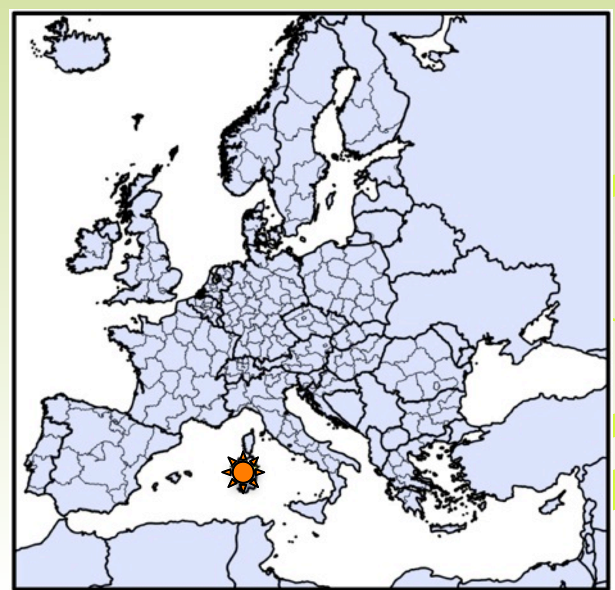
Modelling European Agriculture with Climate Change for Food Security

Oristano,Sardinia, Italy

Winner and losers from climate change in agriculture: a case study in the Mediterranean basin

Pier Paolo Roggero, Giovanna Seddaiu, Luigi Ledda, Luca Doro, Paola Deligios, Thi Phuoc Lai Nguyen, Massimiliano Pasqui, Sara Quaresima, Nicola Lacetera, Raffaele Cortignani, Davide Dell'Unto, Gabriele Dono

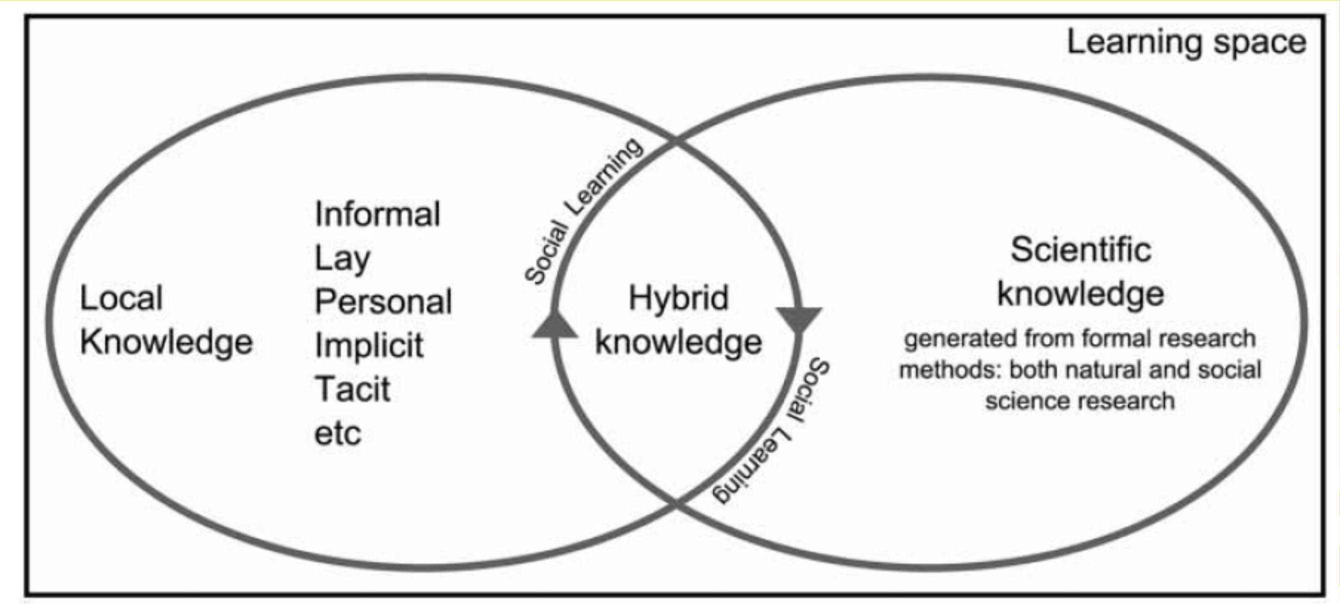


Framing research question(s):

- How to support effective adaptive responses to CC and stimulate proactive attitudes of farmers, policymakers & researchers?
  - Which level of response are we interested to support?
    - Level 1 – No response
    - Level 2 - Compliant
    - Level 3 – Efficient management
    - Level 4 – Breakthrough projects, strategic, win-win
    - Level 5 – Strategic management at all levels to ensure resilence
    - Level 6 – Champion, visionary, influencial organization
- How to co-construct the nature of the issues about CC adaptation?
  - i.e.: How to identify the right questions to engage pathways within the “adaptive space” (Wise et al GEC)?

Hybrid knowledge paradigm

- "**CC adaptation**" is a socially constructed concept
- Contextualized **background experience** informs…
  - …CC understanding and response-abilities/capacities
  - …farmers' CC perception that drive changes in practice



Nguyen et al 2014 Int J Agric Sustain

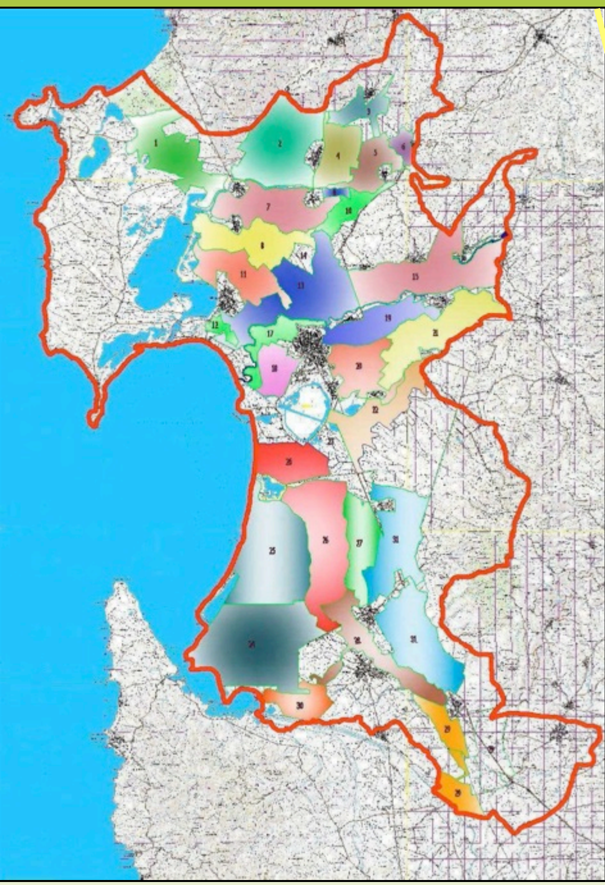
The «Oristanese» case study

- One of the 6 Italian case studies (www.agroscenari.it)
  - Interdisciplinary team @work
  - Contextual data available from other projects

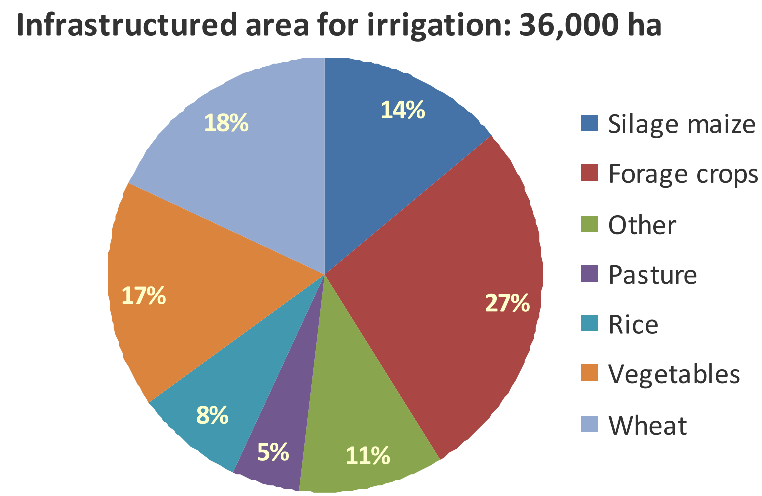
- **Very diversified agricultural district in a Mediterranean context**
  - **Irrigated and rainfed farming systems**
  - **Variety of cropping systems, intensity levels, farm size**

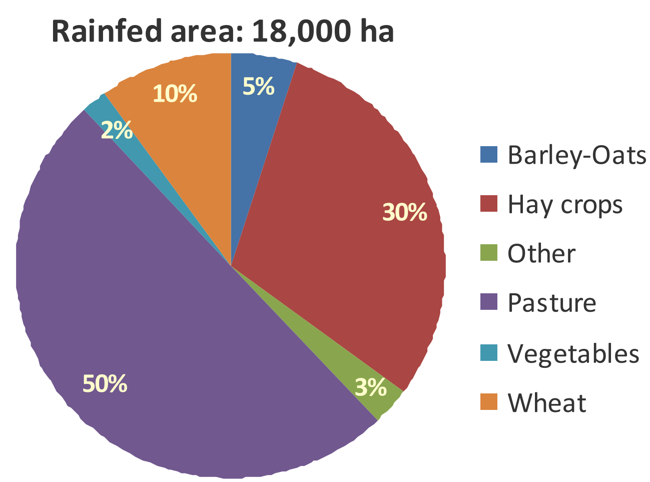
- **Multiple stakeholders**
  - **Cooperative agro-food system**
  - **Producers' organizations (rice, horticulture)**
  - **Variety of extensive pastoral systems**

Oristanese




Sassari
Oristano
Dairy sheep farm
Dairy cattle district, Arborea
Cagliari
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
© 2014 Google
40°06'41.07" N 9°17'10.39" E


Infrastructured area for irrigation: 36,000 ha
14%
27%
11%
5%
8%
17%
18%
Silage maize
Forage crops
Other
Pasture
Rice
Vegetables
Wheat


Rainfed area: 18,000 ha
5%
30%
3%
50%
2%
10%
Barley-Oats
Hay crops
Other
Pasture
Vegetables
Wheat

Main farming systems

Farming system typologies

	% total land area		% total net income	
Irrigated crops	***57.7***		***82.5***	
Rice	*5.2*		*4.2*	
Citrus	*1.6*		*3.9*	
Dairy cattle A	*7.6*	10.0	*32.6*	38.3
Dairy cattle B	*2.4*		*5.7*	
Greenhouse	*1.1*		*1.7*	
Vegetables - Cereals	*23.5*		*24.2*	
Cereals - Forages	*15.2*		*8.7*	
Tree and arable crops	*1.1*		*1.5*	
Rainfed crops	***42.3***		***17.5***	
Vegetables - Fruit	*0.8*		*2.3*	
Cereals - Forages	*4.4*		*2.0*	
Sheep A	*7.4*	37.2	*2.5*	12.2
Sheep B	*14.6*		*3.8*	
Sheep C	*15.2*		*6.9*	

CC impact assessment

Cnr Ibimet

RAMS scenarios forced by sea T coupled with atm (2000-10 vs 2020-30)

WXGEN

150 years PC vs FC

Calibration

Local weather dataset (59 yrs)

Social learning

NRD Uniss

Calibrated EPIC model for main cropping systems

Calibration

Local cropping system dataset

Social learning

@RISK

P distributions of performance of main crops and net ET under CP vs FC

Social learning

Farmers and local organizations, participatory field experiments

Social learning

Unitus

Calibrated 3-stages DSP model for main rainfed and irrigated farm typologies and @district scale

Calibration

Local farming systems dataset

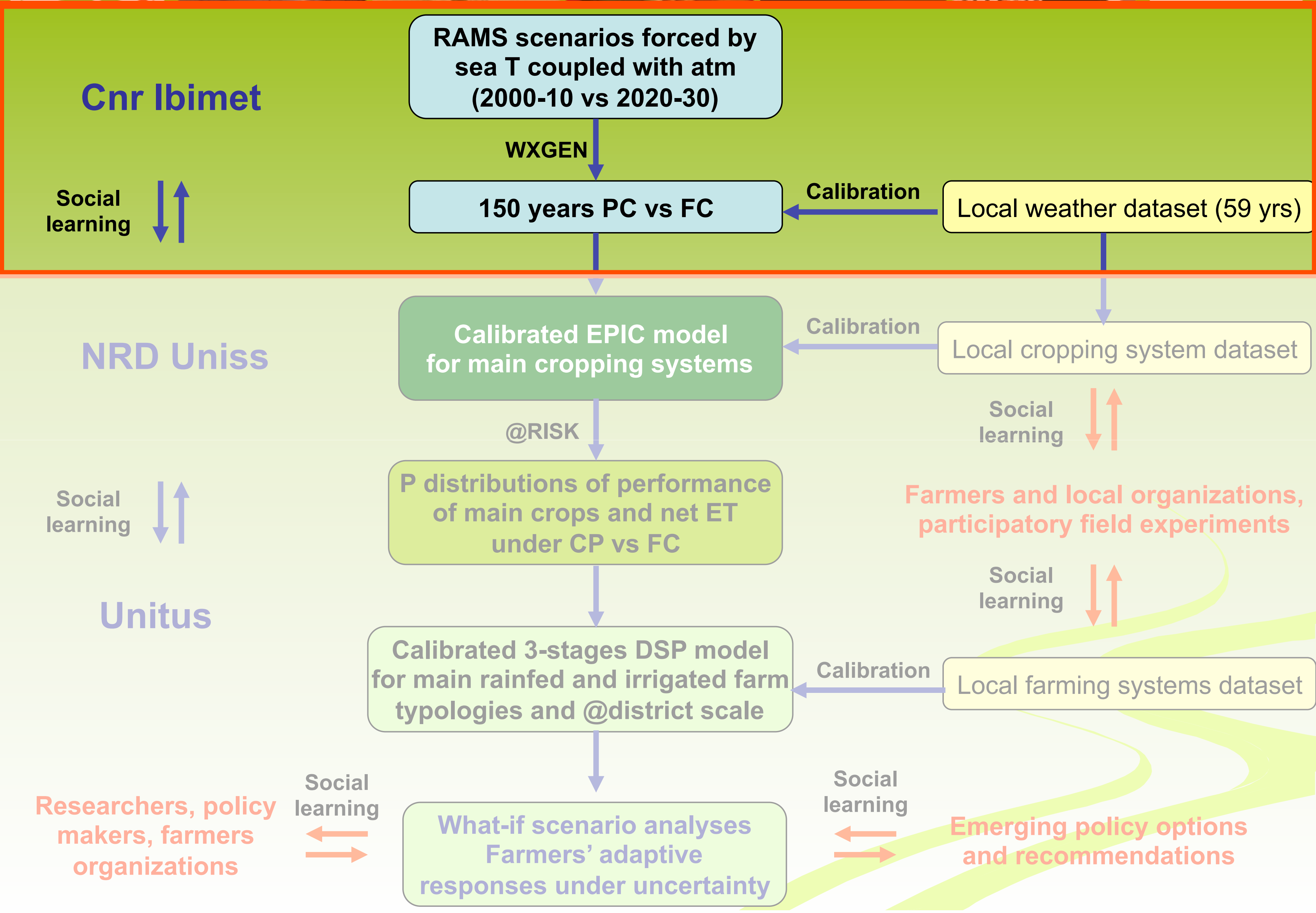
Researchers, policy makers, farmers organizations

Social learning

What-if scenario analyses Farmers' adaptive responses under uncertainty

Social learning

Emerging policy options and recommendations



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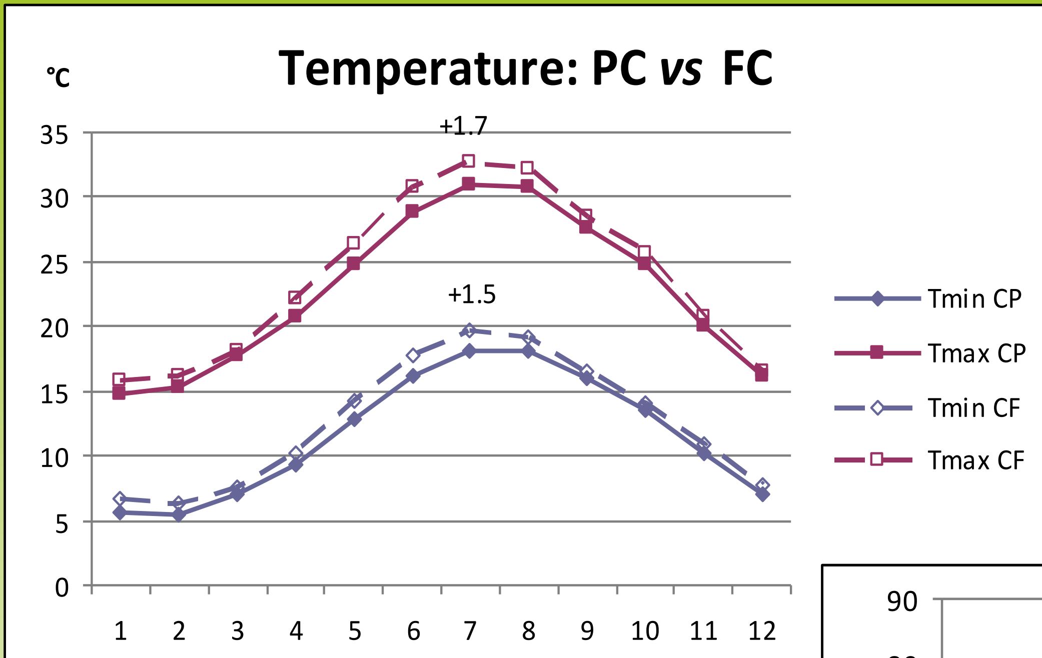
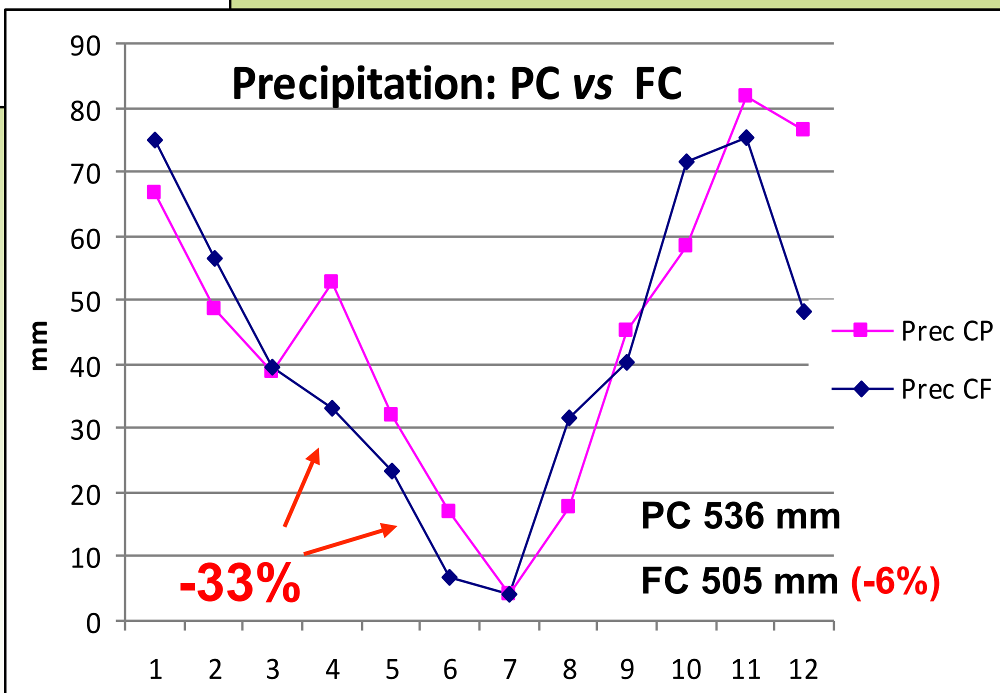
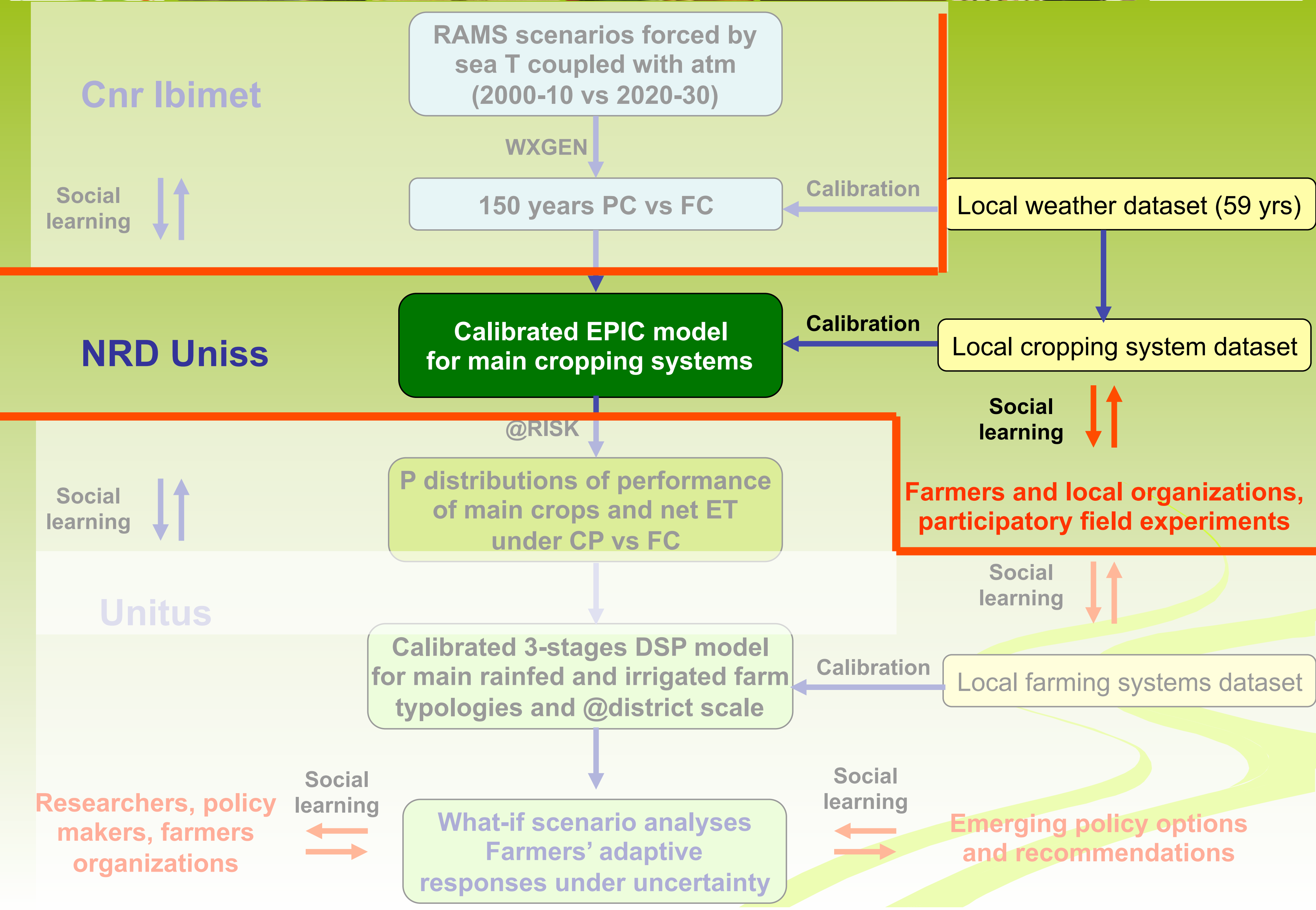
Climate change signals







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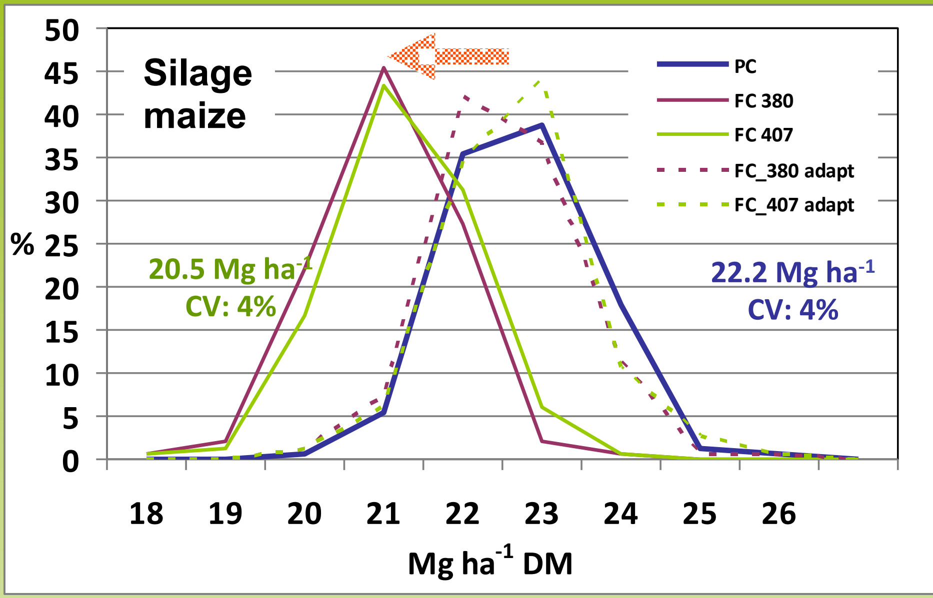
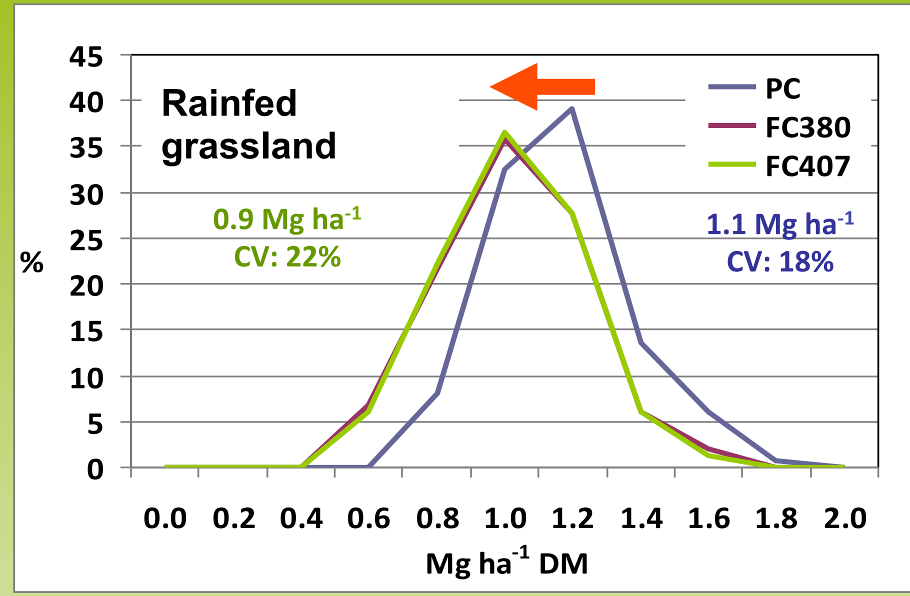
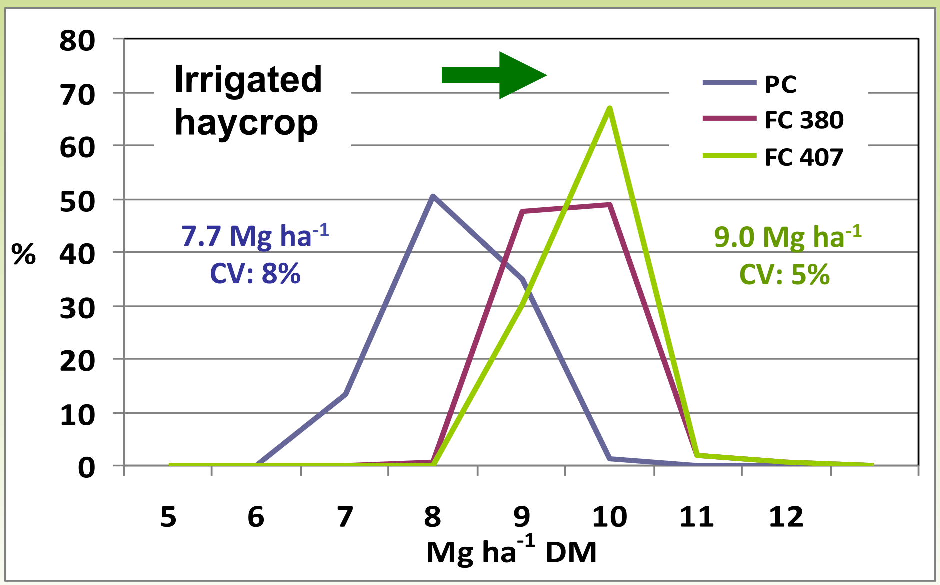


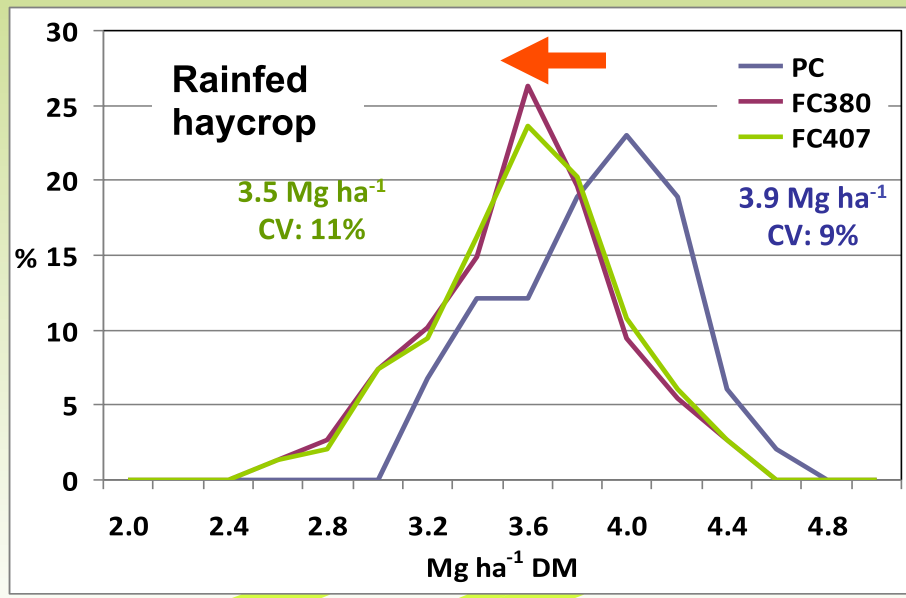
Silage maize
PC
FC 380
FC 407
FC_380 adapt
FC_407 adapt
20.5 Mg ha-1
CV: 4%
22.2 Mg ha-1
CV: 4%
%
0 5 10 15 20 25 30 35 40 45 50
18 19 20 21 22 23 24 25 26
Mg ha-1 DM



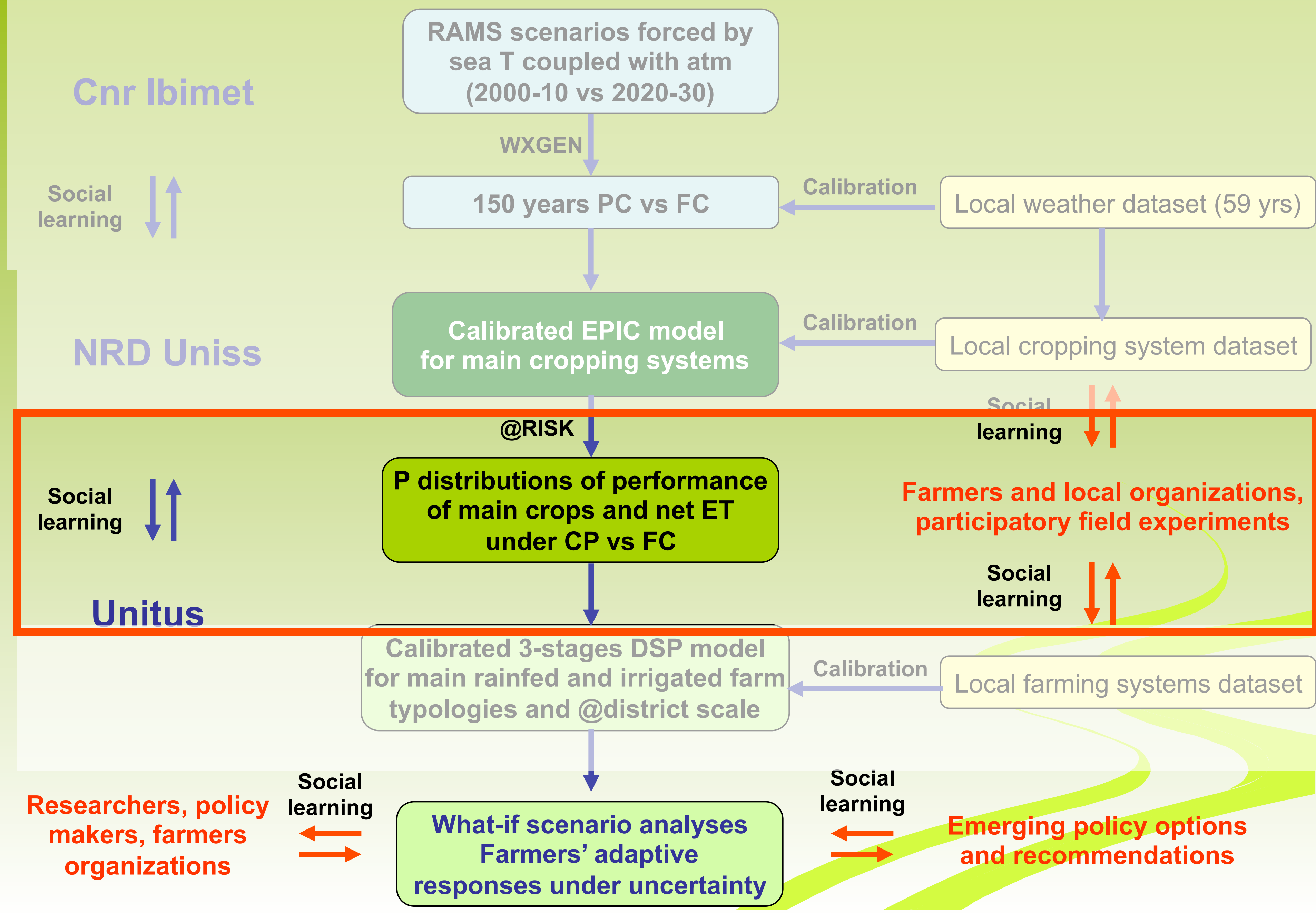
Rainfed grassland
PC
FC380
FC407
0.9 Mg ha-1
CV: 22%
1.1 Mg ha-1
CV: 18%
%
0 5 10 15 20 25 30 35 40 45
0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0
Mg ha-1 DM



Irrigated haycrop
PC
FC 380
FC 407
7.7 Mg ha-1
CV: 8%
9.0 Mg ha-1
CV: 5%
%
0 10 20 30 40 50 60 70 80
5 6 7 8 9 10 11 12
Mg ha-1 DM



Rainfed haycrop
PC
FC380
FC407
3.5 Mg ha-1
CV: 11%
3.9 Mg ha-1
CV: 9%
%
0 5 10 15 20 25 30
2.0 2.4 2.8 3.2 3.6 4.0 4.4 4.8
Mg ha-1 DM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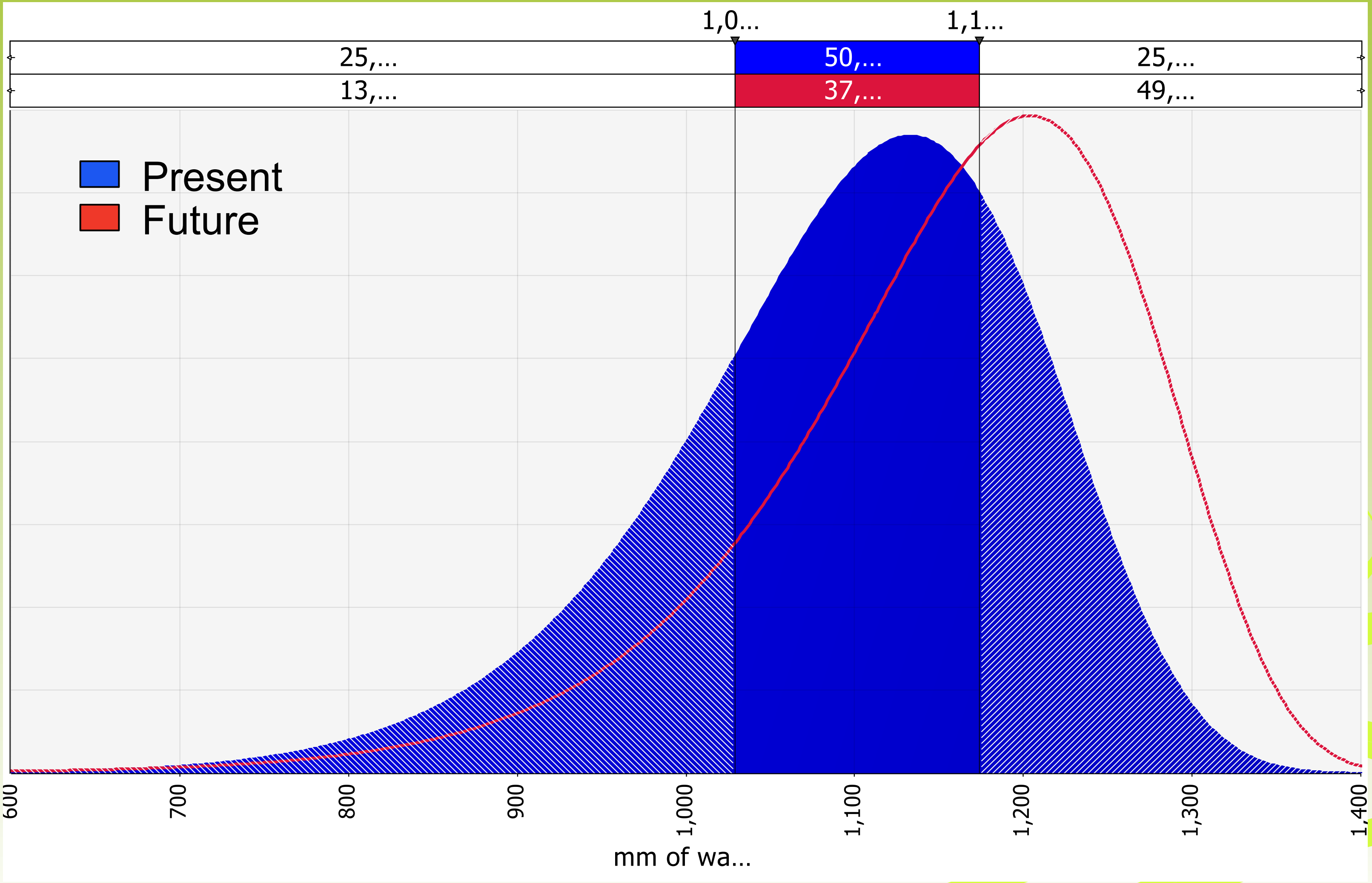
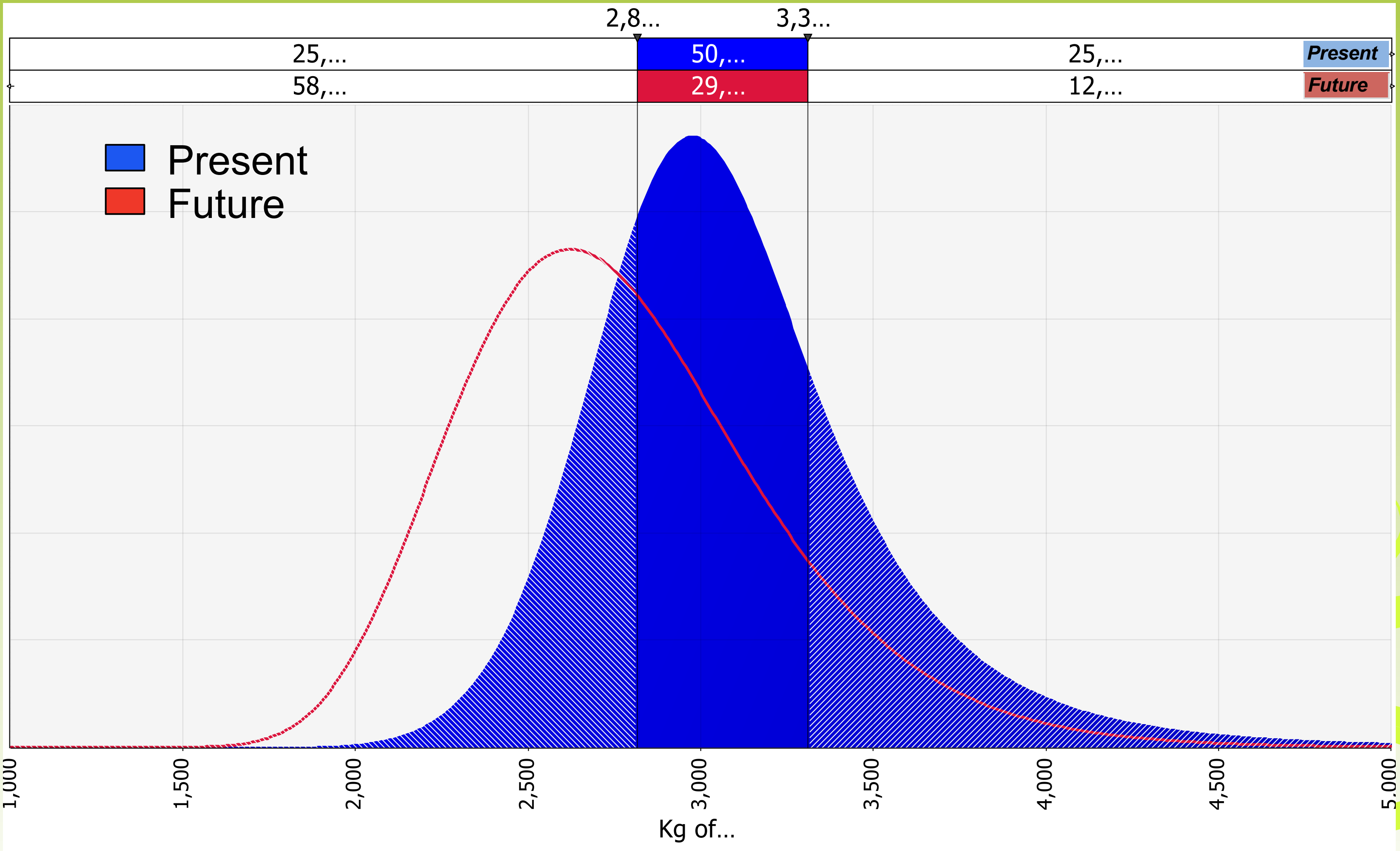
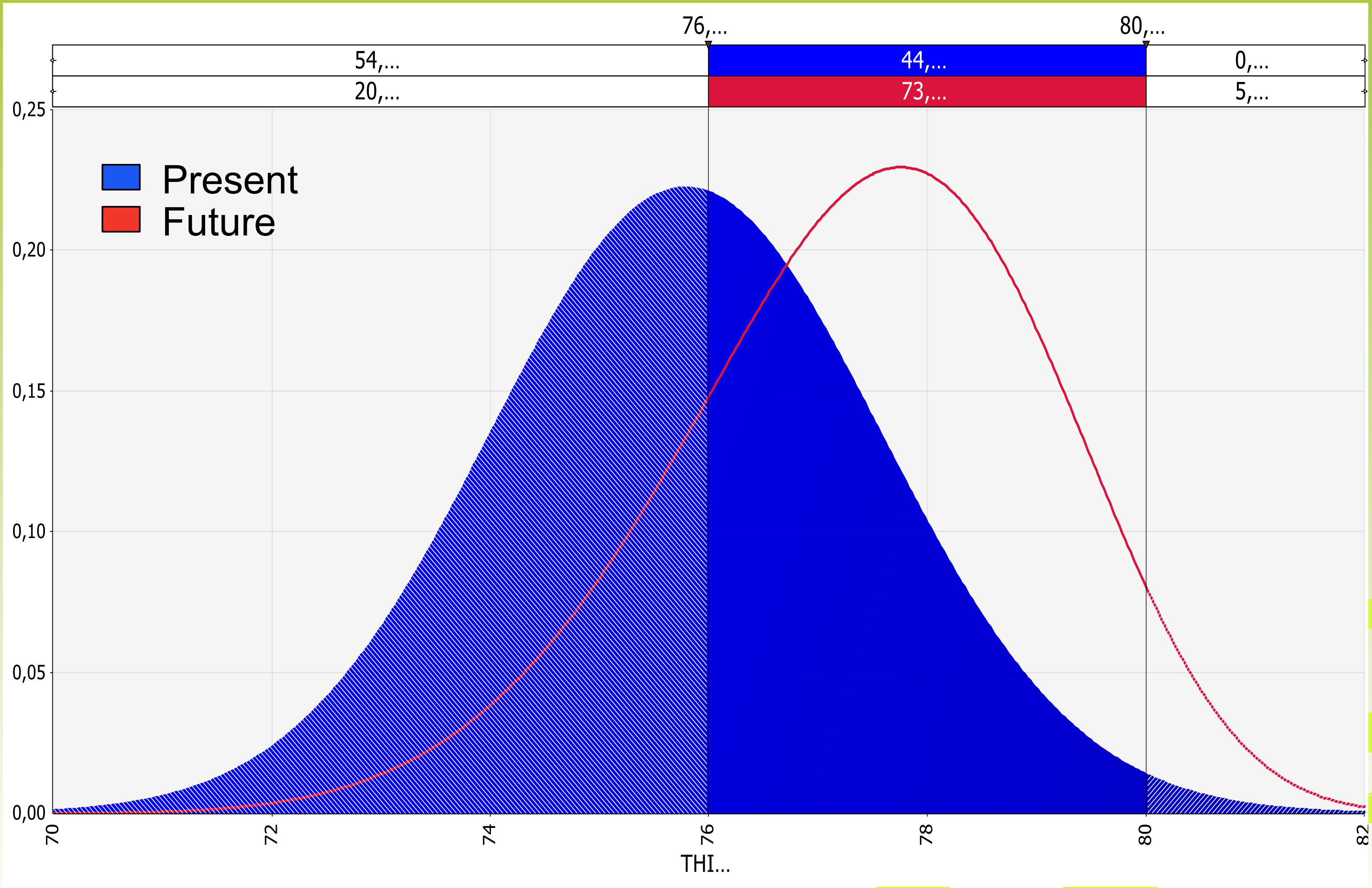
Cumulative ETn in April-October

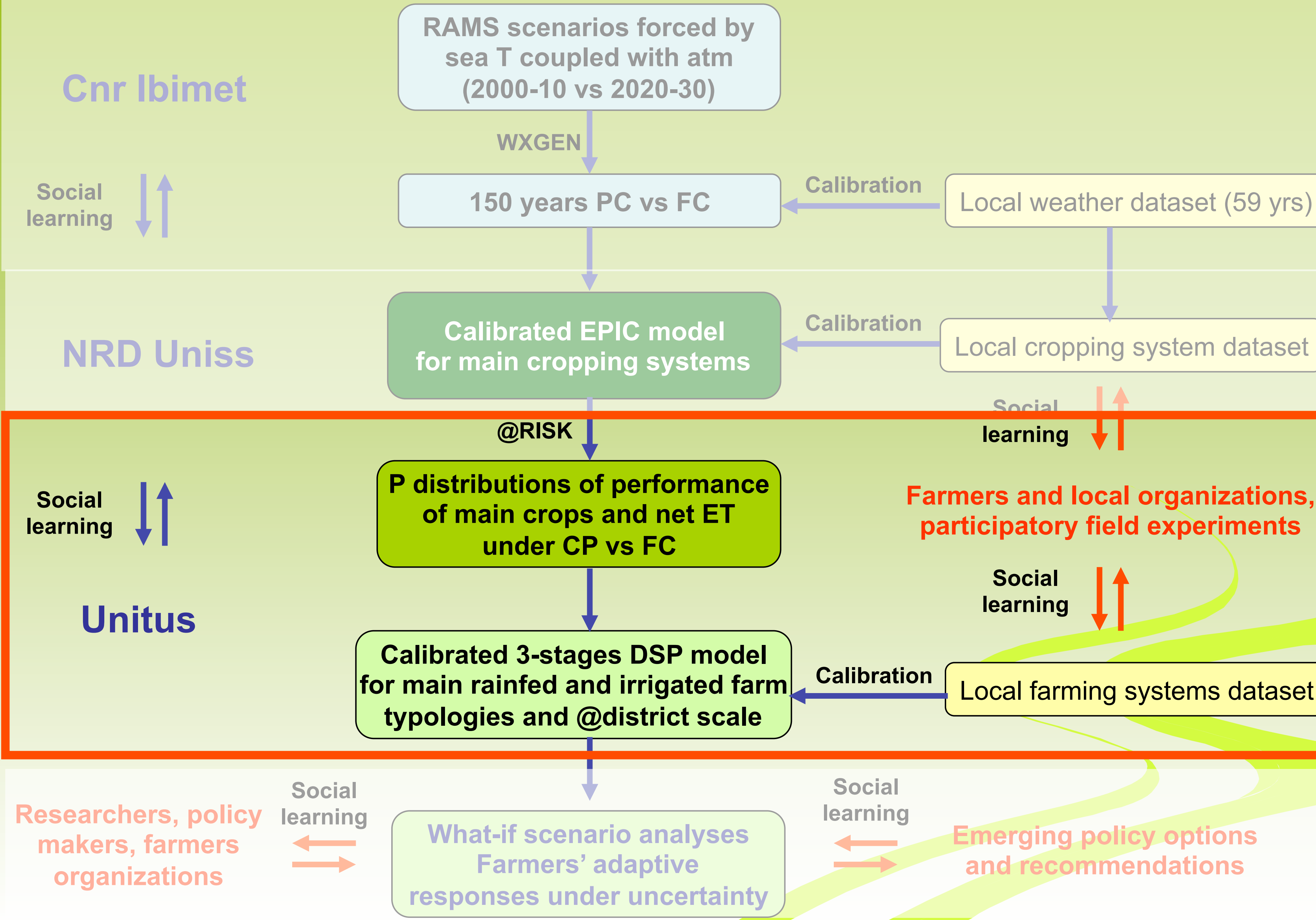


Spring Hay yield from rain-fed crops



THI max in May-September





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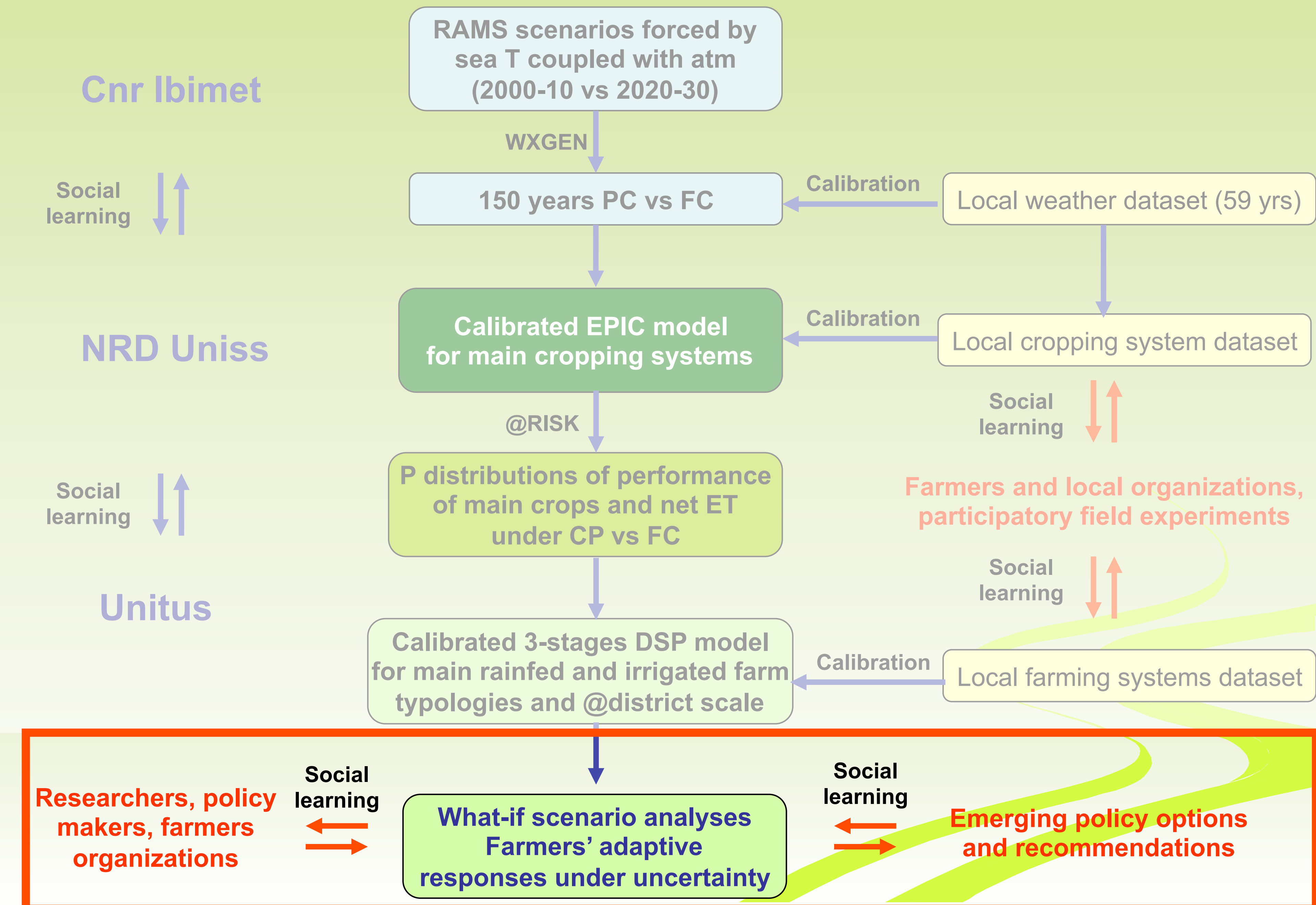
Net Income per farming system typology

Farming system type	2000-10 (k€)	2020-30 (Δ%)
Rice	4,097	**+9.9**
Vegetables - Cereals	18,656	-0.8
Cereals - Forages	7,593	**+1.4**
Cattle A	26,355	**-5.1**
Cattle B	6,825	**-5.9**
Sheep A	2,461	**-5.3**
Sheep B	1,984	**-11.8**
Sheep C	3,984	**-7.4**
Other	3,721	+0.1

Shift of the district **economic performance** driven by CC variables considered in the assessment, by sub-zone

Economic indicators	**Weights**		**Δ% 2020-30 vs 2000-10**		
	Irrigated	**Rainfed**	**Irrigated**	**Rainfed**	**Total area**
Total revenues	100	100	-0.4	+0.8	-0.3
Variable costs	64	62	+0.5	**+5.5**	**+1.1**
Technical means	*33*	*23*	*+0.8*	***+8.1***	*+1.5*
Feed	*11*	*16*	***-5.4***	***+29.3***	*+0.7*
Extra-farm labor	*4*	*8*	*-0.6*	***-8.0***	***-2.6***
Payments for irrigation	*1*	*0.1*	*+1.2*	*0.0*	*1.2*
Well water pumping	*0.1*	*0.6*	*-0.2*	*+1.0*	*0.5*
Gross margin	52	7	**-1.5**	**-3.8**	**-1.9**
Net income	38	47	**-2.1**	**-5.4**	**-2.6**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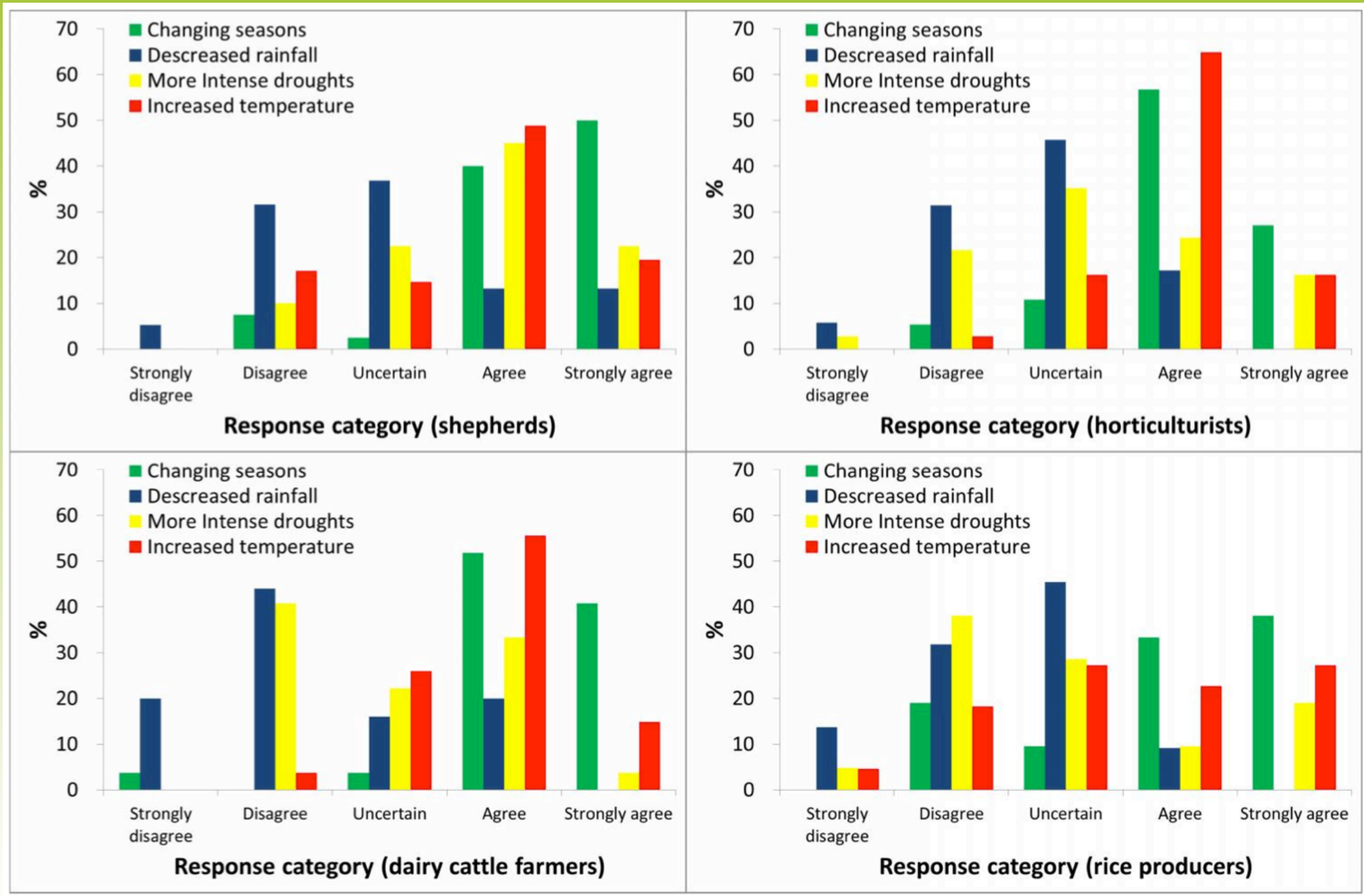
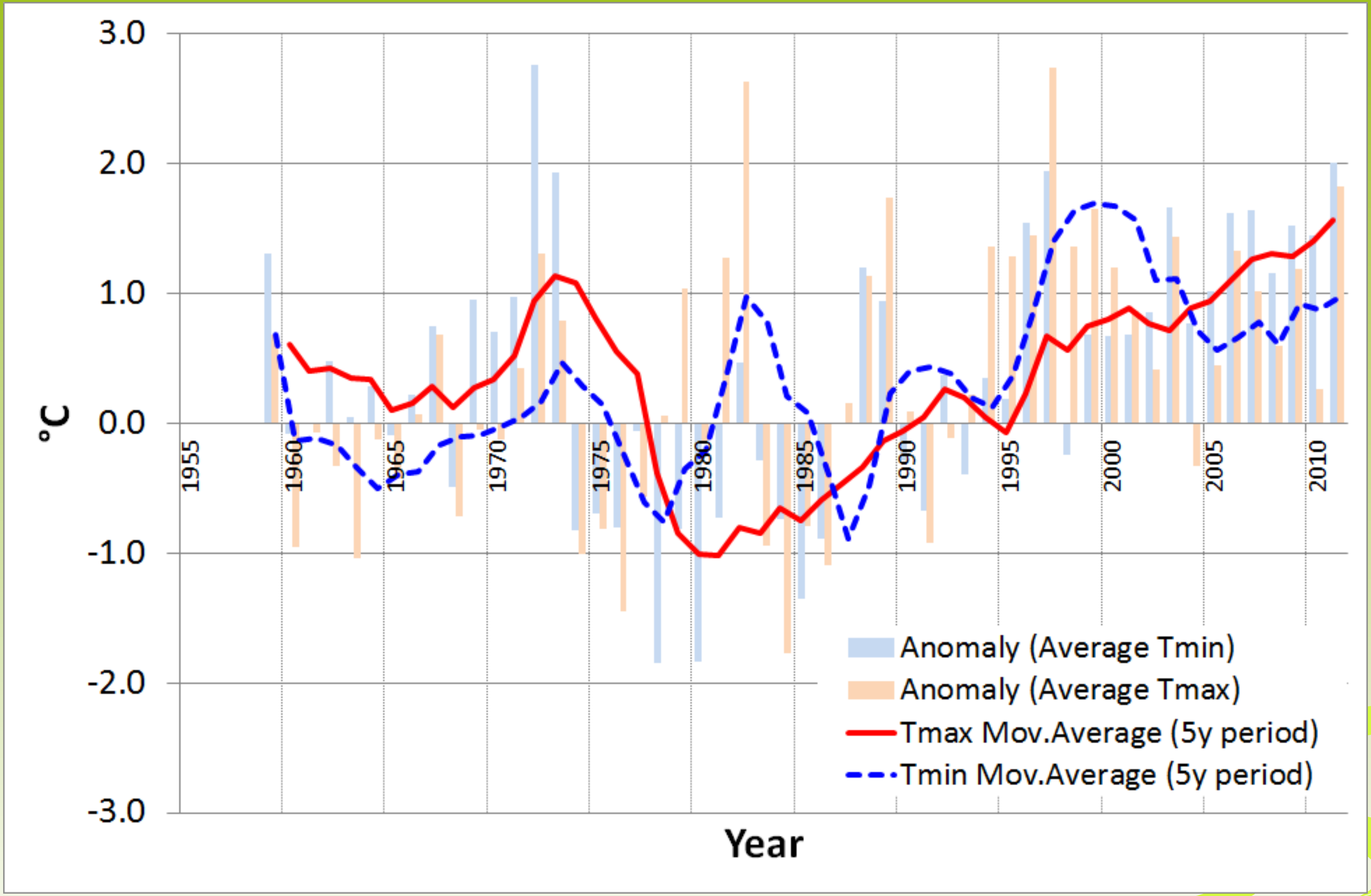
Farmers’ perceptions Nguyen et al submitted





Annual mean temperature anomaly for Tmax and Tmin at Santa Lucia Station (Oristano) from 1959 to 2012

Actions already taken by farmers to cope with climate variability

Practice	Hort	Rice	Cattle	Sheep
Adopt new agronomic practices	60%	25%		
Change/diversify crops	**80%**			
Improve irrigation systems	**100%**		**55%**	
Improve animal health and welfare			**88%**	42%
Change/improve the diet of animals			66%	42%
Follow daily weather forecast	60%	**75%**	20%	**57%**
None	0%	25%	1%	**29%**

Nguyen et al submitted

Actions farmers think to plan in case of climate worsening

Practice	Hort	Rice	Cattle	Sheep
Improve farm infrastructures			**89%**	57%
Adopt new tech (i.e. air conditioning for animals, video surveillance)			**89%**	
Improve water management	**80%**	**100%**	**78%**	28%
More interactions with technical advisors, colleagues, neighbors	50%		**78%**	50%
Participate to social networks	>65%	>65%	>65%	**14%**
Consult weather forecast	80%	80%	80%	80%
Do nothing		16%		16%

Nguyen et al submitted

Emerging outcomes

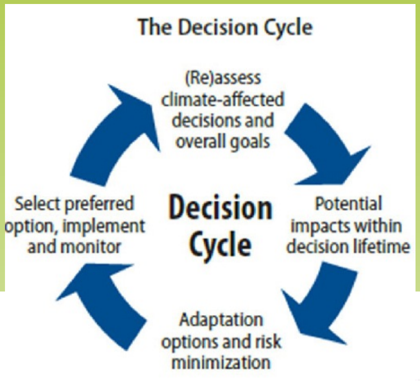
- The dairy cattle coop is developing a new win-win pathway linking hi-input dairy cattle farming with low input beef cattle grazing systems

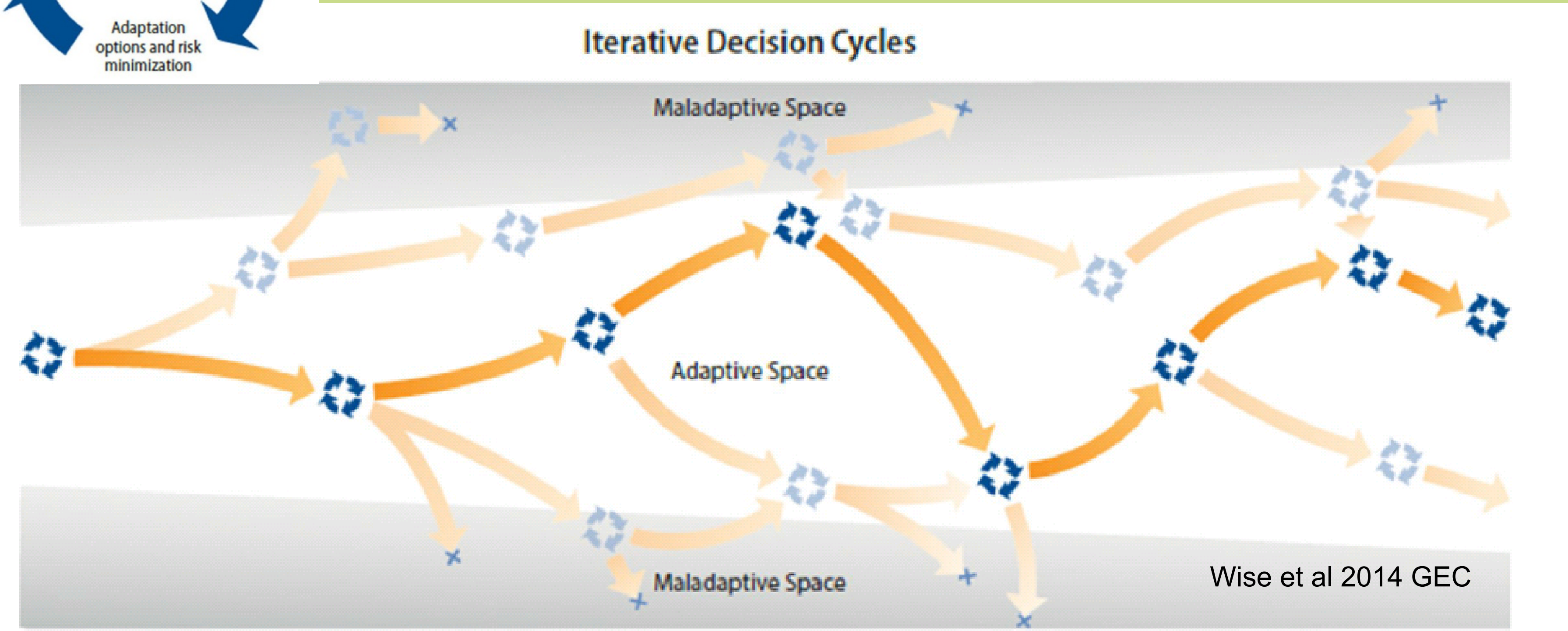
- The local government is investing in the EIP for supporting the local beef production chain to reduce meat imports and enhance pasture biodiversity and ecosystem services (eg wildfire prevention)

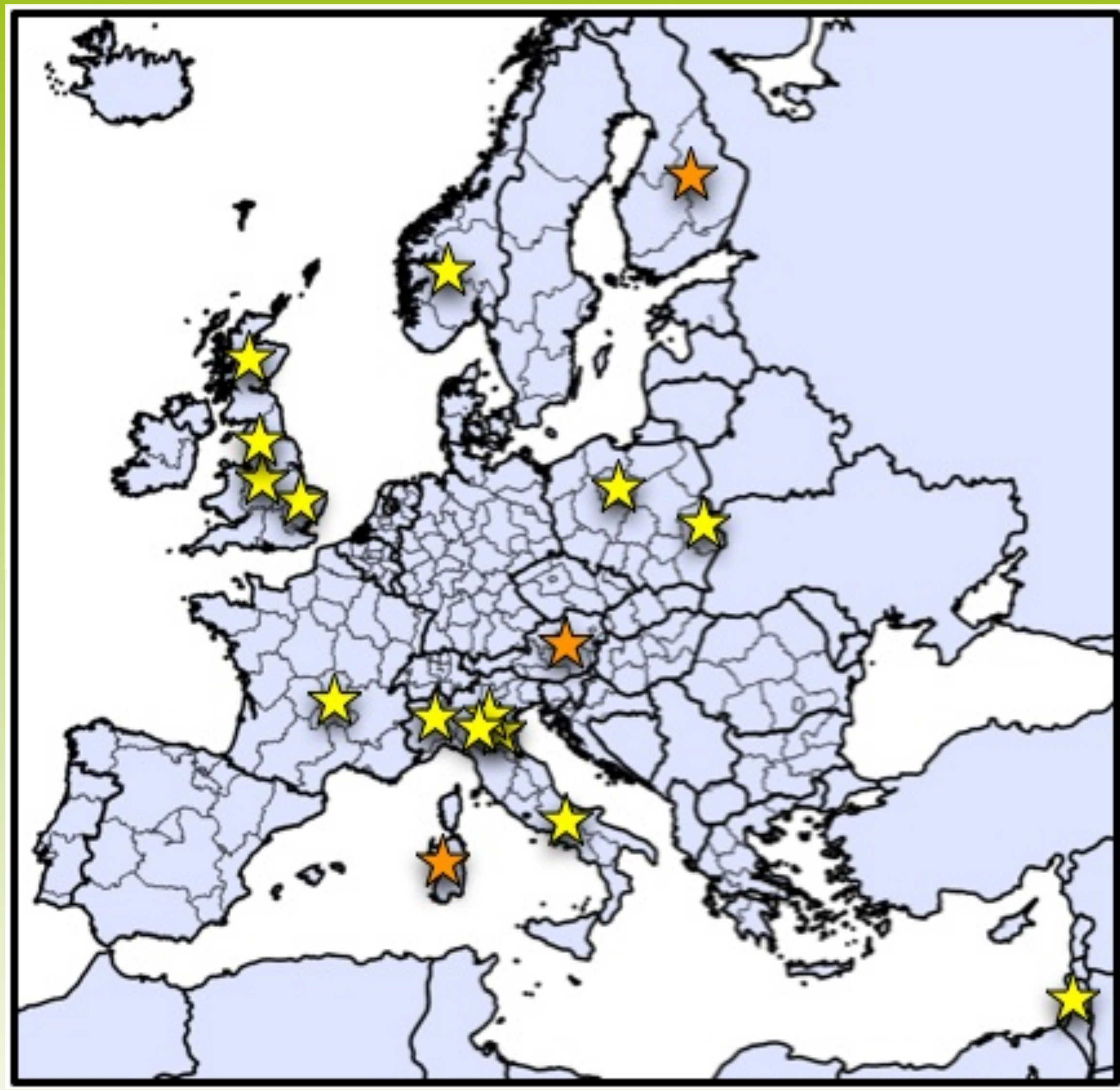
Emerging challenges

Adaptive responses as co-evolution pathways

- design social learning spaces for researchers, stakeholders and policy makers
- combining integrated assessment modeling and social learning facilitation







http://macsur.eu/index.php/regional-case-studies/