Impacts of climate change, potential adaptations and assessment of the role of small ruminants on mitigating climate change

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Collaborators:

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Climate Change: the dimensions

How much European small ruminants (in Europe) are to blame for climate change?

https://www.youtube.com/watch?v=NbO4EEaH7YM&t=29s (English)
https://www.youtube.com/watch?v=QVHS142nhkg (Español)

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GHG EMISSIONS/WARMING

CLIMATE CHANGE

IMPACTS

RESPONSES

CLIMATE CHANGE MITIGATION

CLIMATE CHANGE ADAPTATION

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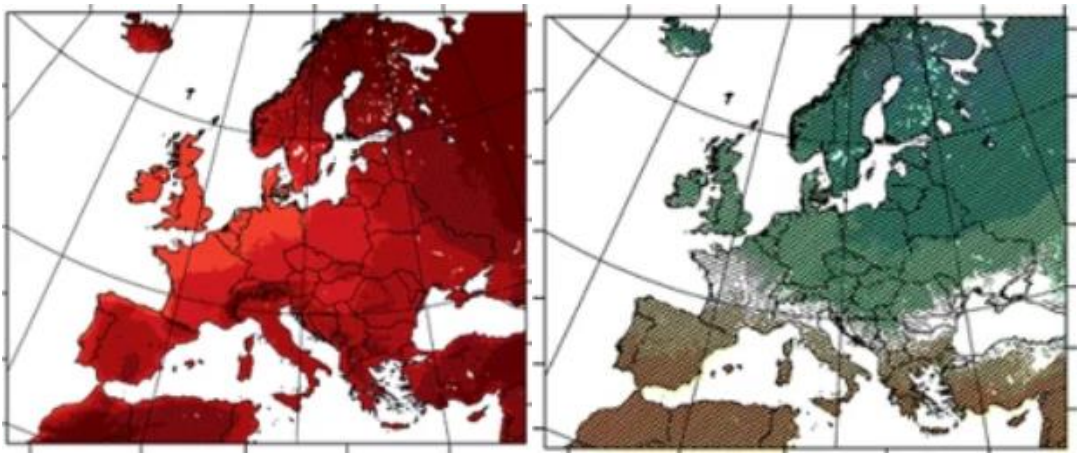
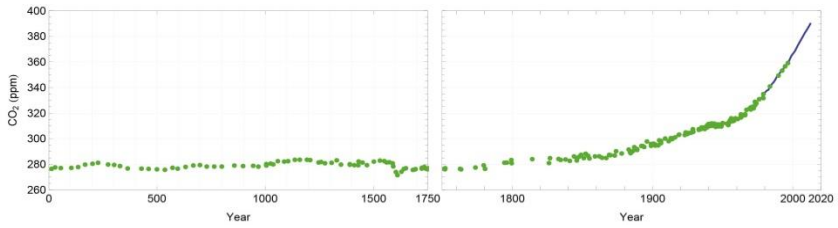
Impacts

Indirect effects on sheep and goat systems (pastures)

Pastures are affected by:

- Rising temperatures
- Changes in rainfall patterns and water availability
- Increasing atmospheric CO_2 concentrations

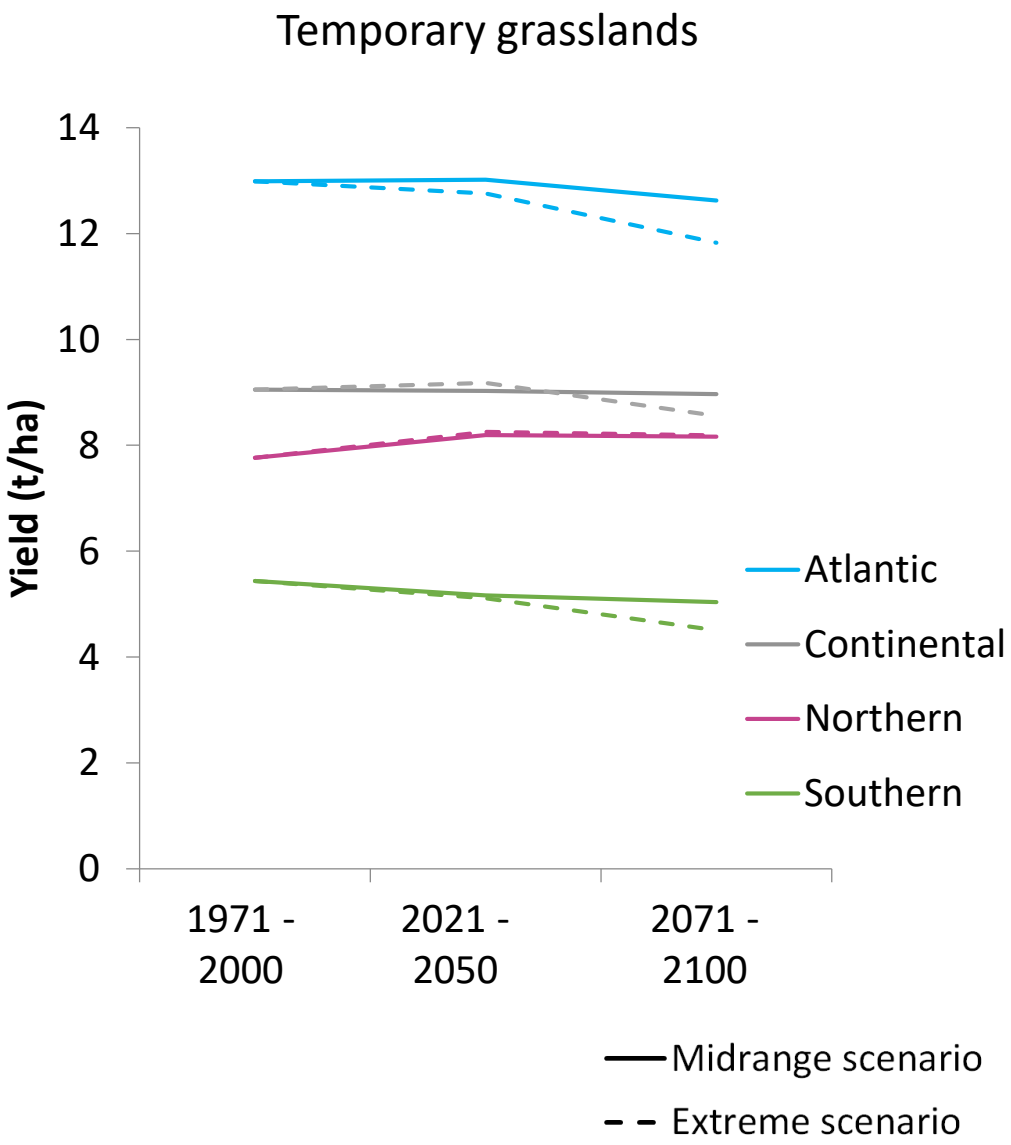




Images: Jacob et al (2014), IPCC (2013)

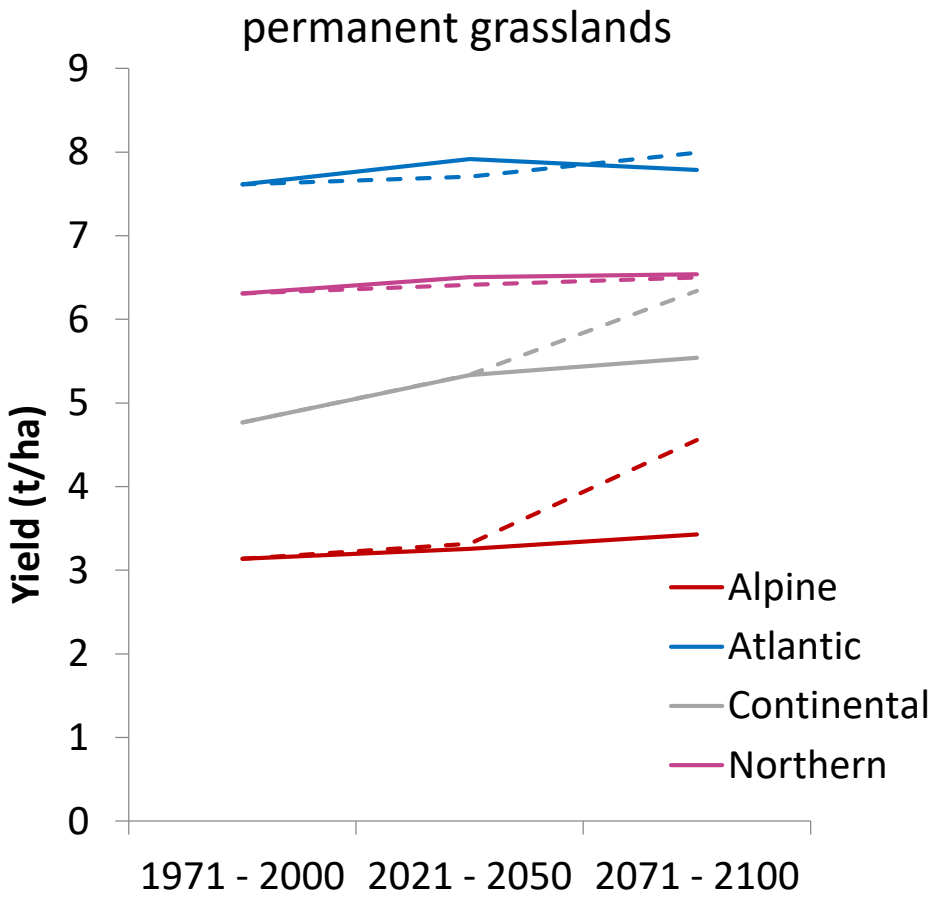
Indirect effects on sheep and goat systems (pastures)

- Our models showed reduced yields in Atlantic and southern Europe
- Yield increased in northern Europe
- Little change in continental Europe



Indirect effects on sheep and goat systems (pastures)

- Our models showed increased yields in most regions (*no data for Mediterranean*)
- Permanent grasslands do better under climate change – favours extensive grazing systems



Mediterranean is warming up faster than the rest of the planet

CLIMATE CHANGE ›

Mediterranean is warming up faster than the rest of the planet, report warns

Some 500 million people are at risk of drought, lack of freshwater and food shortages if no action is taken

The Entrepeñas reservoir in Guadalajara during a drought in 2017. JAIME VILLANUEVA

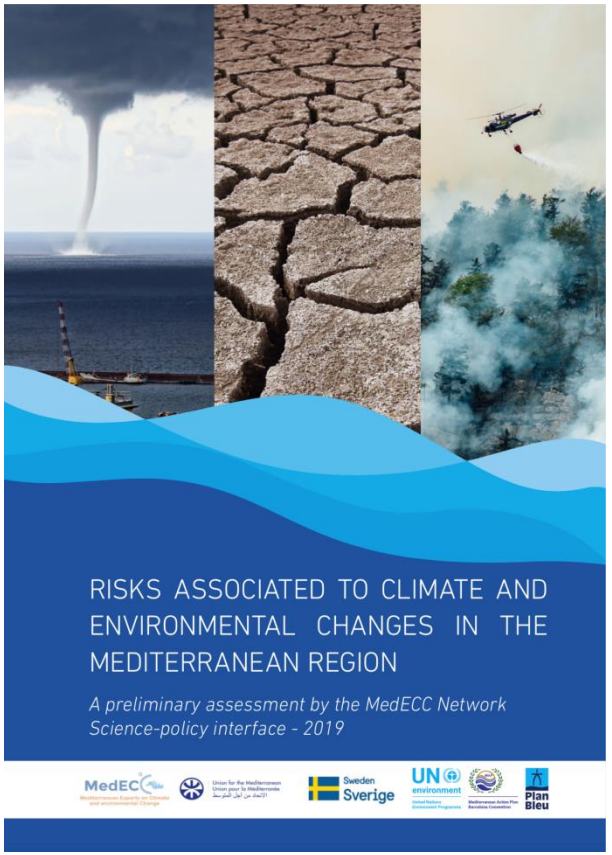
MANUEL PLANELLES

Madrid - 11 OCT 2019 - 10:01 BST

Whether they like it or not, 500 million people from three continents are united by the same problem: climate change.

NEWSLETTER

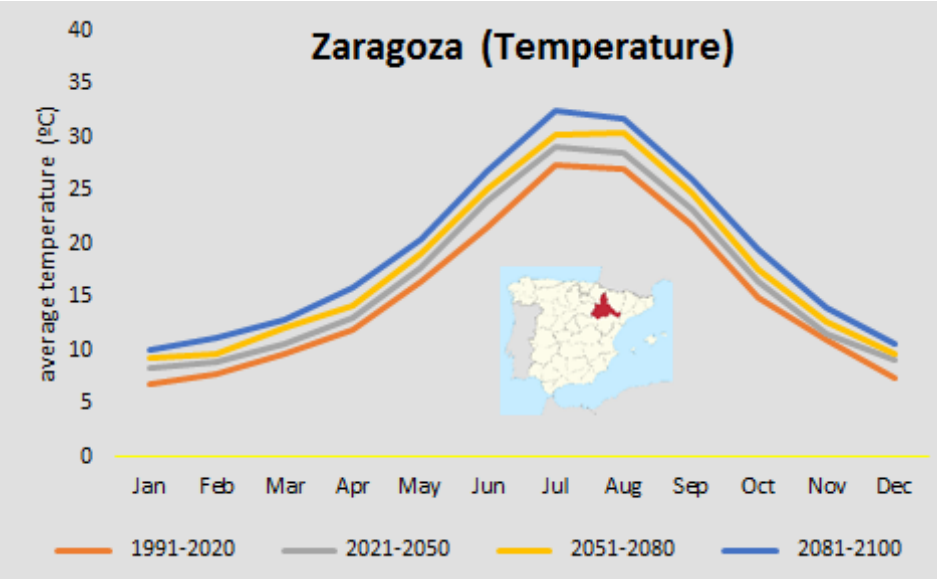
Sign up to EL PAÍS in English Edition bulletin

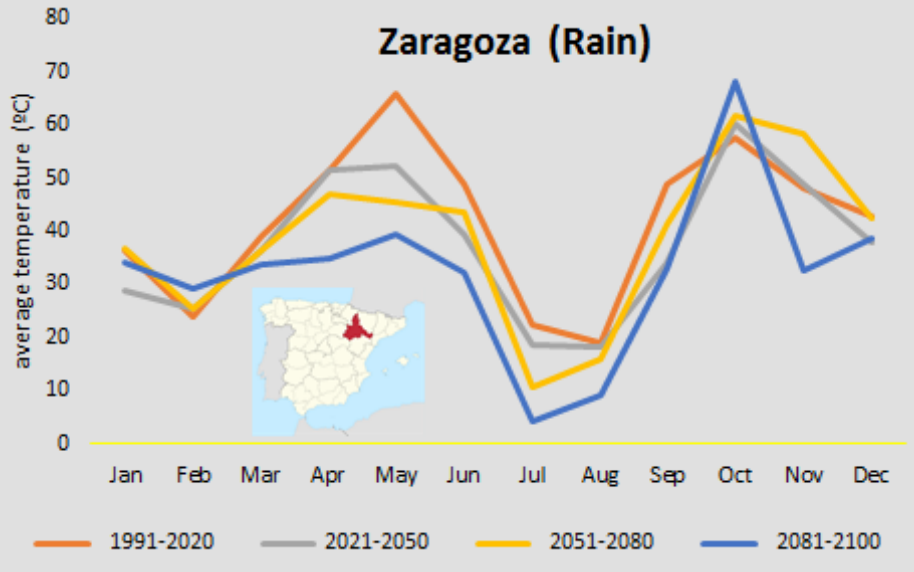


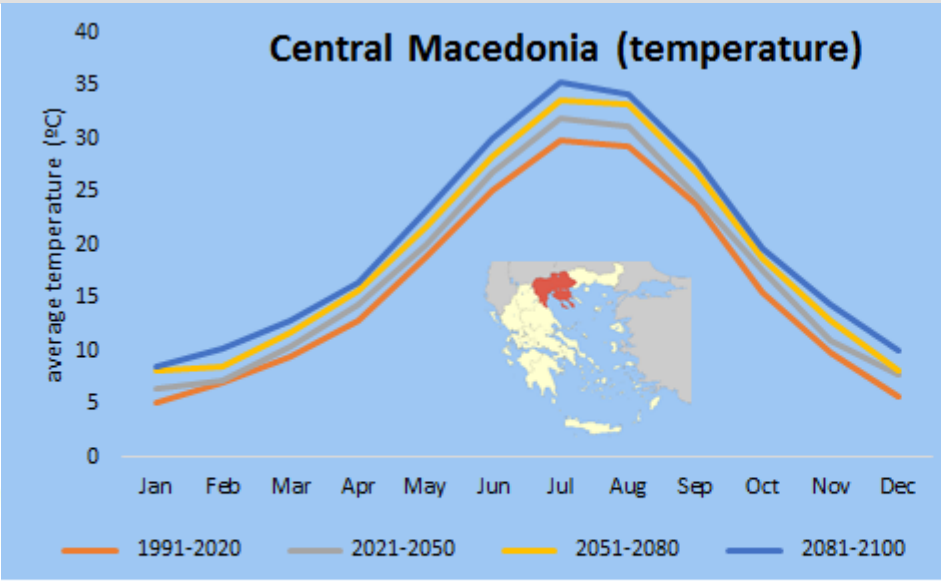
Impacts in the Mediterranean region

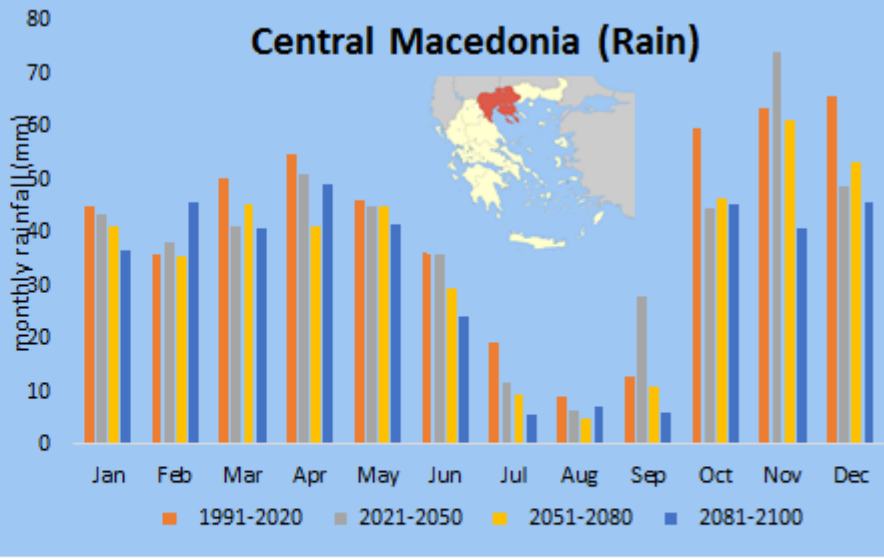
- Reduction in forage yields and quality due to less rainfall and risk of drought projection
- Grazing season is expected to be shortened. Grazing activity will suffer from irregular patterns due to extreme events.
- Encroachment (increase of shrubs)
- Soil erosion and degradation
- Heat stress in animals: more frequency and length of heat waves

Examples at farm level (Spain and Greece)



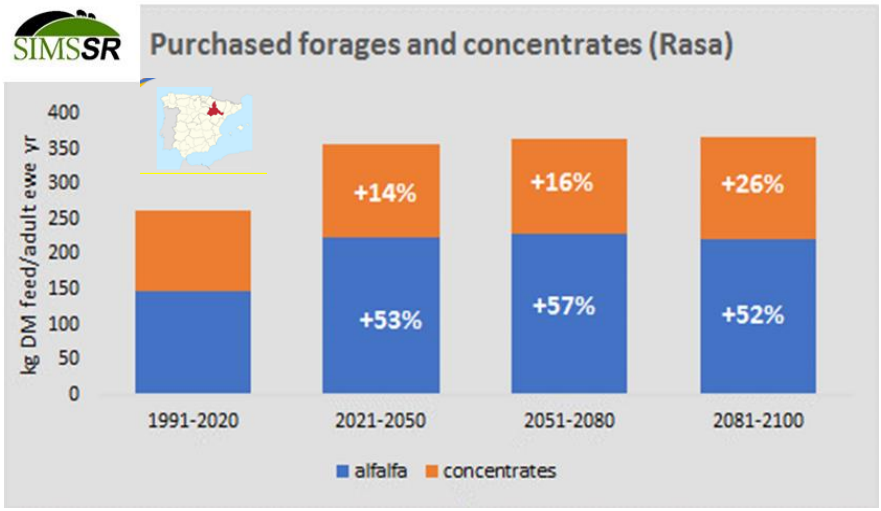




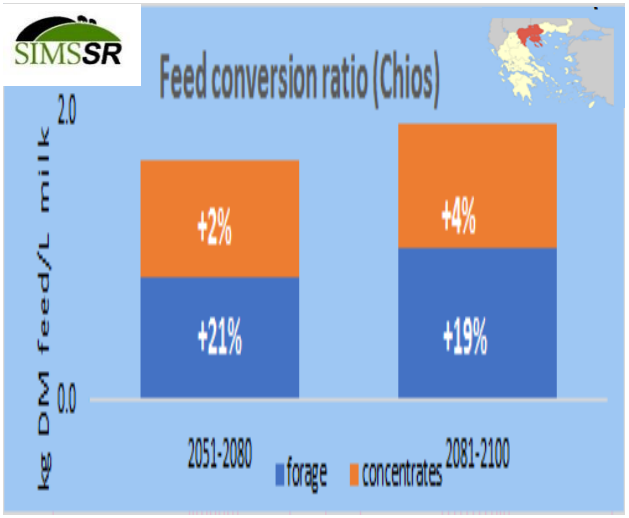


2021-2050 rainier in autumn, not so drier compared with 1991-2020

Examples at farm level (Spain and Greece)



- From 2021 we need to buy more feed



- >20% more feed /L after year 2050

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Adaptations

Adaptations: forage

- Increase pasture diversity:
  - to enhance resilience under variable climatic conditions to adapt to potential shortages of protein sources (mixed legume-grass)

- Improved plant breeding (long-term):
  - developing varieties that can survive long drought periods and recover rapidly following autumn rains (e.g. tall fescue, cocksfoot and Lucerne varieties)

Adaptations: forage

- Crop residues: Post-harvest cereals, olive leaves
- Underutilized feedstuffs from agro-industry by-products
  - Olive cake
  - Citrus pulp
  - Tomato by-products
  - Other vegetables and fruits (e.g. cucumbers, pomegranate)

Adaptations: forage (integrated approaches)

- soil and water protection (cover crops)
- different feeds aligned to different seasonal constraints (agro-forestry)
- fire-risk protection (grazing management)

Dehesa system in Sierra de Gata, Extremadura (Spain)
Source: http://reservabiologicacampanarios.es/

Pasture under trees in winter

Pasture under trees in early June

Pictures taken in Iberian dehesas (CW Spain) by D. Howlett and A. Carrara, respectively

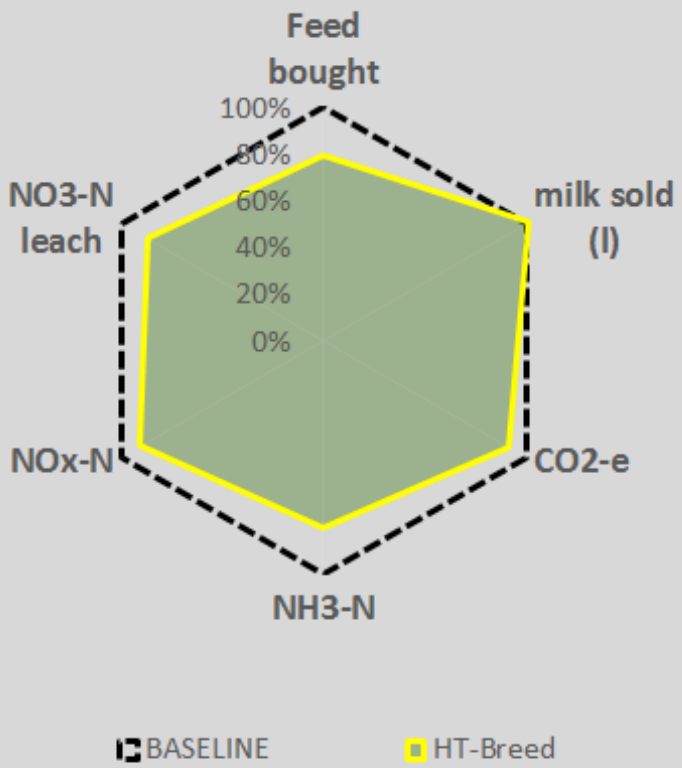
Adaptations: animal

- Prevention of heat stress conditions
  - -Indoors: stock density, barn orientation/dimensions, ventilation, spraying
  - -Outdoors: provide protection with trees or artificial shelters

- Feeding/Nutritional management:
  - -shifting meals to late afternoon or evening, increasing number of meals
  - -low fibre diets (decrease forage:concentrate), increase energy density, supplements (fat-rich feeds, whole flaxseed)
- Animal breeding

Adaptations at the farm level: animal breeding

Chios (dairy) (Greece)



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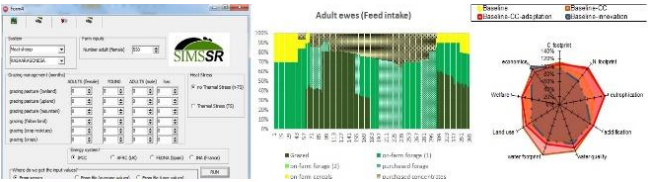
Adaptations at the farm level

Effect of heat on milk productivity on Summer Housed (alfalfa+corn fed)

4 scenarios

- No HS
- HS (non-adapted)
- HS (adapted-diet)
- HS (Adapted-spraying)

Modelled with $SIMS_{SR}$



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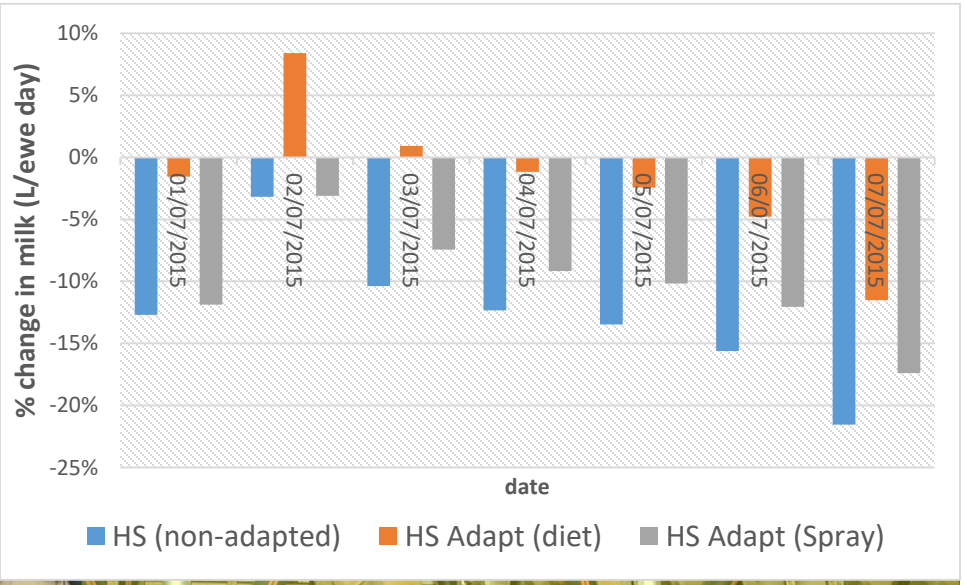
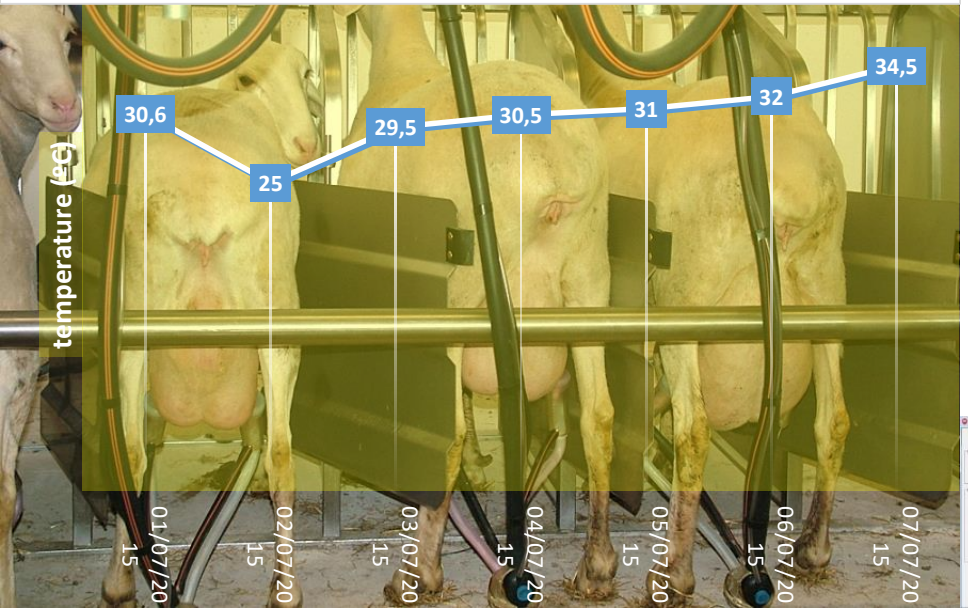
Adaptations at the farm level





HS (non-adapted)

>10% reduction in milk

0.12 kg DM extra/L milk (less efficient)

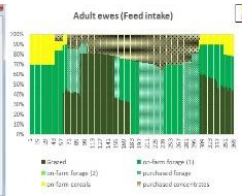
HS (adapt-diet)

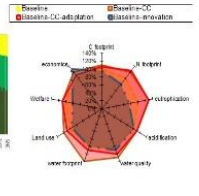
soybean meal

2% reduction in milk

HS (adapt-spraying)

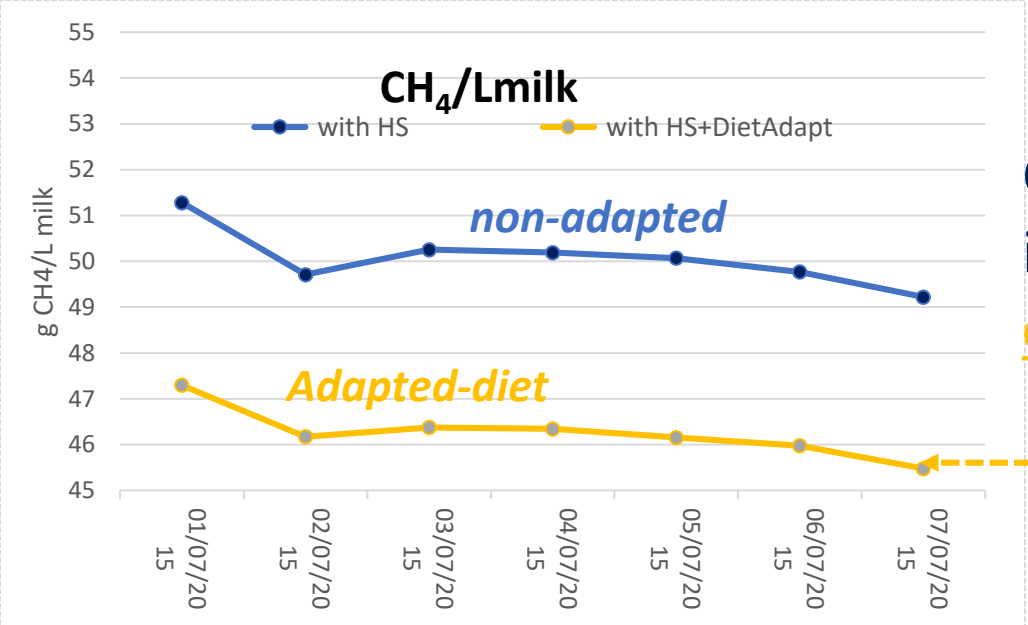
Small positive effect





Adaptations *vs.* mitigation at the farm level

Enteric-CH_4



CH_4 intensity (CH_4/L milk) increases with heat stress **except if adapted with diet**

So, supplementation of more dense diet is a win-win for both adaptation to climate change and mitigation?

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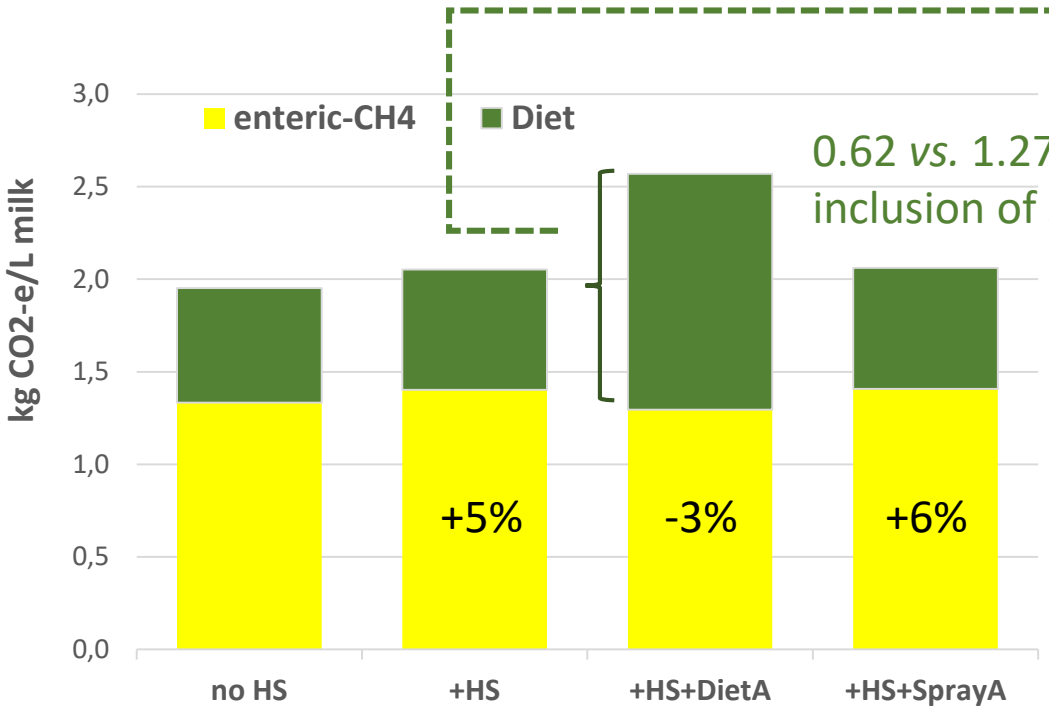
Adaptations *vs.* mitigation at the farm level

+32% total C-footprint using soybean meal



0.62 *vs.* 1.27 kg CO2-e/kg DM feed after inclusion of soybean meal

C footprint accounting enteric CH_4 + feed footprint

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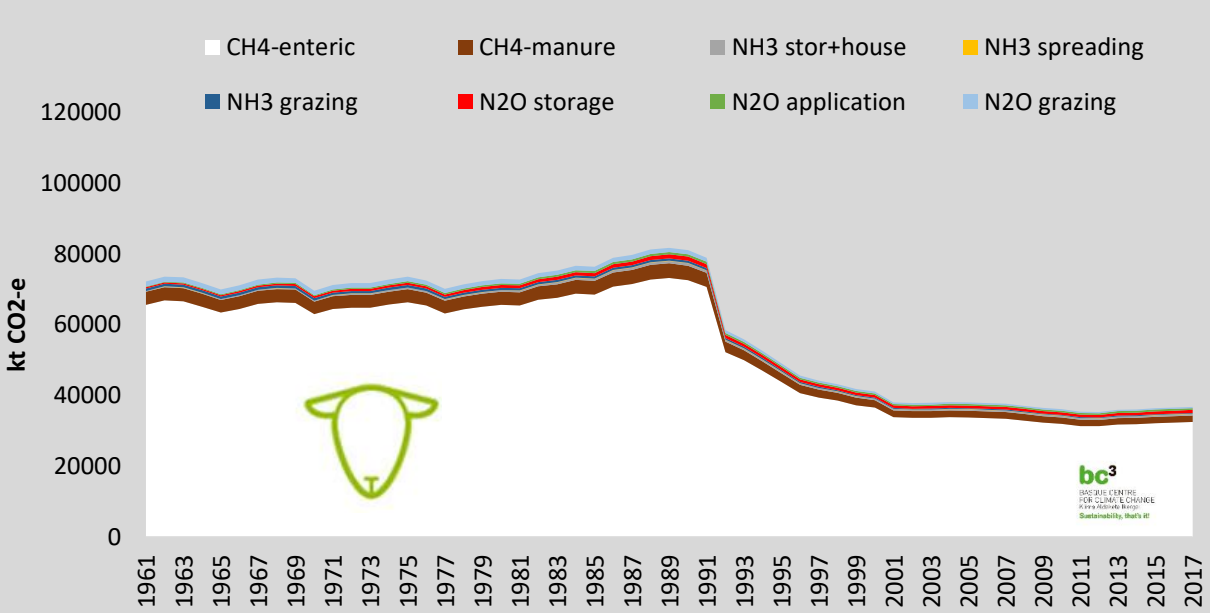
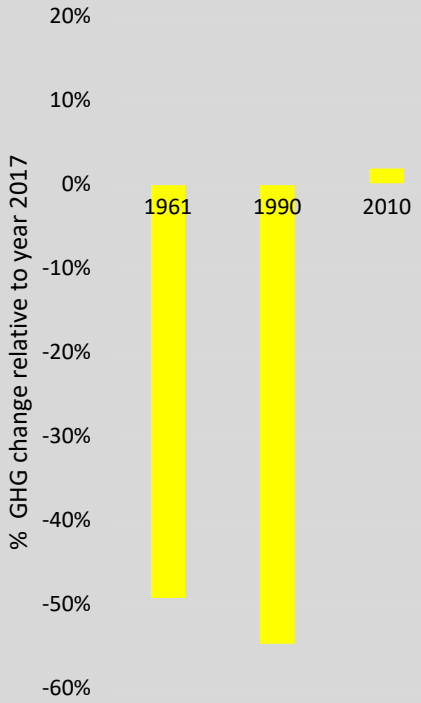
GHG emissions from small ruminant systems in Europe

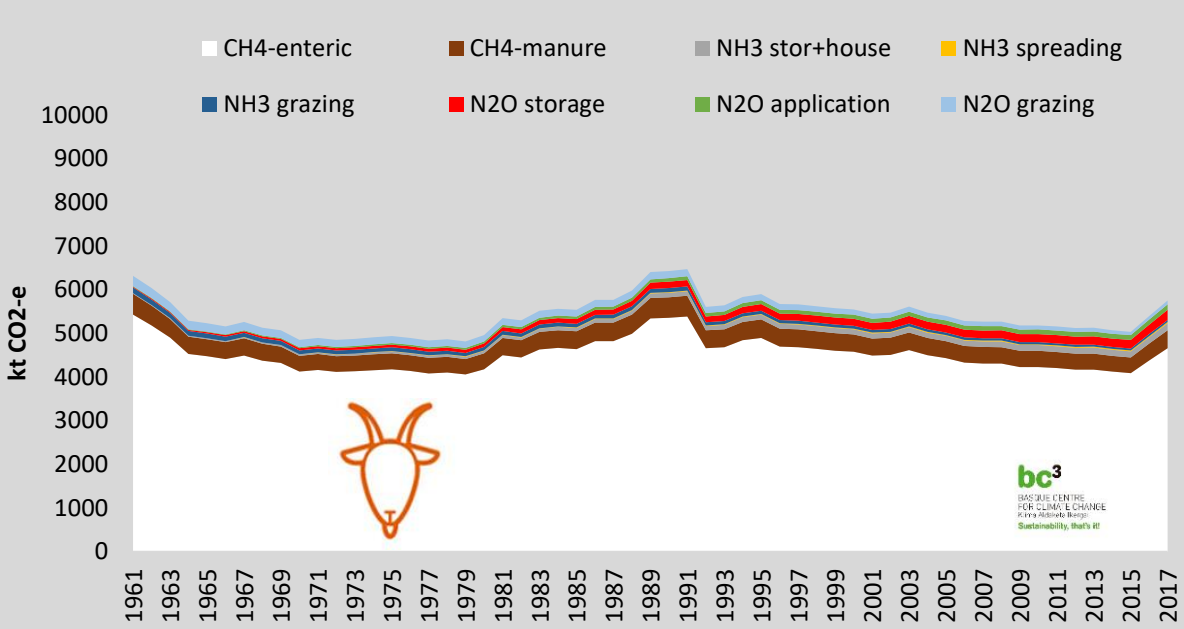
Direct emissions

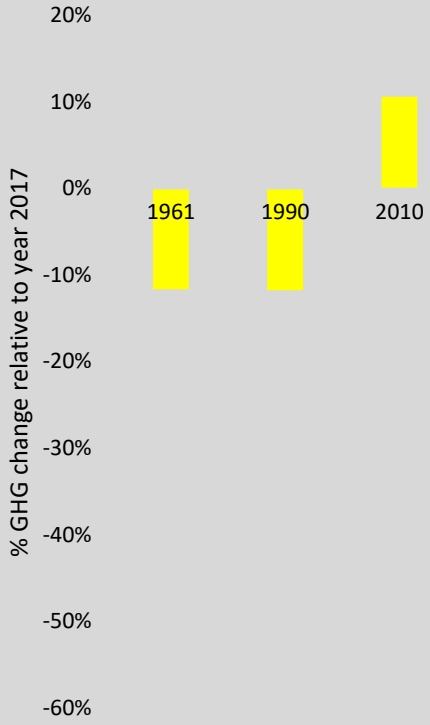




GHG emissions from small ruminant systems in Europe

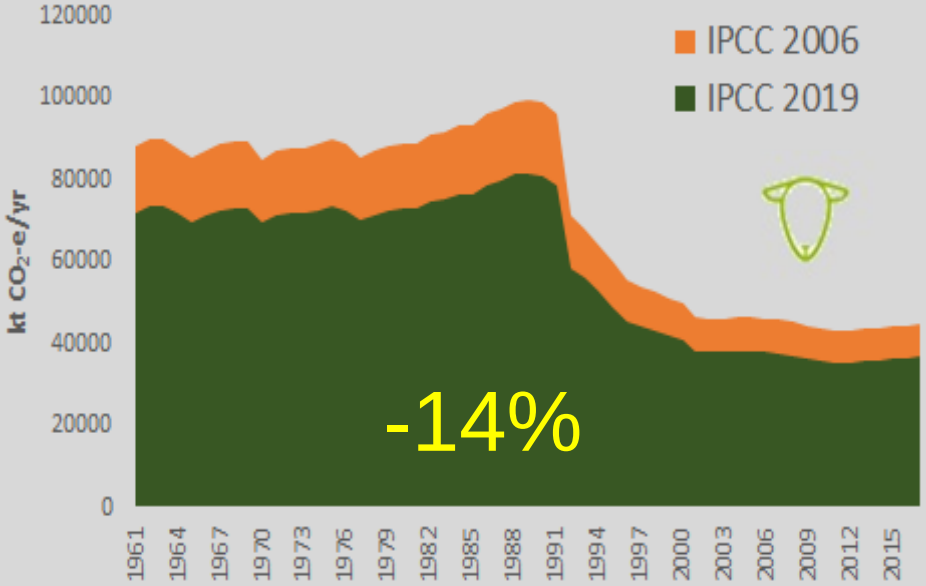
Direct emissions

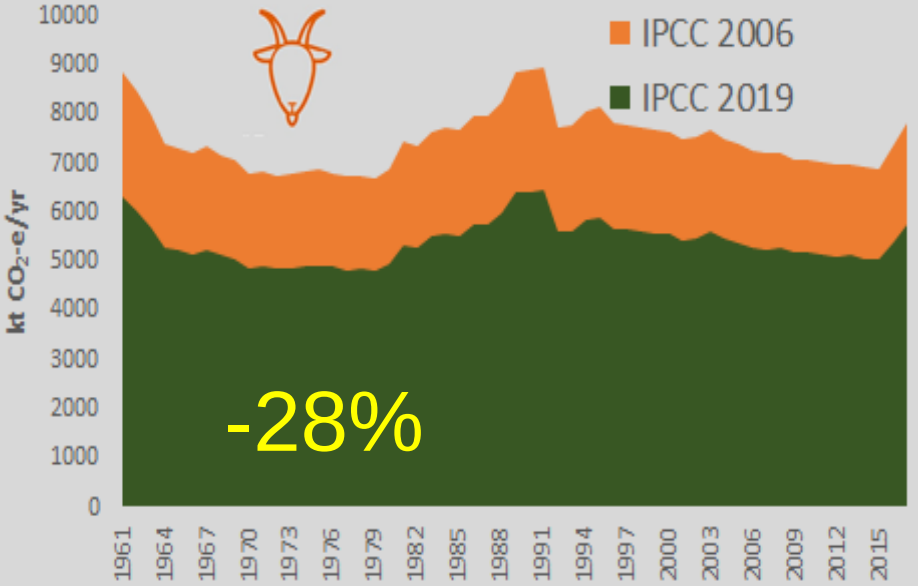




Update of methodologies for GHG emissions

Direct emissions





GHG based on IPCC (2006) were overestimated by 18% (sheep) and 28% (goats)

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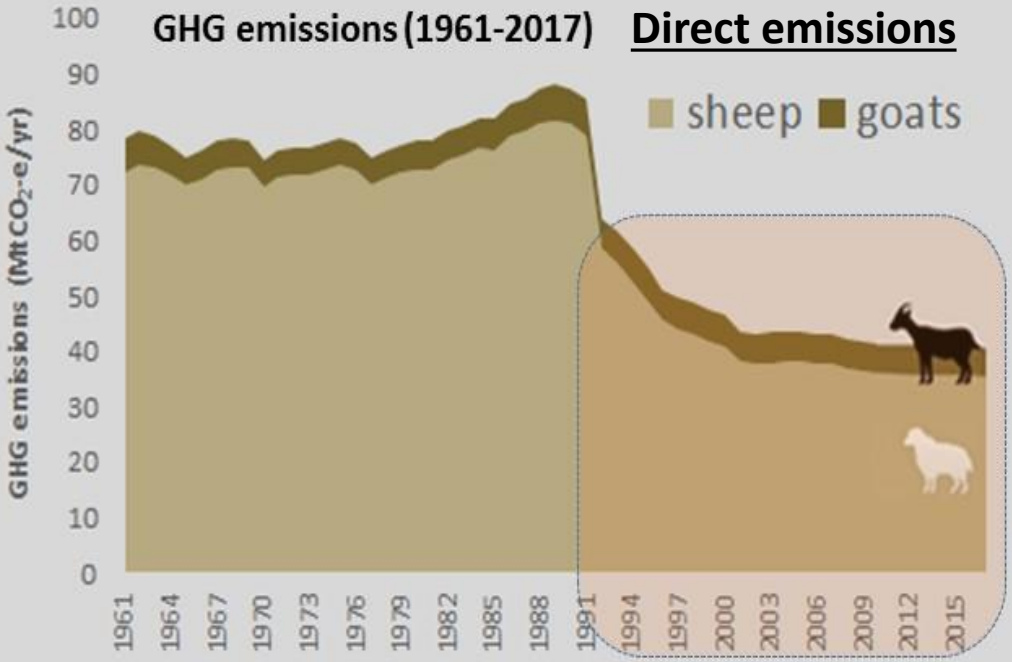
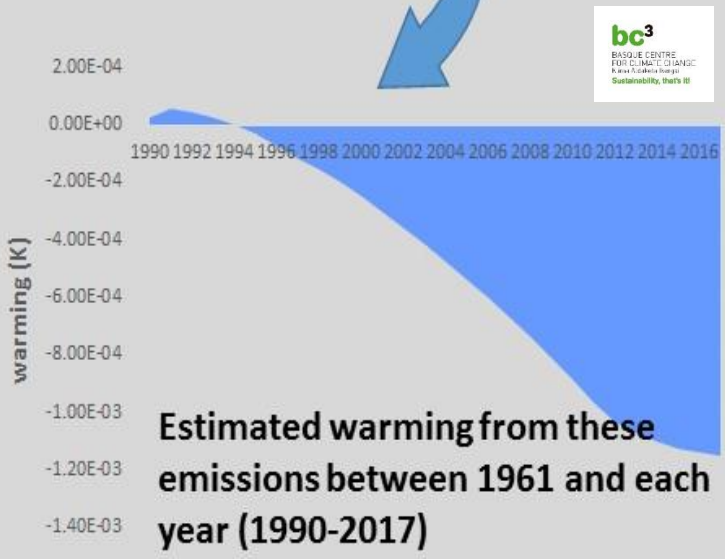
How much CH_4 and N_2O have contributed to warming?



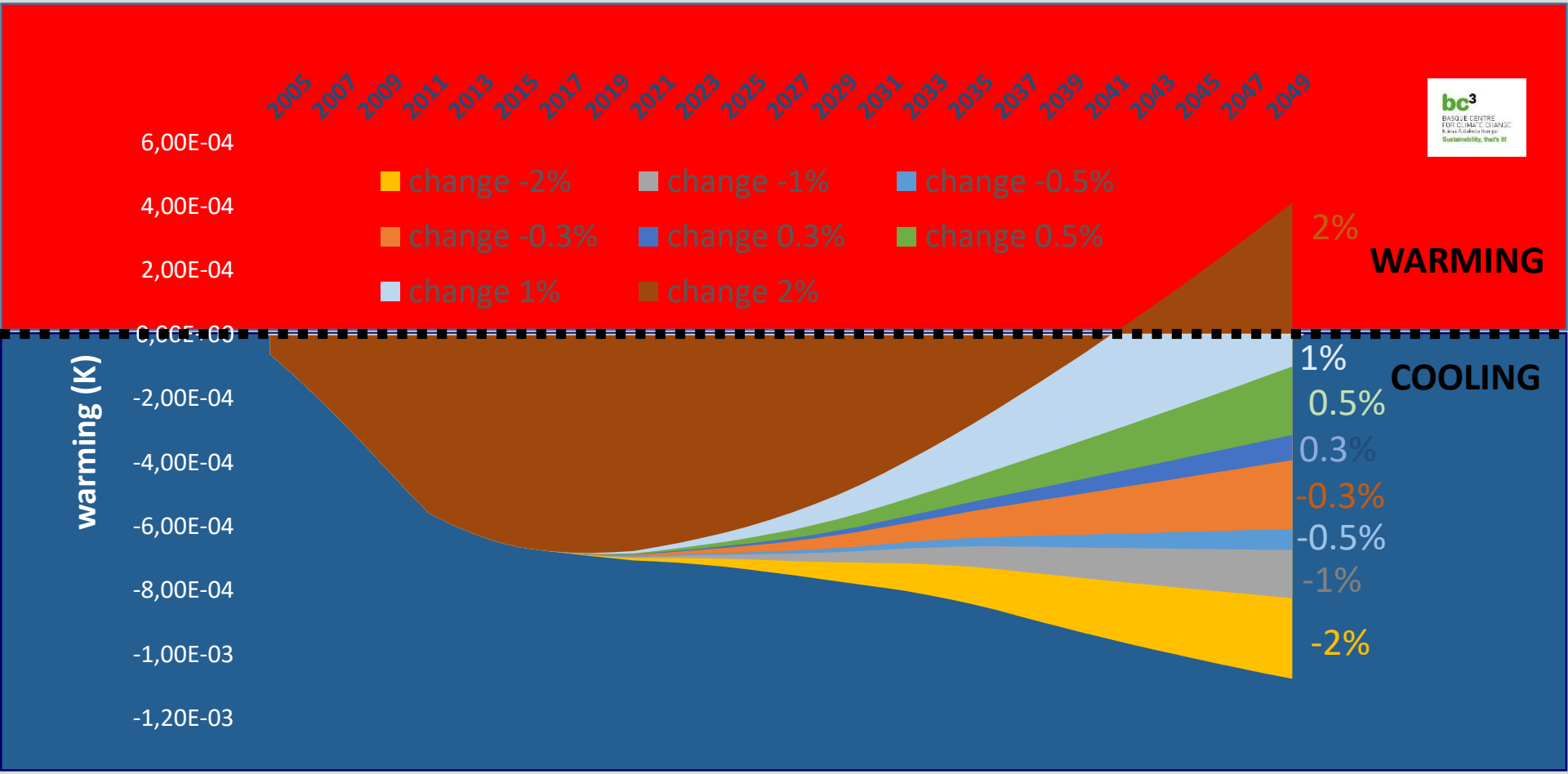
The large decrease in methane Contributes to a relative cooling effect



Based on Cain et al. (2019)

Scenarios to mitigate CH_4 & N_2O from European sheep and goats

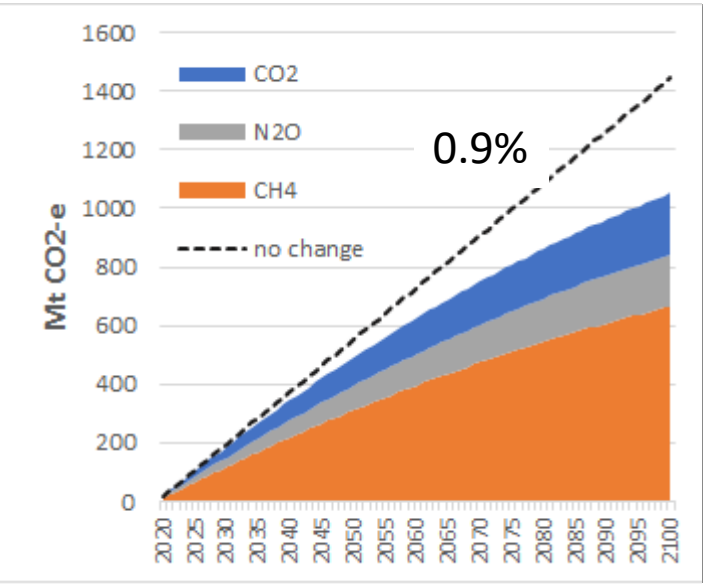
Direct emissions

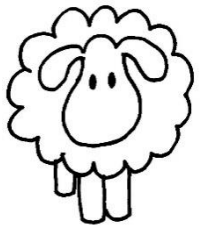


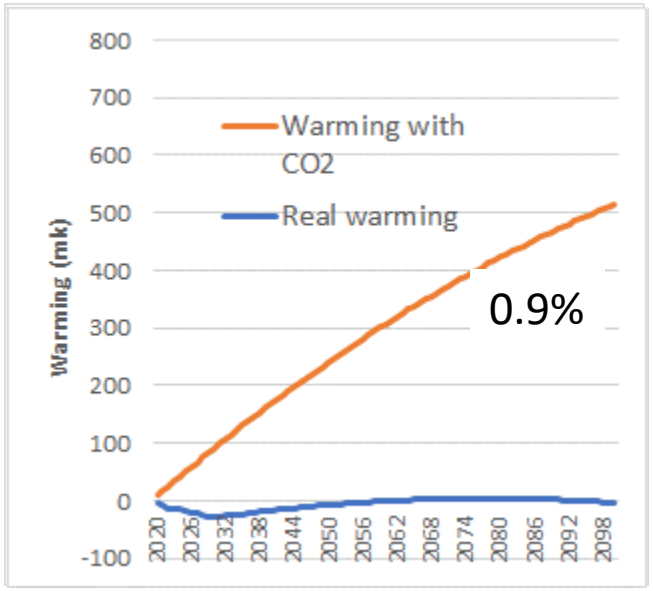
Based on GWP*

Looking at European GHG emissions as an LCA regional approach

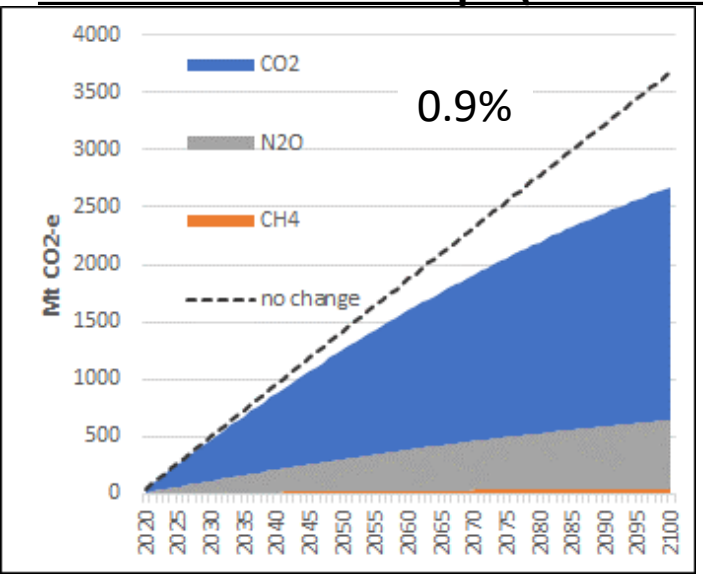
Sheep meat in Europe (LCA-based)

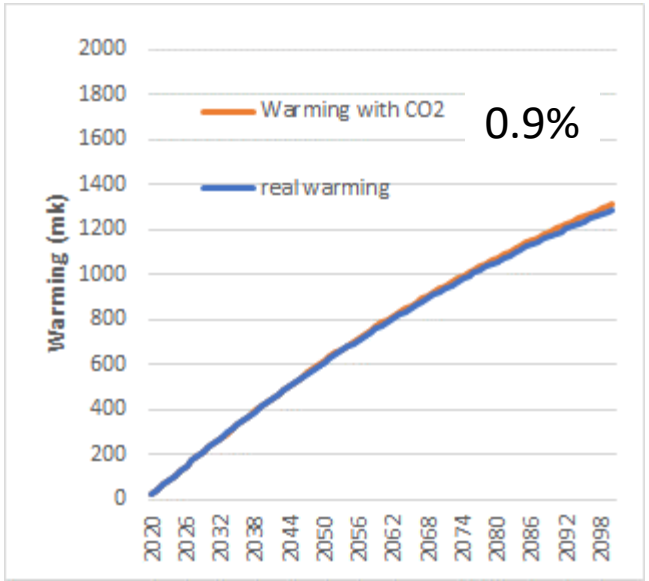






Chicken meat in Europe (LCA-based)





FAO data as inputs

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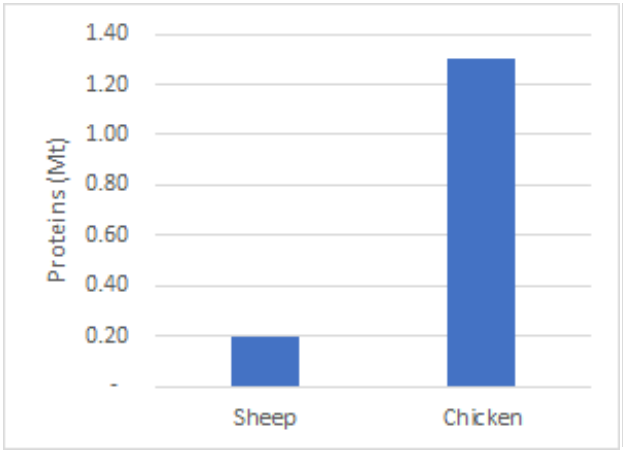
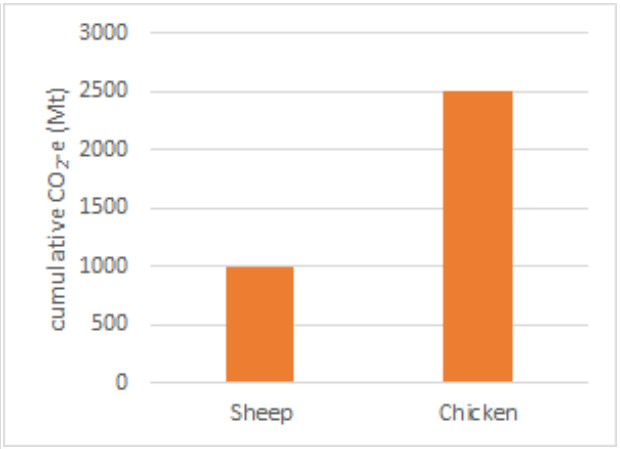
Looking at European GHG emissions as an LCA regional approach

protein



GHG emissions



warming

Year 2010

Reducing 0.9%
Until 2100

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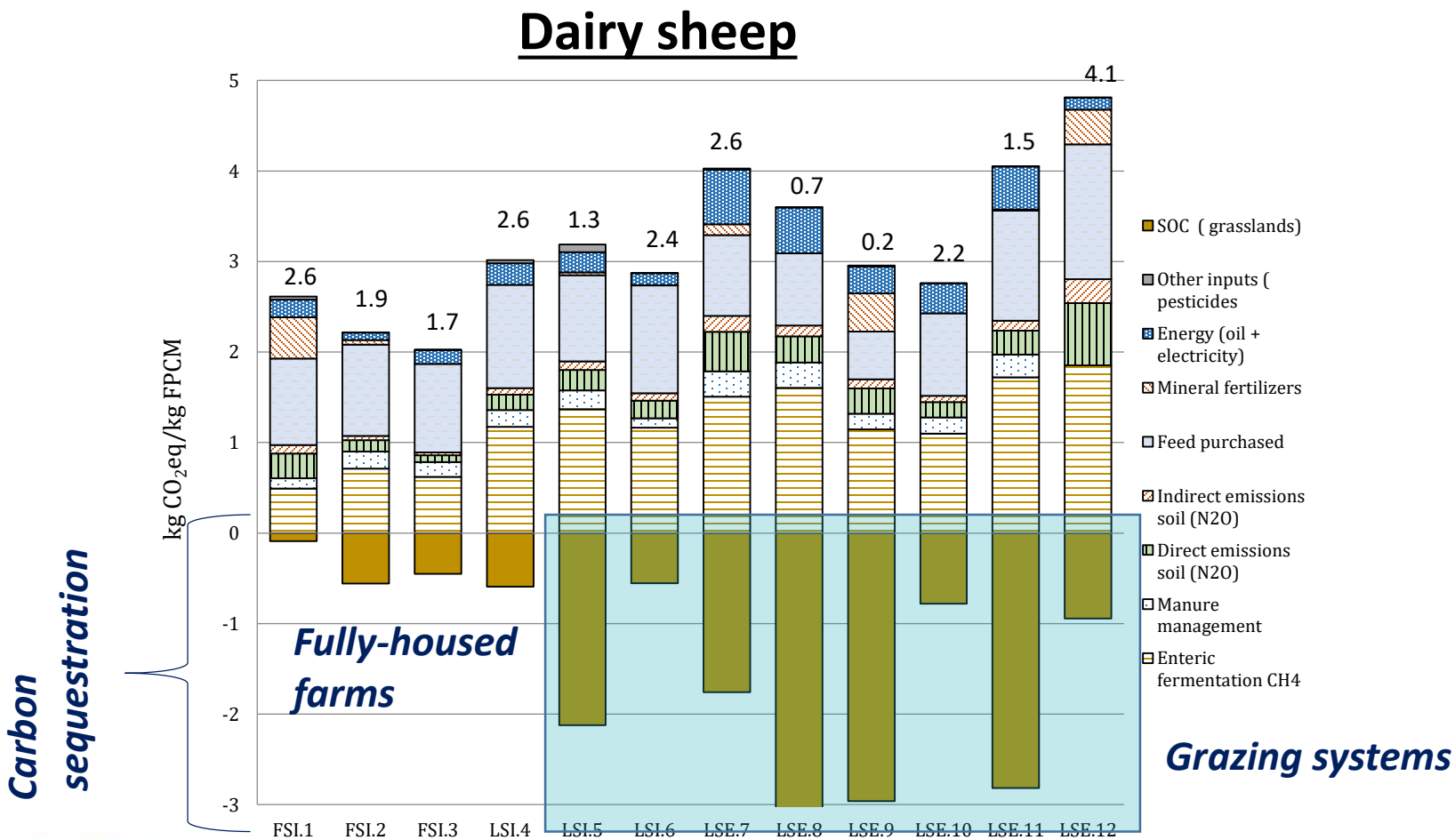
Efforts to reduce GHG intensity and support C sequestration



Batalla et al. (2015)

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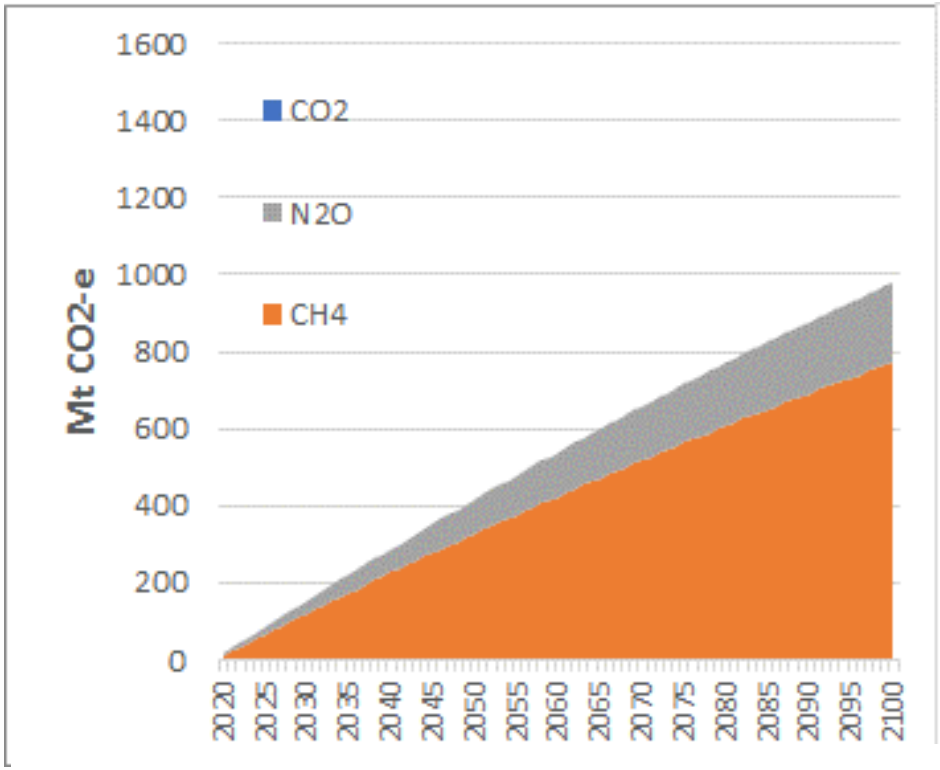
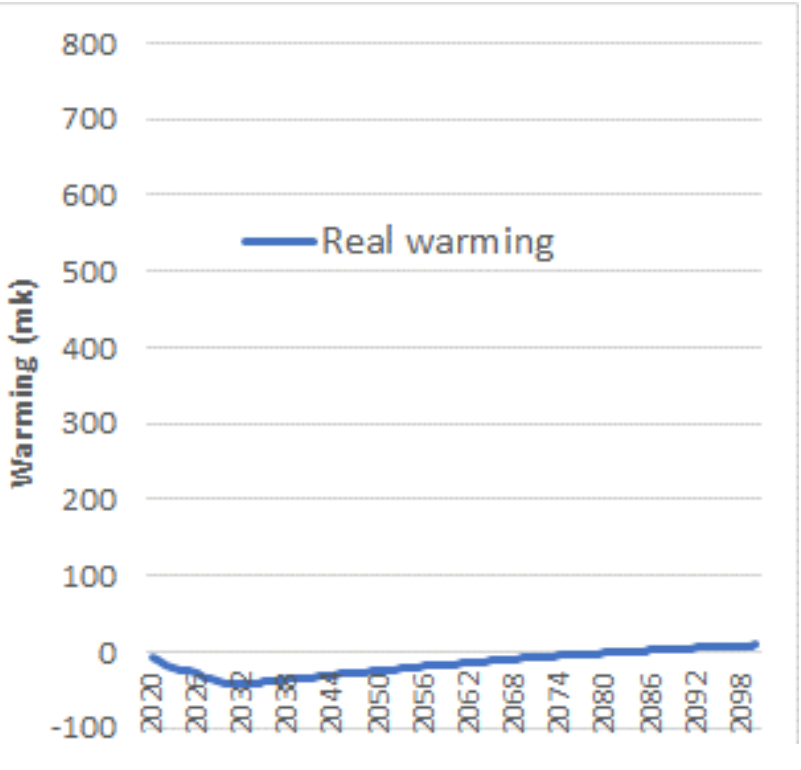
Accounting for soil C sequestration (CO_2 emissions can be off-set)

Sheep meat in Europe (LCA-based)





0.4% reduction of CH_4 and N_2O emissions per year

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Take homes

- Impacts on small ruminant systems can be severe in some areas in Europe
- Climate policies should include tailored CC adaptation strategies
- European sheep and goats have not caused additional warming to the atmosphere in the last decades from direct GHG emissions.

Take homes

- Any strategy towards climate neutrality should consider separating methane from long-lived GHG emissions and account for SOC sequestrations in pastures
- GHG reductions at farm level can provide great climate benefits in comparison with meat from other species

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