Integrating the impact of climate change, price changes and recent CAP orientation on Mediterranean farming systems

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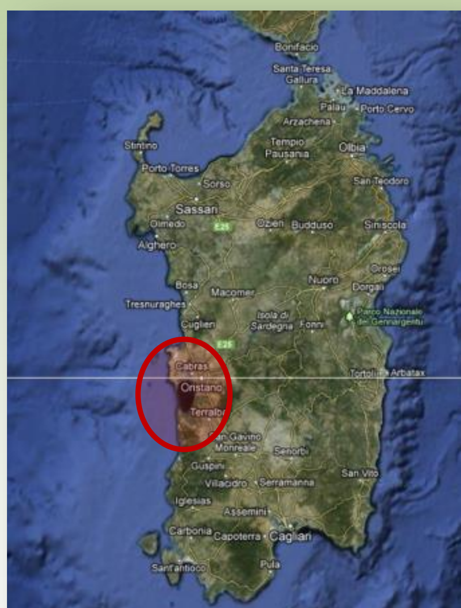
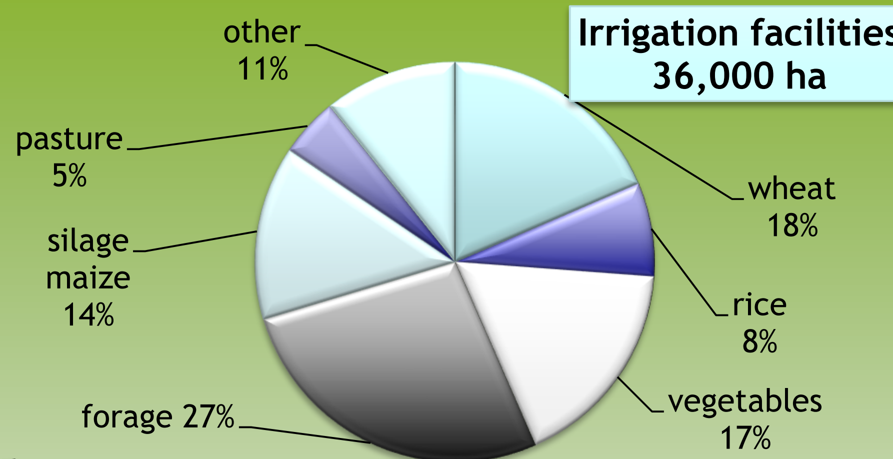
Presentation outline

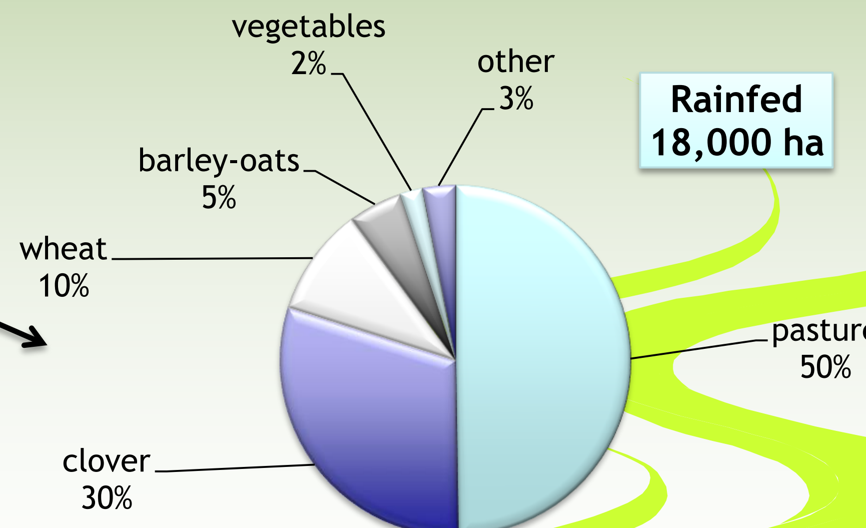
- Study area
  - ✓ *Oristano* (Sardinia, Italy)
- Methods
  - ✓ Integration between different groups
  - ✓ Economic model: CC and policy aspects
- Results
  - ✓ Land use and livestock number
  - ✓ Input uses (water, nitrogen, feeds)
  - ✓ Net income
- Conclusions

Study area: general

Water User Association
"Consorzio Oristanese"
(Sardinia, Italy)







Study area: farm types

	Represented farms (N)	Farm land (ha)	Types % total land	Family Labour Units	Gross sales (€ 000)	Net Income (NI - € 000)	Types % total NI
Irrigation facilities							
Rice	*24*	115.3	*5.2*	2.0	303.0	139.5	*4.2*
Citrus	*68*	12.6	*1.6*	1.7	73.7	45.7	*3.9*
Cattle A	*130*	30.9	*7.6*	4.4	507.2	199.2	*32.6*
Cattle B	*40*	31.9	*2.4*	6.3	452.5	112.7	*5.7*
Greenhouse	*46*	12.9	*1.1*	3.5	146.9	29.7	*1.7*
Mixed A	*562*	22.2	*23.5*	1.7	97.6	34.2	*24.2*
Mixed B	*55*	146.4	*15.2*	1.2	236.3	126.3	*8.7*
Mixed C	*100*	5.8	*1.1*	2.0	43.6	11.8	*1.5*
Rainfed							
Mixed D	*100*	4.1	*0.8*	1.7	64.6	18.2	*2.3*
Mixed E	*94*	24.5	*4.4*	1.2	40.7	16.9	*2.0*
Sheep A	*45*	86.9	*7.4*	2.1	110.5	43.6	*2.5*
Sheep B	*188*	41.2	*14.6*	1.5	34.5	16.1	*3.8*
Sheep C	*129*	62.4	*15.2*	1.6	82.4	42.5	*6.9*

Methods outline

Climatology

- ✓ climatic scenarios (present and near future)

Agronomy (CROP-M)

- ✓ weather-generated scenarios
- ✓ Net Evapotranspiration (ETn), yields and water needs (EPIC-DSSAT)

Animal science (LIVE-M)

- ✓ impact of temperature and humidity (THIndex) on milk quality and quantity, and mortality of cattle

Economics (TRADE-M)

- ✓ probability distribution functions (PDFs) on ETn, yields, water needs and THI
- ✓ stochastic territorial model

Climatology: model and scenarios

- Two climate scenarios:
  - Present (2000 – 2010)
  - Near future (2020 – 2030)

- The numerical model for future climate scenarios downscaling is the Regional Atmospheric Modelling System - RAMS (www.atmet.com).

- RAMS is forced from a global simulation model, from surface temperatures of the sea coming from the ocean model coupled with the atmosphere.

- The global climate change is simulated by ECHAM 5.4 developed and used by the Euro - Mediterranean Centre for Climate Change (CMCC - www.cmcc.it).

- The greenhouse gas emissions scenario is A1B.

CROP-M: crop models and outcomes

EPIC and DSSAT outcomes on Net Evapotranspiration (ETn), yields and water needs: simulation of 150 years both for present and near future scenarios

Silage maize
Ryegrass
Alfalfa
} yields and water needs

Pasture
Hay production
Rice
Durum wheat
Barley
} yields

Vegetables and Orchards } water needs are ETn driven

LIVE-M: data analysis and outcomes

- The relationships between climate and animal production in the current and future scenarios were estimated on the basis of the results of studies carried out in Holstein breed, which is widely prevalent in the local dairy district.

- Impact of temperature and humidity (THIndex) on milk quality and quantity, and mortality of cattle under the two climate scenarios (present and near future)

- The relationships between THI, mortality, milk quality and quantity were established by a 2-phase linear regression procedure

TRADE-M: model, PDFs, policy scenario

- Territorial economic model that represents the structural and economic characteristics of the farm types in each sub-area
- On the present and near future scenarios series of 150 values for each variable, probability distribution functions (PDFs) have been estimated
- PDFs are implemented into the territorial economic model
  - stochastic territorial economic model
- Policy
  - CAP First pillar reform
  - abolition of milk quota

Territorial economic model

	Farms (n)	Land (ha)	Net Income (€ 000)
Irrigation facilities			
Rice	*24*	115.3	139.5
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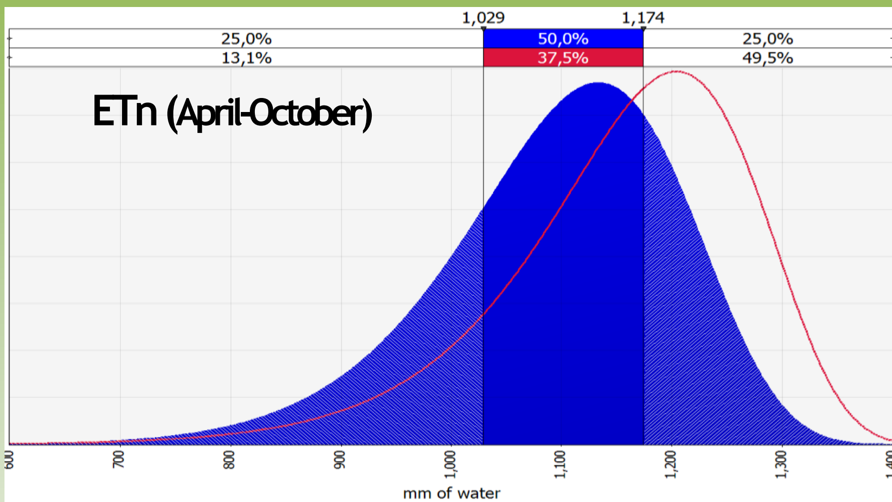
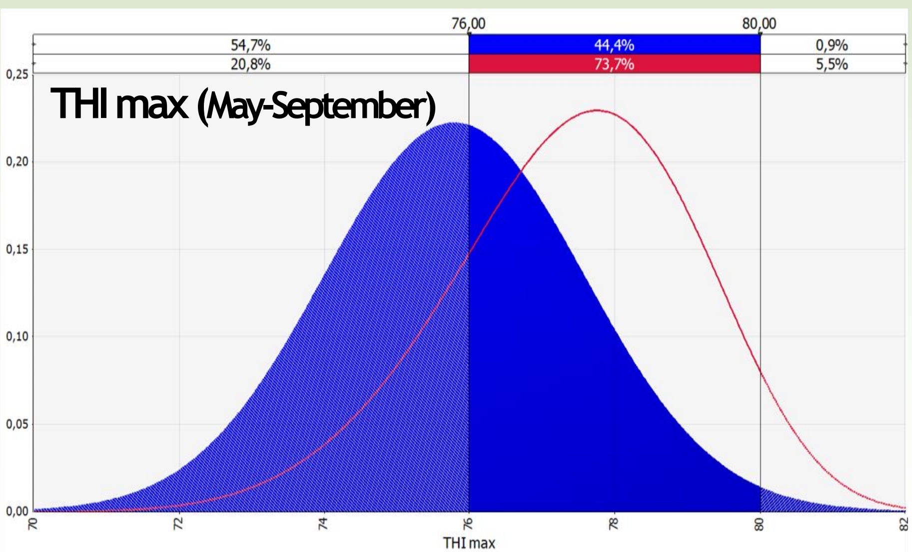
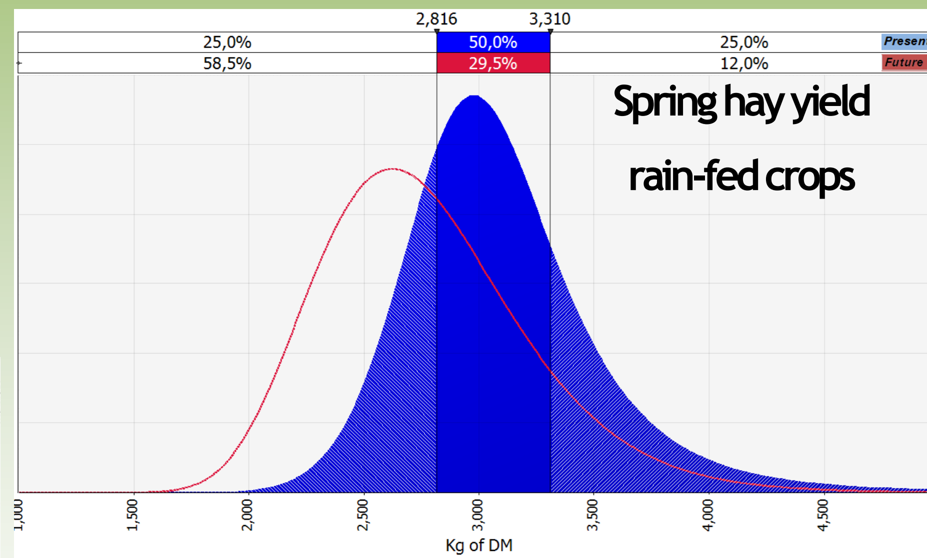
FARM TYPES

Sharing and exchange of common resources (water, labour)

PDFs: some examples







Stochastic territorial economic model

- ✓ The farmer allocates scarce resources (land, water and labor) under uncertainty about irrigation needs and crop yields
- ✓ Three states of nature for yields and irrigation needs
- ✓ Corrective actions as regard the use of groundwater and the purchase of feeds
- ✓ The impact of temperature and humidity on milk quality and quantity, and mortality is an ex post simulation

Stochastic territorial economic model: Policy scenario

1. CAP First pillar reform

Basic Payment Scheme

- ✓ internal convergence: to move towards a more **uniform payment per hectare** at national level

Greening payments

- ✓ **agricultural practices** beneficial to climate and environment: diversification of crops, maintenance of pasture, Ecological Focus Area

Coupled payments

- ✓ Crops: durum wheat, rice, processed tomatoes, clover
- ✓ Livestock: dairy cows, ewe lambs

2. Abolition of milk quota

- ✓ EU decided to abolish completely the supply milk quotas, since April 1, 2015

Stochastic territorial economic model: general formulation

$$\max_{X_1, XR_{n_s}, XA} z = GI\, X_1 + VE\, NE - \sum_{n=2}^{N} \sum_{s=1}^{S} P_s\, Cr\, XR_{n_s} + Prm\, Qm \quad (1)$$

subject to

$$GI = Pr\, Y + CP - C \quad (2)$$

$$Qm = Ym\, XA \quad (3)$$

$$A\, X_1 \leq B \quad (4)$$

$$A_s\, X_1 \leq B + \sum_{n=2}^{N} XR_{n_s} \qquad \forall\, s \quad (5)$$

$$N\, Y_s\, X_1 + \sum_{n=2}^{N} XR_{n_s} \geq R \qquad \forall\, s \quad (6)$$

$$X_1 \geq 0, XR_{n_s} \geq 0 \text{ and } XA \geq 0 \qquad \forall\, s \quad (7)$$

Results on land use and livestock number

	Baseline	Policy scenario	Policy + CC scenario
Land use			
Grain cereals	13,533	2.2	4.4
Durum wheat	*8,335*	*6.3*	*8.6*
Rice	*2,700*	*0.6*	*2.9*
Forage crops	32,478	-0.9	-1.3
Grasslands	*11,394*	*0.5*	*-0.6*
Hay crops	*9,523*	*-3.6*	*-4.4*
Silage maize forage	*4,265*	*0.7*	*11.8*
Silage maize other	*1,446*	*-3.0*	*-12.5*
Italian ryegrass	*3,582*	*1.6*	*7.3*
Alfalfa	*1,978*	*-2.7*	*-26.4*
Field horticultural crops	6,022	0.7	1.3
Processing tomato	*1,935*	*7.1*	*7.3*
Greenhouse crops	177	*0.0*	*-0.9*
Tree crops	1,702	*0.6*	*0.6*
Dairy livestock number			
Cows	18,440	4.4	3.6
Ewes	17,292	5.5	5.5

Results on input uses

	Baseline	Policy scenario	Policy + CC scenario
Total water	121,586	-0.1	2.0
WUA water	114,590	0.0	2.1
Water pumping	6,996	-1.4	-0.6
Nitrogen	9,828	-0.4	1.5
Phosphorus	4,993	0.1	1.8
Potassium	6,562	-1.1	-0.8
Feeds	1,100	12.4	12.5

Results on net income

	Baseline	Policy scenario	Policy + CC scenario
Rice	4,345	-1.2	9.5
Citrus	2,734	6.6	6.6
Cattle A	27,115	4.2	-1.4
Cattle B	6,597	5.4	-0.9
Greenhouse	1,203	0.4	0.5
Vegetables - Cereals	19,155	-2.0	-2.8
Cereals - Forages	4,772	-15.4	-12.7
Tree and arable crops	1,075	1.2	1.3
Vegetables - Fruit	1,039	-1.1	-1.1
Cereals - Forages	2,738	-2.6	-2.7
Sheep A	2,288	6.3	1.7
Sheep B	1,798	9.5	-1.9
Sheep C	3,711	-8.3	-14.3
Irrigated zone	66,997	0.8	-1.4
Rain-fed zone	11,574	-0.7	-5.3
Total area	78,571	0.6	-2.0

Conclusions - main remarks (1)

- In general the considered policy changes determine (small) positive effects
  - ✓ on net income
  - ✓ on use of groundwater and nitrogen

  - ✓ but also an large increased use of feeds (imported from other areas): possible negative environmental impact

- The CAP reform of the first pillar determines very diversified impacts in the considered farm types
  - ✓ internal convergence at national level: reallocation of the decoupled payments between farms and territories

- The coupled payments provided for the livestock sector and the abolition of milk quota seem advantageous
  - ✓ the price of milk remains unchanged

- The impact of the *greening* practices is limited in the present climate scenario

Conclusions - main remarks (2)

- The impact of the *greening* practices is limited but larger in near future climate scenario
  - ✓ the new climatic conditions affect, in negative way, some key crops of the greening practices (for the implementation of EFA and maintenance of pastures) such as alfalfa, clover and pasture
- The CC causes a worsening of the economic and environmental results
  - ✓ greater negative effects would have occurred without the policy
  - ✓ a part of the effect of income support of agriculture and mitigation of its impact on the environment is impaired in the new climatic conditions
- The CAP post-2020 should consider the negative effects of climate change, strengthening some aspects of support to income and environmental protection

Conclusions - future developments

The study could be improved under various aspects regarding the modelling and the empirical analysis

- ✓ the model could consider other structural changes involving land and labour markets
- ✓ other drivers could be considered in the simulations such as output and input prices and the technological improvements
- ✓ CAP post-2020
- ✓ …

…in the next phase of MACSUR project !

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