). Higher climatic variability and more frequent and severe extreme events (e.g. heat waves, dry spells, heavy rains) during the growing season is very likely increase various abiotic and biotic stresses. Such problems have been widely observed in northern Europe already and require more attention to crop protection and crop rotation and other mitigation measures. On the other hand, longer growing season will provide possibilities for higher yields and implied cost savings for skilled farmers who are able to cope with the problems and increased risks. Such benefits are needed due to the fact the production costs are relatively high in northern Europe, especially in least favoured areas where dependence on subsidies is a major limiting factor.

Climate change, if resulting in higher volatility of agricultural output and input prices, will negatively affect profitability of investments in agriculture, also of those investments which are necessary in terms of agricultural adaptation and mitigation.

Important adaptation measures that will be considered in the study

Water management	is important to this region.
Irrigation	is important to this region.
Drainage	is important to this region.
Species/varietal choice	is important to this region AND will be included in the modelling exercise.
Plant breeding	is important to this region AND will be included in the modelling exercise.
Changed planting/sowing days	is important to this region AND will be included in the modelling exercise.
Crop rotations	is important to this region AND will be included in the modelling exercise.
Alternative tillage methods	
Pest/weed management	is important to this region AND will be included in the modelling exercise.

Housing of livestock	is important to this region.
Land consolidation	is important to this region.
Management of feeding and reproduction of livestock	is important to this region AND will be included in the modelling exercise.
Structure and scale of production adjustment	is important to this region AND will be included in the modelling exercise.
Crop insurance	is important to this region.
Exit from agriculture	is important to this region AND will be included in the modelling exercise.
Climate alertness	is important to this region.
Political regulations at various administrative levels	is important to this region AND will be included in the modelling exercise.
Others	is important to this region AND will be included in the modelling exercise.
	Also overall farm production re-organisation implied by the CC adaptation / mitigation needs, is taken into account. The work is going on.

Models, stakeholders, advancement of knowledge

Models used in the study

Socio-economy	Crops	Grassland	Livestock
Dremfia (Dynamic multi-regional sector model of Finnish agriculture), dynamic farm level economic model of crop rotation and management	▪ WOFOST (Reimund Rötter, Taru Palosuo) ▪ DAISY for grassland modeling (Taru Paloso) ▪ possibly COUP (Tapio Salo) and few others	DAISY model under development/testing at MTT, Finland	No Finland specific livestock model to be used. However, most likely some cooperation with Norwegian team of HOLOS (farm level animal production calculation model of Canadian origin, adjusted for Norway), in cooperation with the Norwegian case study (contact person of HOLOS/Norway: Helge Bonesmo).

Stakeholders involved in the study

Agro-business or agro food chain

- ProAgria Pohjois-Savo, Nerkoo, Finland

Administrative bodies or regional or national governments

- NN

Contribution to answering the focus question

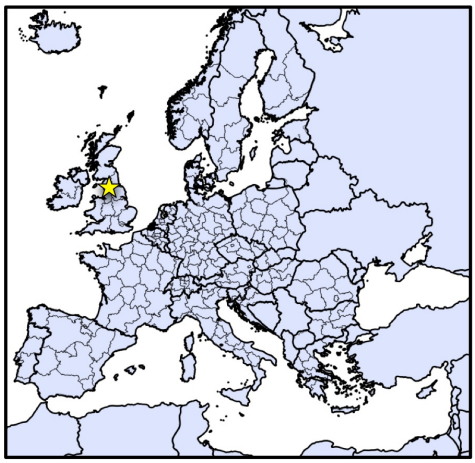
Value of investments in productivity promotion are evaluated, esp. long-term investments in soil improvements, drainage and plant / (animal breeding ?) are evaluated. The role of reducing yield gaps (differences between potential yields, attainable yields and actual yields) are evaluated in the context of different CC and market scenarios, i.e. RRAPS (regional representative agricultural pathways) explicitly developed as one of the main outputs in the northern European case studies. The joint evaluation and comparison of the RRAPs require some interaction with the stakeholders as well. In this, an economic dimension is emphasized and some scenario development from RRAPs are still needed to quantify crucial parameters in farm and sector level economic models. For example, evolution of productivity and efficiency parameters in response to market and policy variables includes significant uncertainties. Nevertheless, sensitivity analysis facilitated by the economic models consistently linked to results of agro-ecological models and farm level adaptation analysis provides early understanding on the role and potential of main adaptation measures in creating economic value for farms and farming sector.
This is done taking into account the presence of CC mitigation measures that can be reasonably anticipated since several studies and research projects exist on the effectiveness of different CC mitigation measures in agriculture e.g. in Finland and Norway already.
Uncertainty analysis includes not only sensitivity analysis in terms of key parameters in specific economic models, but also in terms of explicit silage yield risk analysis (mentioned above) and risk aversion accounting in dynamic economic crop rotation modeling (mentioned above). This means that the significance of extreme events, market and policy drivers, as well as risk aversion behavior of different levels are all included considering the most relevant parts the farm level. At the same time it must be understood that all uncertainty and risk assessments are incomplete given the many changing issues in long-term agricultural developments. Nevertheless from this perspective the treatment of uncertainty, which starts from the work done in CropM and continued here at the farm level and extending to the sector level implications is a good start.

Further information

In the Northern Europe regions it will be considered both the productivity potential due to longer growing season due to climate change, and the likely increase in climate and market related risks. Specific themes deserving special attention are drought (or flood) risks for silage grass production, future developments of such risks and their direct and indirect cost implications for farms; similar analysis in the case of pig farms in the context of high cereals and protein feed prices. We see highly relevant to analyse the impacts and necessary actions to cope with increased pressure of pests and plant diseases, the role of new cultivars – i.e. the benefits of improved crop protection management versus additional costs. This task is primarily attacked using farm level dynamic crop rotation models whose applications will be modelled on dynamic farm level management, land use and crop rotation analysis in climate and market scenarios of longer than 20 year span. This analysis, when done in cases of different farms in terms of size, orientation (part-time, full-time, high and low level of specialization), risk aversion, and other key preferences (such as available labour and price of labour), reveals already key insights on the socio-economics of CC adaptation.
Also relevant are economic benefits of higher productivity and resulting production re-organisation, including machinery choices and logistic benefits due to higher yields (especially logistic and roughage storage costs in dairy production). Such benefits are less important but probably still significant in the case of cereals-pigmeat production. The GHG mitigation costs include changes in logistic costs of feed and manure, which are conditional on the distance from different field parcels to farm centre, and on the development of feed crop yields. Different adaptations can be taken into account as in the case of manure processing such as mechanical separation of slurry into liquid and solid fractions. More efficient utilization of manure nutrients with related additional costs and cost savings can be analysed from the viewpoint of farm level profitability and reduced need for purchased inorganic fertilizers. In Norway, the crop model LINGRA, among others, the livestock model HOLOS and the sector model Jordmod will be applied to address these questions in an integrated approach. While crop models such as WOFOST are calibrated in Finnish conditions, and results utilised in farm and sector level models and economic analysis of adaptation (utilising multi-regional dynamic sector model DREMFIA), it is aimed that specific problems and solutions of multilevel adaptation analysis and integration are shared between northern European case studies.

Lehtonen, H.S., Rötter, R.P., Palosuo, T.I., Salo, T.J., Helin, J.A., Pavlova, Y., Kahiluoto, H.M. 2010. A Modelling Framework for Assessing Adaptive Management Options of Finnish Agrifood Systems to Climate

Change. Journal of Agricultural Science, Vol 2, No 2 (2010), p. 3-16. ISSN: 1916-9752. E-ISSN: 1916-9760. http://ccsenet.org/journal/index.php/jas/article/viewFile/4599/4888



Northwest England (UK)

General information

Name of region	Northwest England
Contact (general)	Eric Audsley
Contact (scenarios)	Richard Kipling
Location (NUTS code)	UKD
The three most important farming systems in region (SEAMLESS nomenclature)	• Arable / cereal • Dairy cattle / permanent grass • Beef and mixed cattle / permanent grass • Mixed farms / all land use types

Specific issues the region deals with/will deal with

Currently a large part of the area is unsuitable for arable farming and is too cold and wet. Much of the area is livestock and extensively grazed. With CC lowland will become suitable for arable crops but maybe too wet. Will ther upland becoem suitable for more livestock?

Regional challenges with regard to climate change

It will become warmer allowing new crops. Will it become wetter or drier?

Important adaptation measures that will be considered in the study

Water management	
Irrigation	
Drainage	

Species/varietal choice	is important to this region AND will be included in the modelling exercise.
Plant breeding	
Changed planting/sowing days	is important to this region AND will be included in the modelling exercise.
Crop rotations	is important to this region AND will be included in the modelling exercise.
Alternative tillage methods	
Pest/weed management	
Housing of livestock	
Land consolidation	
Management of feeding and reproduction of livestock	
Structure and scale of production adjustment	
Crop insurance	
Exit from agriculture	
Climate alertness	
Political regulations at various administrative levels	
Others	

Models, stakeholders, advancement of knowledge

Models used in the study

Socio-economy	Crops	Grassland	Livestock
REGIS self-contained model givemn oparameers of production required.	REGIS - metamodels derievd from IMPEL crop models Soil and climate data	REGIS - metamodel derived from IMPEL grass model Soil and climate data	REGIS - profitability of land use for dairy or extensive grazing

Stakeholders involved in the study

Agro-business or agro food chain
none

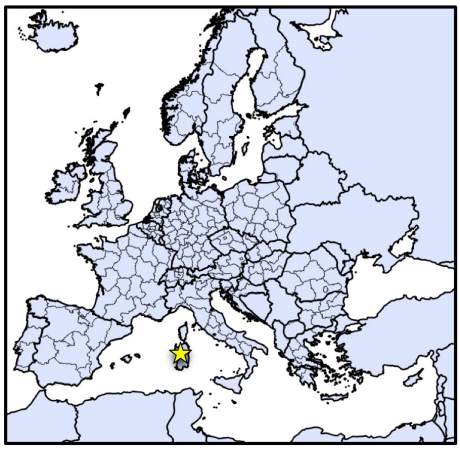
Administrative bodies or regional or national governments
none

Contribution to answering the focus question

Parameters of demand for production and parameters of improved production such as breeding and water use for irrigation.

Further information

http://www.ukcip.org.uk/wordpress/wp-content/PDFs/ReGIS2_summary[1].pdf
http://www.cranfield.ac.uk/sas/naturalresources/research/projects/regis2.html



Oristano (IT)

General information

Name of region	Oristano, Sardinia, Italy
Contact (general)	Gabriele Dono
Contact (scenarios)	Pier Paolo Roggero
Location (NUTS code)	ITG28
The three most important farming systems in region (SEAMLESS nomenclature)	• Arable / cereal • Arable / fallow • Arable / specialised crops • Dairy cattle / temporary grass • Sheep and goats / others

Specific issues the region deals with/will deal with

Dairy farming in an intensive cropping systems:

- Nitrate Vulnerable Zone, 30,000 cattle in 5,500 ha
- High dependence on extra-farm and costly inputs (feeds, fertilizers...)
- Nitrate pollution of groundwater
- Phosphorus pollution of surface water

Regional challenges with regard to climate change

- Near future downscaled RAMS climatic scenarios revealed:
- Increasing maximum temperature paprticularly in summer, resulting in increased irrigation water requirements
- Enhancing precipitation variability in spring, reduction in spring rainfall, resulting in increased irrigation water requirements for hay-crops (or reduced hay production under rainfed conditions)
- Drop in milk production, cow's fertility and increased animal mortality related to forecasted increased temperature-humidity index
- Farm management in conditions of increased climatic and market uncertainty
- Serious drops in farmers' income

Important adaptation measures that will be considered in the study

Water management	is important to this region AND will be included in the modelling exercise.
Irrigation	is important to this region AND will be included in the modelling exercise.

Drainage	
Species/varietal choice	is important to this region.
Plant breeding	
Changed planting/sowing days	
Crop rotations	is important to this region.
Alternative tillage methods	
Pest/weed management	
Housing of livestock	
Land consolidation	
Management of feeding and reproduction of livestock	
Structure and scale of production adjustment	
Crop insurance	
Exit from agriculture	
Climate alertness	
Political regulations at various administrative levels	is important to this region.
Others	
	Increased local production of forage and feeds Reduction of the cattle stocking rate in the district, also by relocating part of the livestock in a neighboring areas to reduce costs (to be assessed through the DSP model) Diversifying production activities Connecting with other districts in Sardinia, for instance developing a Sardinian beef cattle production chain GHG emissions both from animals and fertilizers Water pollution

Models, stakeholders, advancement of knowledge

Models used in the study

Socio-economy	Crops	Grassland	Livestock
A4SMOD: Discrete Stochastic Programming Model (territorial and representative farms) Farm Budget analysis Input (available from	EPIC v. 0810 DSSAT v4.5 Input (already available from UNISS for the Sardinian site, from UNIMI for the Po	EPIC v 0810 (see above) Input (already available from UNISS for the Sardinian site, from UNIMI for the Po	The basic input will be the THI: Daily Tmax Tmin (measured) RHmax RHmin (estimated) are available for both sites

Models used in the study

Socio-economy	Crops	Grassland	Livestock
P62 UNISS, UNIMI, CRA, FADN, ISTAT) Farm structures: FADN, 2010 Agricultural Census Land Use: FADN, 2010 Agricultural Census, Corinne Land Cover Use of inputs and yields: UNISS, UNIMI, CRA	Valley site): climate: daily Tmax Tmin rainfall soil (by horizon): texture (%gravel sand silt clay) %C, bulk density cropping system practices crops (silage maize) dataset useful for calibration partly available	Valley site): climate: daily Tmax Tmin rainfall soil (by horizon): texture (%gravel sand silt clay) %C, bulk density cropping system practices crops (Italian ryegrass, alfalfa) dataset useful for calibration partly available	Observed data (1958-2012), downscaled RAMS scenarios for current climate (2000-10) and near future (2020-30) are already available from CMR IBIMET (M Pasqui) The model is based on the calculation of a 2-phase linear regression procedure (Nickerson et al., 1989), which detects an inflection point, if one exists, in the relationship between the independent (temperature humidity index THI) and dependent variable (milk yield, milk quality, mortality, etc.).

Stakeholders involved in the study

Agro-business or agro food chain

Agro-business: local farmers' cooperative (some 200 cattle farms including almost all 30,000 cows, organized also as a suppliers of feeds and agro-inputs), www.produttoriarborea.it, http://www.lattearborea.eu/
Consorzi di bonifica e Irrigazione (Water Users Associations): Consorzio di bonifica dell'Oristanese, http://www.bonificaoristanese.it

Administrative bodies or regional or national governments

Ministero delle Politiche Agricole, Agroalimentari e Forestali http://www.politicheagricole.it
Sarinia Region http://www.regione.sardegna.it/agricoltura

Regional agency for extension service http://www.sardegnaagricoltura.it/assistenzatecnica/laore/
Oristano Livestock Farmers' association Associazione Regionale Allevatori Sardegna http://www.ara.sardegna.it/
Farmers' unions: Confagricoltura Sardegna www.confagricoltura.sardegna.it/
Coldiretti Sardegna www.sardegna.coldiretti.it/
Confederazione Italiana Agricoltori Sardegna http://www.copagri.it/webapp/ChiSiamo.aspx

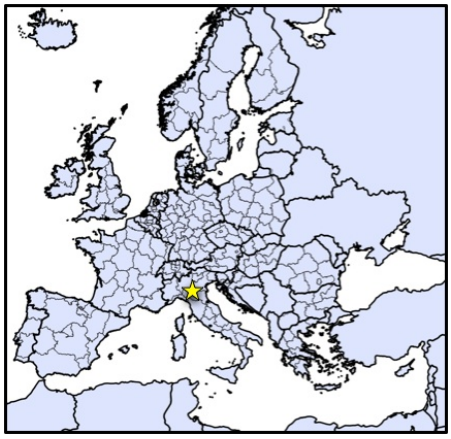
Contribution to answering the focus question

The dairy system is a strategic agro-business all over Europe which is facing a variety of challenges, among which climate change uncertainties. We propose that the Italian pilots on dairy farming is networked through MACSUR with other similar regional pilots to develop a Pan European pilot to address climate change adaptation strategies.

Further information

Collaborators of the Italian team:
NRD UNISS - Roggero P.P., Deligios P., Doro L., Ledda L., Mula L., Seddaiu G. http://nrd.uniss.it
UNITUS - Dono G, Cortignani R, Giraldo L., Mazzapicchio G
CNR IBIMET - Pasqui M, Tomozeiu R
References

Nguyen, P.L., Seddaiu, G., Roggero, P.P., 2013. Hybrid knowledge for understanding complex agri-environmental issues: a case study on nitrate pollution in Italy. International Journal of Agricultural Sustainability, 1-19. DOI: 10.1080/14735903.2013.825995.
Allan, C., Nguyen, P.L., Seddaiu, G., Wilson, B., Roggero, P.P., 2013. Integrating local knowledge with experimental research: case studies on managing cropping systems in Italy and Australia. Italian Journal of Agronomy, 8(e15), 108-116.
Lai, R., Seddaiu, G., Gennaro, L., Roggero, P.P., 2012. Effects of N fertilizer sources and temperature on soil CO2 efflux in Italian ryegrass crop under Mediterranean conditions. Italian Journal of Agronomy, 7, 196-201.
Dono G, Cortignani R, Doro L, Giraldo L, Ledda L, Pasqui M, Roggero PP, An Integrated Assessment of the Impacts of Changing Climate Variability on Agricultural Productivity and Profitability in an Irrigated Mediterranean Catchment, WATER RESOURCES MANAGEMENT, DOI: 10.1007/s11269-013-0367-3
Dono G., Cortignani R., Deligios P., Doro L., Giraldo L., Ledda L., Mazzapicchio G., Pasqui M., Quaresima S., Roggero P.P., Economic Assessment of impact of uncertainty due to short-term changes in climate variability for in Mediterranean farming systems, Communication at the 2nd UNCCD Scientific Conference on Economic assessment of desertification, sustainable land management and resilience of arid, semi-arid and dry sub-humid areas 9 - 12 April 2013 - Bonn, Germany



Piacenza, Parma, Emilia-Romagna, Tuscany

General information

Name of region	Piacenza-Parma-Emilia·Romagna-Toscana, Italy
Contact (general)	Domenico Ventrella
Contact (scenarios)	Pier Paolo Roggero
Location (NUTS code)	ITF41, ITE32, ITF32, ITG28
Farming systems in region (SEAMLESS nomenclature)	• arable/cereal

Specific issues the region deals with/will deal with

- durum wheat cropping systems as monoculture or in rotation with grain legumes
- low profitability
- decrease in crop area in many regions (increasing imports)
- resilience to changes in the world commodity market
- few profitable alternative of land use
- risk of abandonment of farming and land desertification

Regional challenges with regard to climate change

- crop yield stability vs. spring drought
- tillage on heavy soils vs. persistent rains constraining seeding dates
- grain quality (N)
- soil organic C dynamics
- soil erosion on slopes
- farm management in conditions of monoculture with growing climatic and market uncertainty

Important adaptation measures that will be considered in the study

irrigation species/varietal choice
changed planting/sowing days
crop rotations
alternative tillage methods

Models, stakeholders, advancement of knowledge

Models used in the study

Socio-economy	Crops	Grassland	Livestock
A4SMOD: Discrete Stochastic Programming Model (territorial and representative farms) Farm Budget analysis	DSSAT v 4.5	NONE	NONE

Models used in the study

Socio-economy	Crops	Grassland	Livestock
Input Farm structures: FADN, 2010 Agricultural Census Land Use: FADN, 2010 Agricultural Census, Corinne Land Cover Use of inputs and yields: UNISS, UNIVPM or CRA SCA	EPIC v 0810		

Stakeholders involved in the study

Agro-business or agro food chain

In Europe: pasta industrial association (http://www.pasta-unafpa.org/)
In Italy:

- Associazione delle industrie del dolce e della pasta
- Confederazione Italiana Agricoltori Puglia
- Consorzi di bonifica e Irrigazione (Water Users Associations): Consorzio di bonifica dell'Oristanese
- Associazione nazionale bonifiche, irrigazione e miglioramenti fondiari (ANBI)

Administrative bodies or regional or national governments

- Ministry of Agricultural Food and Forestry policies www.politicheagricole.it
- Marina Montedoro mmontedoro@politicheagricole.gov.it
- Agricultural councillorship and agricultural agencies in the following regions: Sardinia, Campania, Puglia, Marche
- Farmers Unions of Italy
- Italian national research project "IC-FAR"
- Coldiretti www.coldiretti.it
- Confagricoltura www.confagricoltura.it
- Confederazione Italiana Agricoltori www.cia.it
- Farmers organizations at district level (Organizzazione dei produttori)

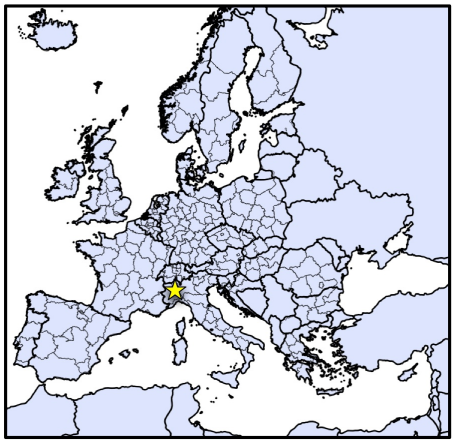
Contribution to answering the focus question

- food security
- agriculture sustainability
- investments on plant breeding
- GHG emissions associated to durum wheat production under Mediterranean conditions
- farm profitability under uncertain climate and market conditions

Further information

- Ventrella D., Giglio L., Charfeddine M., Lopez R., Castellini M., Sollitto D., Castrignanò A., Fornaro F. 2012. Climate change impact on crop rotations of winter durum wheat and tomato in southern Italy: yield analysis and soil fertility. Italian Journal of Agronomy, 7:e15, 100-108, DOI: 10.4081/ija.2012.e15.
- Ventrella D., Charfeddine M., Moriondo M., Rinaldi M., Bindi M. 2012. Agronomic Adaptation Strategies under Climate Change for Winter Durum Wheat and Tomato in Southern Italy: Irrigation and Nitrogen Fertilization. Regional Environmental Change, 12, 407-419.
- L. Gutierrez, F. Piras, P.P. Roggero 2013. Short and long-run impact of climate changes on worldwide grain prices, Communication at the 2nd UNCCD Scientific Conference on Economic assessment of desertification, sustainable land management and resilience of arid, semi-arid and dry sub-humid areas 9 - 12 April 2013 - Bonn, Germany

- Dono G, Cortignani R, Doro L, Giraldo L, Ledda L, Pasqui M, Roggero PP, An Integrated Assessment of the Impacts of Changing Climate Variability on Agricultural Productivity and Profitability in an Irrigated Mediterranean Catchment, WATER RESOURCES MANAGEMENT, DOI: 10.1007/s11269-013-0367-3
- Dono G., Cortignani R., Deligios P., Doro L., Giraldo L., Ledda L., Mazzapicchio G., Pasqui M., Quaresima S., Roggero P.P., Economic Assessment of impact of uncertainty due to short-term changes in climate variability for in Mediterranean farming systems, Communication at the 2nd UNCCD Scientific Conference on Economic assessment of desertification, sustainable land management and resilience of arid, semi-arid and dry sub-humid areas 9 - 12 April 2013 - Bonn, Germany
- De Sanctis, G., Roggero, P. P., Seddaiu, G., Orsini, R., Porter, C. H., & Jones, J. W. (2012). Long-term no tillage increased soil organic carbon content of rain-fed cereal systems in a Mediterranean area. European Journal of Agronomy, 40, 18-27.
- Farina, R., Seddaiu, G., Orsini, R., Steglich, E., Roggero, P. P., & Francaviglia, R. (2011). Soil carbon dynamics and crop productivity as influenced by climate change in a rainfed cereal system under contrasting tillage using EPIC. Soil and Tillage Research, 112(1), 36-46.
- Collaborators, CRA: Luisa Giglio, Monia Charfeddine
- Collaborators, UNISS: Luciano Gutierrez, Luca Doro, Paola Deligios, Giovanna Seddaiu, Luigi Ledda
- Collaborators, UNITUS: Gabriele Dono, Raffaele Cortignani, Luca Giraldo, Graziano Mazzapicchio



Pedmont (IT)

General information

Name of region	Piedmont (Piemonte), Italy
Contact (general)	Claudio Cassardo
Contact (scenarios)	Marco Bindi
Location (NUTS code)	ITC1
The three most important farming systems in region (SEAMLESS nomenclature)	• Arable / cereal • Mixed farms / all land use types • Permanent crops / all land use

Specific issues the region deals with/will deal with

Crops, vineyard, fruit trees, rice paddy and cereals production.

Regional challenges with regard to climate change

Water resources, phytopatological diseases, crop prodution and quality, heatwaves and natural hazards, abiotica risks, agronomical practices

Important adaptation measures that will be considered in the study

Water management	is important to this region AND will be included in the modelling exercise.
Irrigation	is important to this region.
Drainage	
Species/varietal choice	is important to this region.
Plant breeding	
Changed planting/sowing days	is important to this region.
Crop rotations	is important to this region.
Alternative tillage methods	is important to this region.
Pest/weed management	is important to this region AND will be included in the modelling exercise.
Housing of livestock	
Land consolidation	is important to this region.

Management of feeding and reproduction of livestock	
Structure and scale of production adjustment	is important to this region.
Crop insurance	is important to this region.
Exit from agriculture	
Climate alertness	is important to this region AND will be included in the modelling exercise.
Political regulations at various administrative levels	is important to this region.
Others	

Models, stakeholders, advancement of knowledge

Models used in the study

Socio-economy	Crops	Grassland	Livestock
None	UTOPIA Biometeorological and Phenological models	None	None

Stakeholders involved in the study

Agro-business or agro food chain

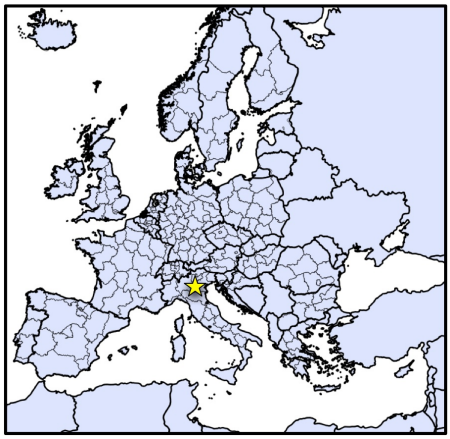
n. 10 Consortia of wine producers of Piedmont region and Piedmont Cantine sociali (wineries) Terre da Vino - www.terredavino.it Vignaioli Piemontesi Scarl - www.vignaioli.it

Administrative bodies or regional or national governments

Piedmont Plant disease and Agrometeorological Service Federico Spanna.
CSV - Tenuta Cannona www.tenutacannona.it
Italian Association of Agrometeorology www.agrometeorologia.it

Contribution to answering the focus question

Our case study will contribute to give some answers regarding the vineyard modellization. The main aim is to mantain an adeguate production level and to rationalize the resources, with particular reference to the following topics Water resources, phytopatological diseases, crop prodution and quality, mitigation ad adaptation to heatwaves and natural hazards, abiotica risks and optimization of agronomical practices also in order to improve the carbon balance.



Po Valley (IT)

General information

Name of region	Grana and Parmigiano district, Po Valley, Italy
Contact (general)	Pier Paolo Roggero
Contact (scenarios)	Pier Paolo Roggero
Location (NUTS code)	ITD51, ITD52
The three most important farming systems in region (SEAMLESS nomenclature)	• Arable / cereal • Dairy cattle / permanent grass • Dairy cattle / temporary grass

Specific issues the region deals with/will deal with

Dairy farming in an intensive cropping systems: - Nitrate Vulnerable Zone, 30,000 cattle in 5,500 ha - High dependence on extra-farm and costly inputs (feeds, fertilizers...) - nitrate pollution of groundwater - phosphorus pollution of surface water

Regional challenges with regard to climate change

Near future downscaled RAMS climatic scenarios revealed: - Increasing maximum temperature paprticularly in summer, resulting in increased irrigation water requirements - increasing precipitation variability in spring, reduction in spring rainfall, resulting in increased irrigation water requirements for hay-crops (or reduced hay production under rainfed conditions) - drop in milk production, cow's fertility and increased animal mortality related to forecasted increased temperature-humidity index - farm management in conditions of increased climatic and market uncertainty - serious drops in farmers' income

Important adaptation measures that will be considered in the study

Water management	is important to this region.
Irrigation	is important to this region AND will be included in the modelling exercise.
Drainage	is important to this region.
Species/varietal choice	is important to this region.
Plant breeding	is important to this region.
Changed planting/sowing days	is important to this region AND will be included in the modelling exercise.
Crop rotations	is important to this region AND will be included in the modelling exercise.
Alternative tillage methods	is important to this region AND will be included in the modelling exercise.

Pest/weed management	
Housing of livestock	is important to this region AND will be included in the modelling exercise.
Land consolidation	
Management of feeding and reproduction of livestock	is important to this region AND will be included in the modelling exercise.
Structure and scale of production adjustment	is important to this region AND will be included in the modelling exercise.
Crop insurance	
Exit from agriculture	is important to this region.
Climate alertness	
Political regulations at various administrative levels	is important to this region.
Others	is important to this region.
	• Increased local production of forage and feeds; • Reduction of the cattle stocking rate in the district, also by relocating part of the livestock in a neighboring areas to reduce costs (to be assessed through the DSP model) • GHG emissions both from animals and fertilizers • Water pollution • Please note that not all the entered

Models, stakeholders, advancement of knowledge

Models used in the study

Socio-economy	Crops	Grassland	Livestock
A4SMOD: Discrete Stochastic Programming Model (territorial and representative farms) Farm Budget analysis FADN, 2010 Agricultural Census Land Use Agricultural Census Corinne Land Cover	EPIC v. 0810 DSSAT v. 4.5 Armosa v. 4.13 Cropsyst 4.09.01	EPIC v. 0810 Armosa v. 4.13	Nickerson et al., 1989. The model is based on the calculation of a 2-phase linear regression procedure, which detects an inflection point, if one exists, in the relationship between the independent (temperature humidity index THI) and dependent variable (milk yield, milk quality, mortality, etc.).

Stakeholders involved in the study

Agro-business or agro food chain

Consorzio del Parmigiano Reggiano - http://www.parmigianoreggiano.com/default.aspx
Consorzio Grana Padano http://www.granapadano.it/aspx/Home.aspx?idAmb=103&idMenu=-1&liv=0
Associazione nazionale bonifiche, irrigazione e miglioramenti fondiari (ANBI), www.anbi.it

Administrative bodies or regional or national governments

Ministero delle Politiche Agricole, Agroalimentari e Forestali www.politicheagricole.it
Livestock Farmers' association
Associazione Regionale Allevatori Lombardia http://www.aral.lom.it/

Contribution to answering the focus question

The dairy system is a strategic agro-business all over Europe which is facing a variety of challenges, among which climate change uncertainties. We propose that the Italian pilots on dairy farming is networked through MACSUR with other similar regional pilots to develop a Pan European pilot to address climate change adaptation strategies.

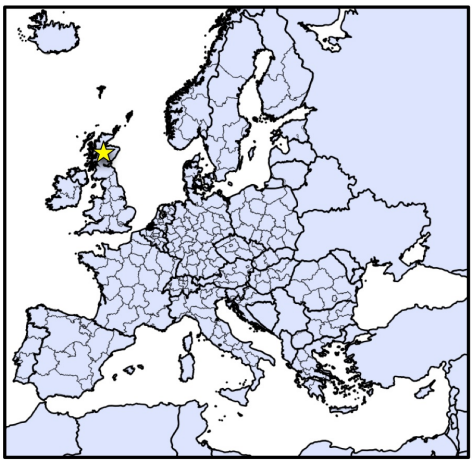
Further information

Collaborators of the Italian team:

NRD UNISS - Roggero P.P., Deligios P., Doro L., Ledda L., Mula L., Seddaiu G. http://nrd.uniss.it
UNITUS - Dono G, Cortignani R, Giraldo L., Mazzapicchio G,
UNIMI - Acutis M, Fumagalli M, Perego A, Sanna M
CNR IBIMET - Pasqui M, Tomozeiu R

References

Nickerson, D. M., D. E. Facey, and G. D. Grossman. 1989. Estimating physiological thresholds with continuous two-phase regression. Physiol. Zool. 62:866–877
Dono G, Cortignani R, Doro L, Giraldo L, Ledda L, Pasqui M, Roggero PP, An Integrated Assessment of the Impacts of Changing Climate Variability on Agricultural Productivity and Profitability in an Irrigated Mediterranean Catchment, WATER RESOURCES MANAGEMENT, DOI: 10.1007/s11269-013-0367-3
Dono G., Cortignani R., Deligios P., Doro L., Giraldo L., Ledda L., Mazzapicchio G., Pasqui M., Quaresima S., Roggero P.P., Economic Assessment of impact of uncertainty due to short-term changes in climate variability for in Mediterranean farming systems, Communication at the 2nd UNCCD Scientific Conference on Economic assessment of desertification, sustainable land management and resilience of arid, semi-arid and dry sub-humid areas 9 - 12 April 2013 - Bonn, Germany



Scotland (UK)

General information

Name of region	Scotland
Contact (general)	Daniel Sandars
Contact (scenarios)	Richard Kipling
Location (NUTS code)	UKM
The three most important farming systems in region (SEAMLESS nomenclature)	• Dairy cattle / permanent grass • Beef and mixed cattle / permanent grass • Mixed farms / all land use types

Specific issues the region deals with/will deal with

Low temperatures, high rainfall, hills and mountains.

Regional challenges with regard to climate change

Land use change to new farming systems and new crops that have become viable

Important adaptation measures that will be considered in the study

Water management	
Irrigation	
Drainage	
Species/varietal choice	
Plant breeding	
Changed planting/sowing days	is important to this region AND will be included in the modelling exercise.
Crop rotations	is important to this region AND will be included in the modelling exercise.
Alternative tillage methods	
Pest/weed management	
Housing of livestock	

Land consolidation	
Management of feeding and reproduction of livestock	is important to this region AND will be included in the modelling exercise.
Structure and scale of production adjustment	
Crop insurance	
Exit from agriculture	
Climate alertness	
Political regulations at various administrative levels	
Others	

Models, stakeholders, advancement of knowledge

Models used in the study

Socio-economy	Crops	Grassland	Livestock
CLIMSAVE No input is needed but could use input from other models to assess effect on output.	CLIMSAVE Have own crop models but as above could make use of others. In particular we have alternative UK crop models of our own which could be used.	CLIMSAVE Have own grass models but as above could make use of others. In particular we have an alternative UK grass model of our own which could be used.	CLIMSAVE. The model only calculates the profitability of livestock and for dairy cows the number supported by the given area. The underlying model uses the DM Intake, energy and protein requirement to determine the forage and concentrates required.

Stakeholders involved in the study

Agro-business or agro food chain
CLIMSAVE stakeholders

Administrative bodies or regional or national governments
CLIMSAVE stakeholders

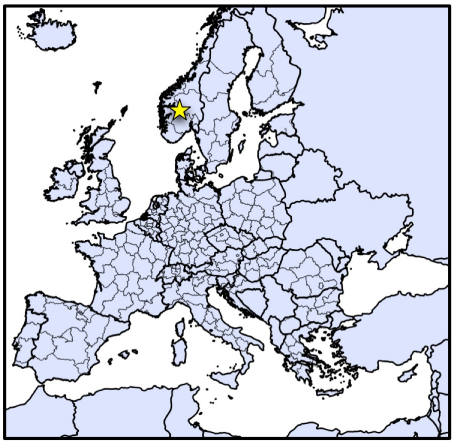
Contribution to answering the focus question

The model allows a number of variables to be adjusted. water savings, breeding, bioenergy, imports, protected areas, setaside for biodiversity. But not population control.

Further information

Go to www.climsave.eu and select Scotland. Although Scotland is a specific case study at 5km resolution, the same model is also applied across the EU at 10' and so any region can be studied. Results are already also reported at NUTS2 level.

Southern Norway



General information

Name of region	Southern Norway
Contact (general)	Klaus Mittenzwei
Contact (scenarios)	Klaus Mittenzwei
Location (NUTS code)	–
Farming systems in region (SEAMLESS nomenclature)	• arable/cereal • dairy cattle/permanent grass • beef and mixed cattle/permanent grass

Specific issues the region deals with/will deal with

*weather dependence of crop yields (cereals, grass) *GHG emissions of dairy/beef cattle systems, incl. Mitigation methods *economic focus on the trade-off between GHG emission reductions, food security, and cultural landscapes

Regional challenges with regard to climate change

*climate change regards foremost crop production: a prospective of increased average yields on the one hand, but on the other hand a higher probability of severe weather conditions in the planting period (too wet, too cold) and in the harvesting period (too wet to access the fields) *indirectly, climate change raised questions about the objectives and means of Norwegian agricultural policy as it is not clear whether the current level of agricultural activity, and even the proposed increase in agricultural activities is sustainable in a national and global perspective

Important adaptation measures that will be considered in the study

species/varietal choice plant breeding changed planting/sowing days management of feeding and reproduction of livestock structure and scale of production adjustment political regulations at various administrative levels

Models, stakeholders, advancement of knowledge

Models used in the study

Socio-economy	Crops	Grassland	Livestock
Jordmod: A spatial, static, multi-commodity partial equilibrium model for the Norwegian Agricultural sector divided into 32 production regions. Single farms at the regional level maximize profits for given prices. These farms constitute the supply side in the market module of the model and are matched with consumer	To be announced	LINGRA model for grass production with a focus on harvest security and biomass yield	HOLOS - a detailed livestock model to calculate GHG emissions of livestock systems. Calibrated with farm accounts and biological information for six Norwegian municipalities

Models used in the study

Socio-economy	Crops	Grassland	Livestock
demand to maximize social welfare. Jordmod will need input for crop yields from the crop models and farm management input from the livestock model			

Stakeholders involved in the study

Agro-business or agro food chain
To be announced

Administrative bodies or regional or national governments
To be announced

Contribution to answering the focus question
Effects of extreme weather events Possibly the social costs of various adaptation strategies needs to be further elaborated with national partners