Sustainable livestock farming systems - methodologies for trade-offs and synergies

Alberto Bernués   Daniel Villalba   Roberto Ruiz

cita CENTRO DE INVESTIGACIÓN Y TECNOLOGÍA AGROALIMENTARIA DE ARAGÓN

Universitat de Lleida

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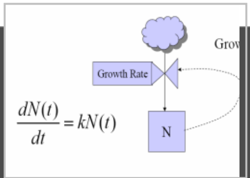
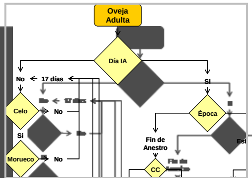
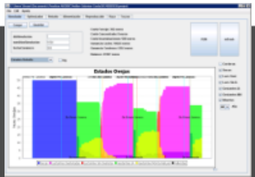
Outline

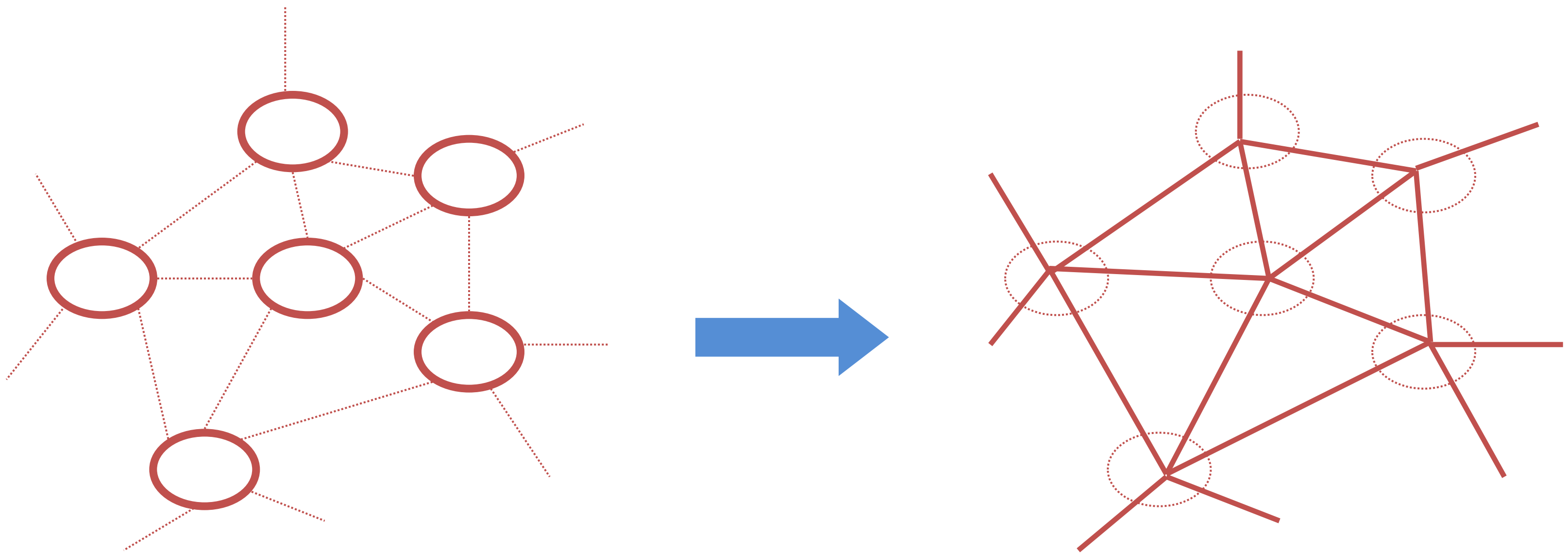
1. Sustainability: a complex dynamic concept
2. Sustainability assessment: sheep farming in Euro-Med. Areas
   - different understandings
   - trade-offs (among sustainability pillars)
   - trade-offs (within sustainability pillars)
3. Tools to explore trade-offs and win-wins under uncertainty
4. Conclusion: responsible & responsive agriculture







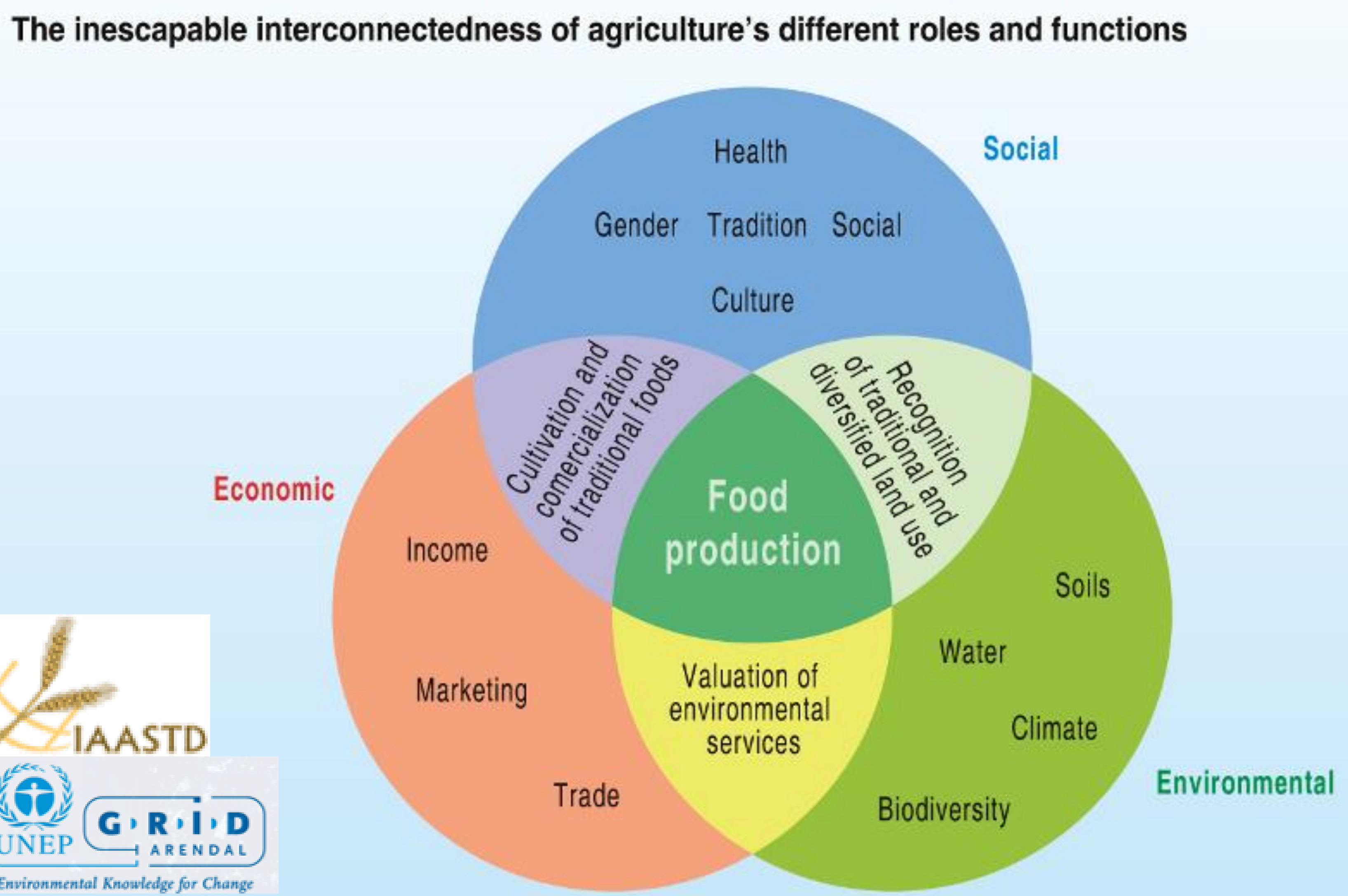
1. Sustainability: a complex dynamic concept



Systems theory:

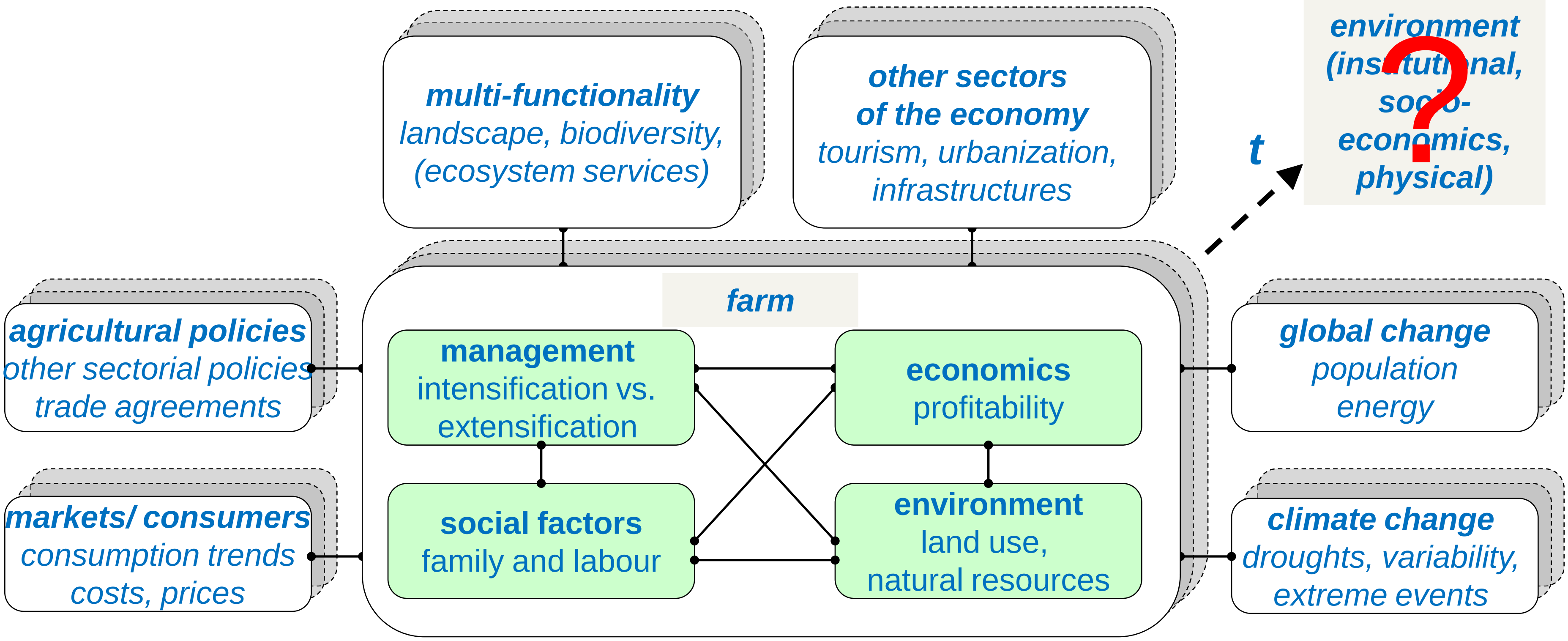
- from parts to the whole
- from objects to relationships

Sustainability and multi-functional agriculture

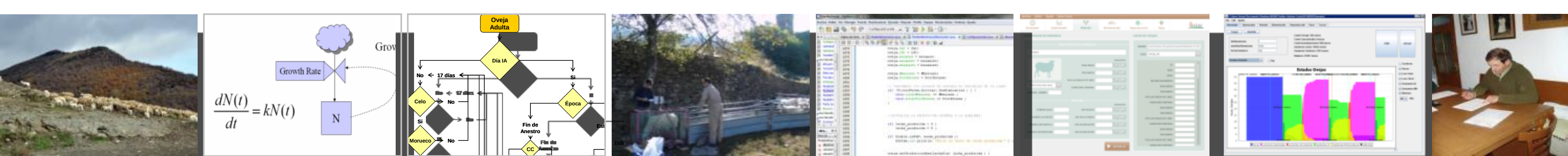


Importance of time

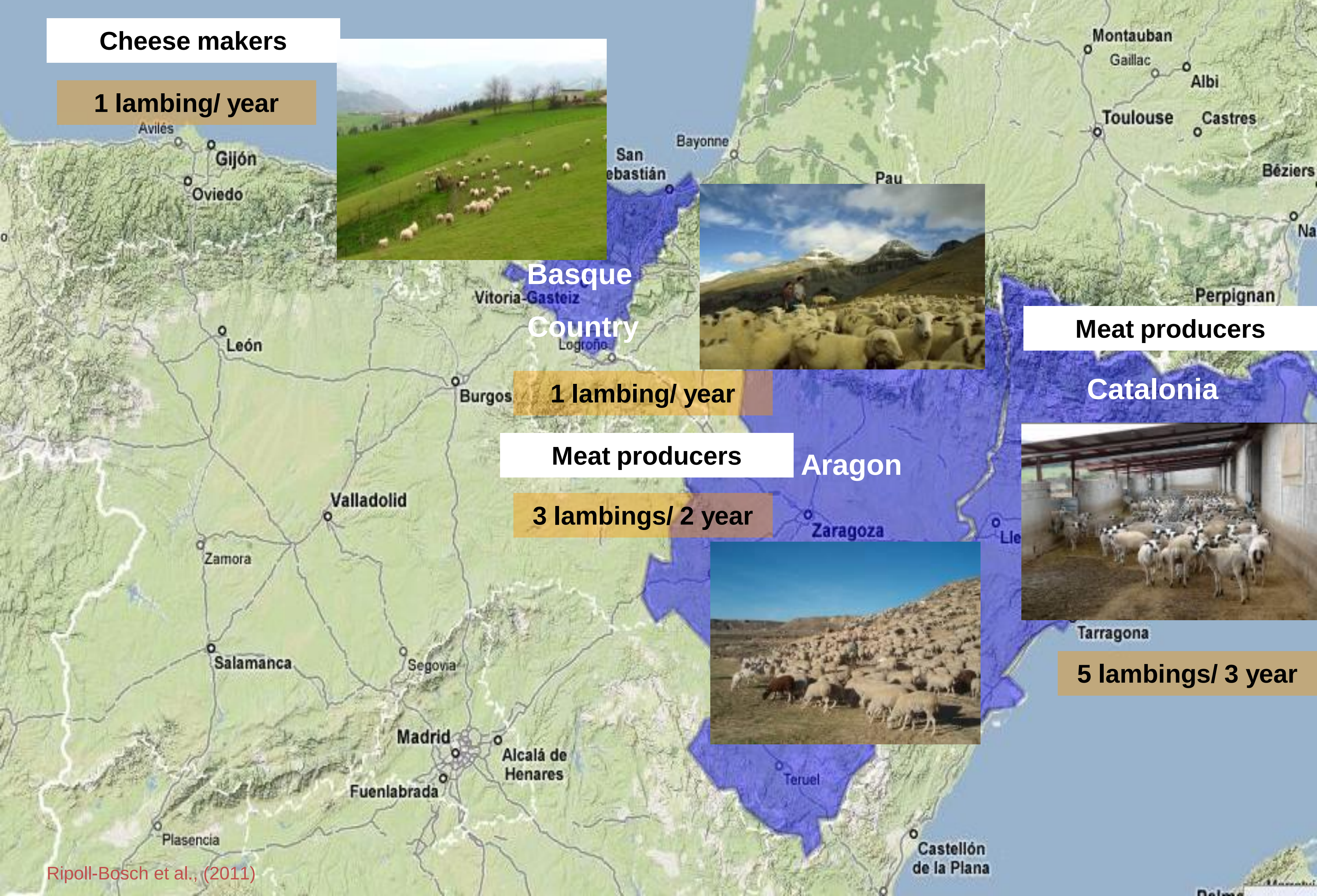
Conceptual framework to study sustainability of LFS



Sustainability of pasture-based livestock farming systems in the European Mediterranean context: synergies and trade-offs (Bernués et al., 2011)



2. Sustainability assess.: holistic, bottom-up



Sustainability understandings

Farmers indicators for sustainability:

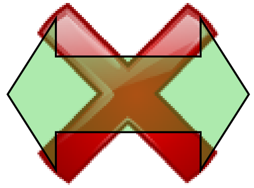
1. **Labour profitability** (Net Margin per Working Unit)
2. Farm **continuity** (15 years, scale)
3. **Diversification** in sources of income (# products)
4. **Salary level** (labour profitability against average salary)
5. Feed **self-sufficiency** (on-farm feed/ total feed)

Importance of indicators

- 46% economics
- 35% social
- 19% environmental

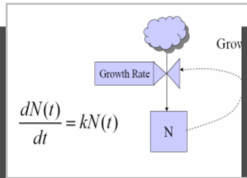
Policy makers' priorities

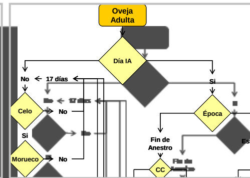
- Climate change (GHG)
- Pollution
- Water
- Land use change
- Landscape
- Biodiversity

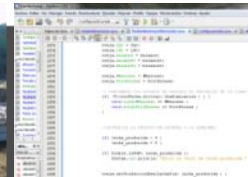


Farmers' priorities

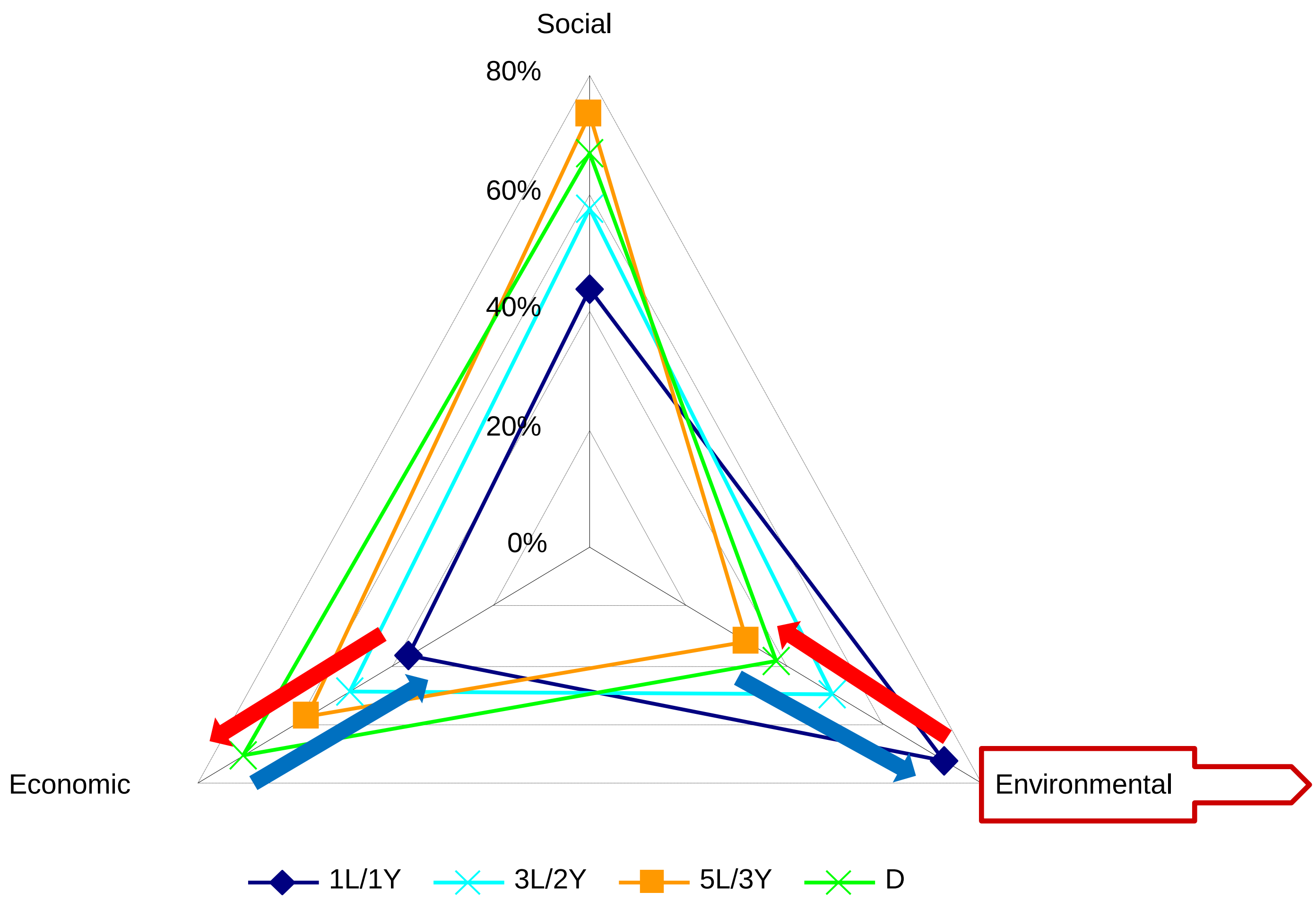
- Maximize grazing
- Energy efficiency
- Use of communals
- Stocking rate
- Local breeds
- Wildlife conflicts







Trade-offs **among** sustainability pillars



An integrated sustainability assessment of Mediterranean sheep farms with different degrees of intensification (Ripoll-Bosch et al., 2012)

Trade-offs **within** sustainability pillars:

E.g. carbon footprint of lamb meat

Accounting for multifunctionality in carbon footprint of lamb meat (Ripoll-Bosch et al., 2013)

	No allocation: kg CO_2-eq / kg LW	Allocation	Corrected: kg CO_2-eq / kg LW
Grazing (1L/1Y)	25.9	53.6 %	13.9
Mixed (3L/2Y)	24.0	73.9 %	17.7
Zero grazing (5L/3Y)	19.5	100 %	19.5

- Multifunctional agriculture
  - Private goods
    - Animal products
  - Public goods and services
    - Conservation of biodiversity
    - Maintenance of cultural landscape
    - Prevention of hazards: forest fires (Med.)
    - Etc.

- Non-marketable
- Inherently linked to extensive livestock farming systems IEEP (2009)

3. Trade-offs and synergies under uncertainty

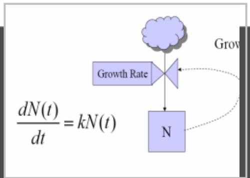
Decision Support Systems:

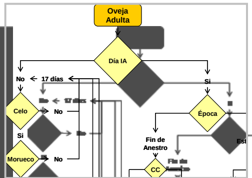
- bio-economical modelling

Stochastic dynamic simulation

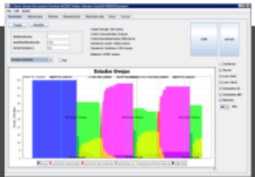
+

Multi-objective optimization






Simulation module

ANIMAL

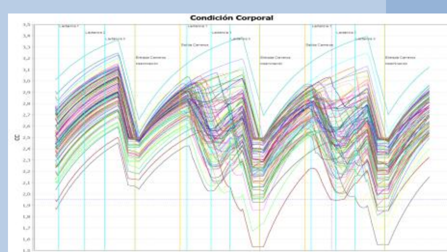
- Voluntary Intake (AFRC)

  Body condition score

- Reproduction (seasonality)

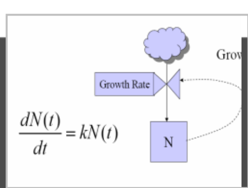
FLOCK

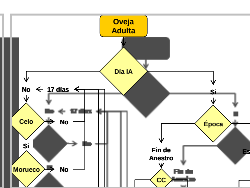
- Herd dynamics
- Management Practices
  - Grazing
  - Supplementation
  - AI, rams, etc.

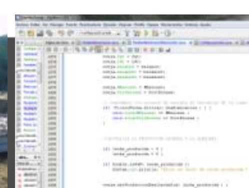


FARM

- Grazing resources
- Off-farm resources
- Economy
  - Costs
  - Incomes

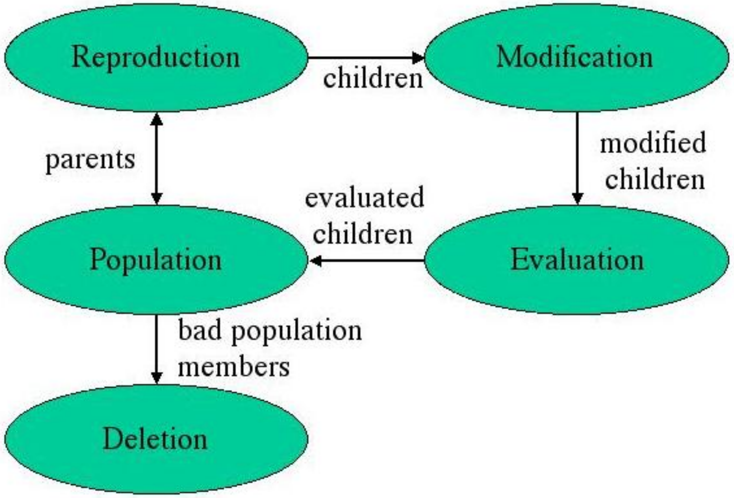



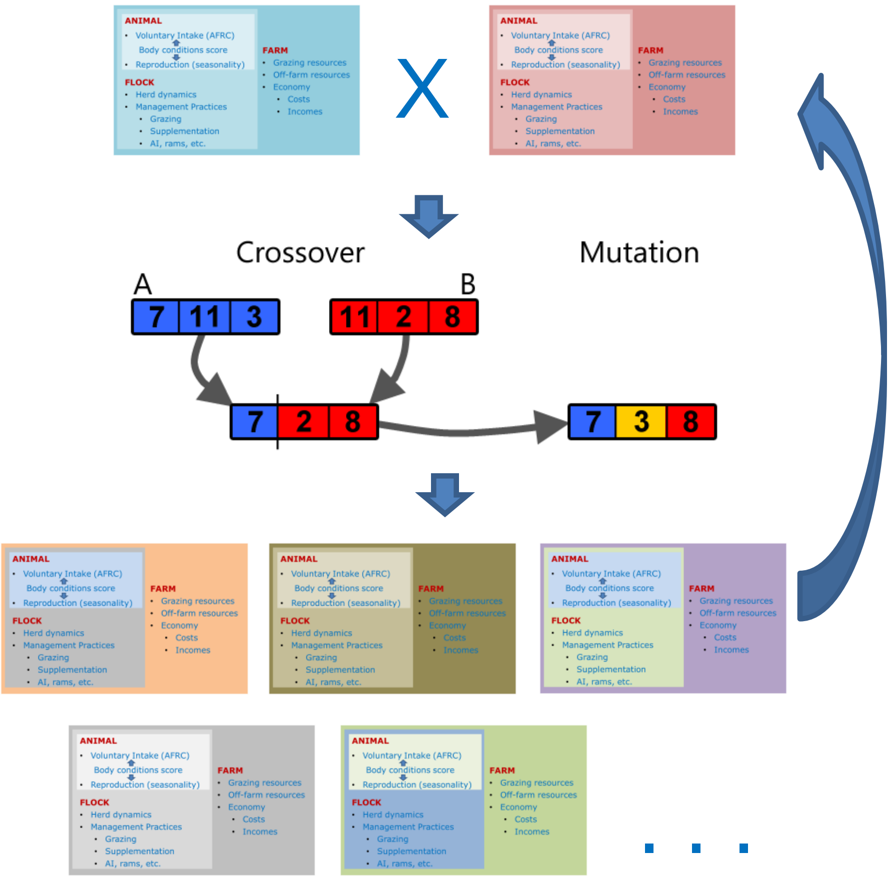


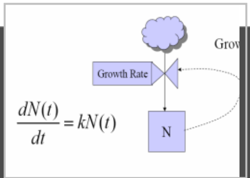



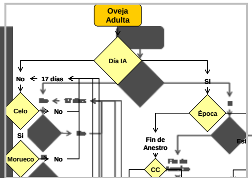
Optimization module: genetic algorithms

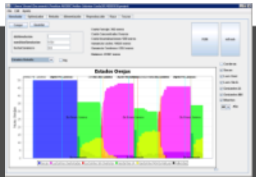
evolutionary optimization
based on mimicking the natural selection process that allows species to adapt to environment







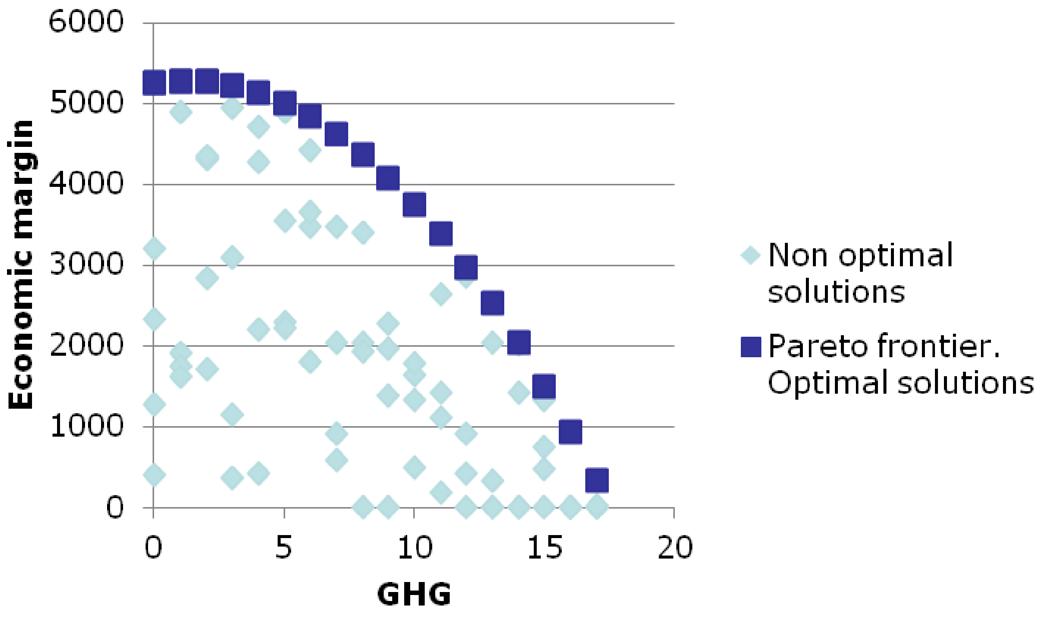


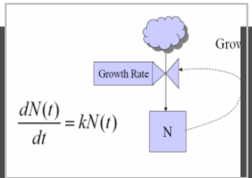


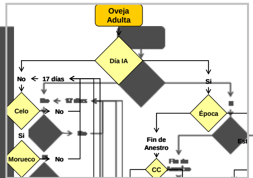
Synergies between functions: Pareto frontier

Fitness (objectives):

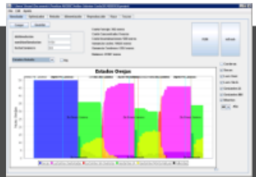
- maximize economic margin
- minimize GHG emissions





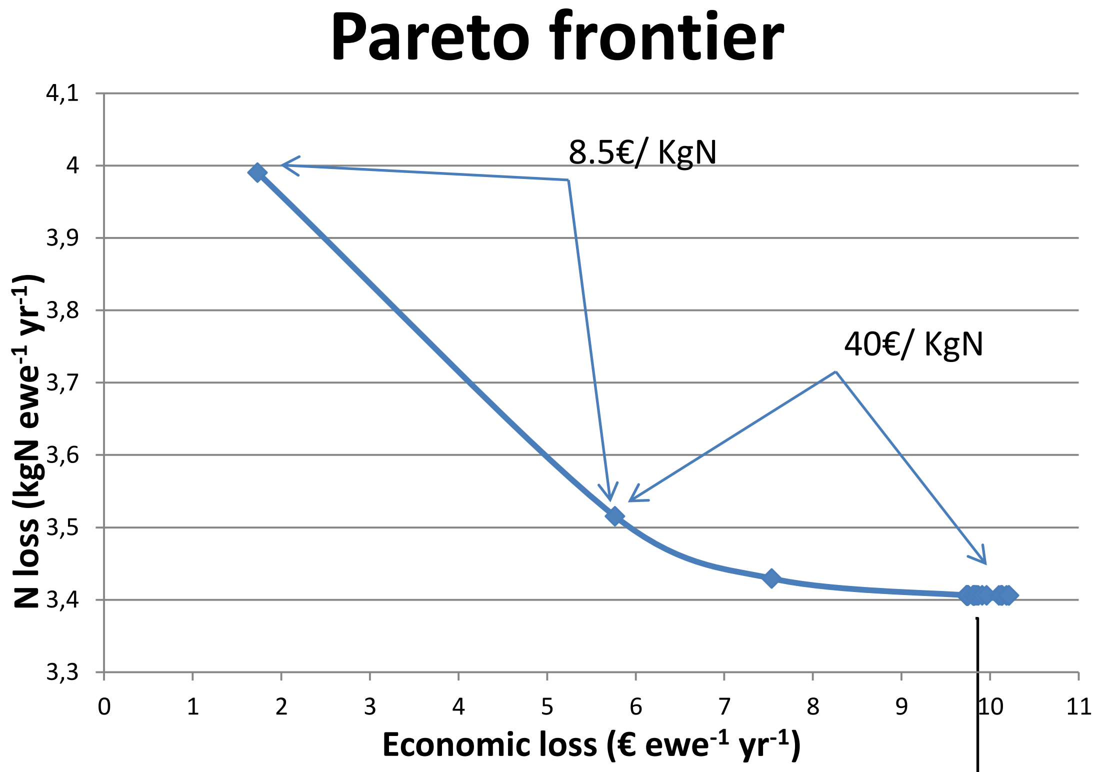


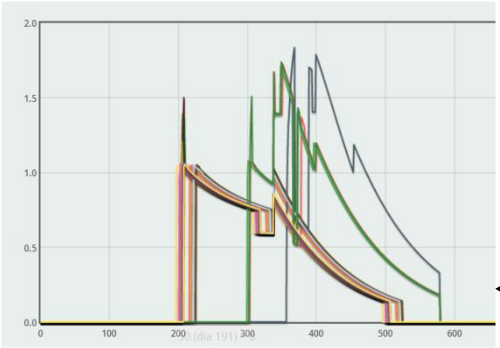




Synergies between functions: real example

Fitness (objectives):
- minimize N loss
- minimize economic loss

Herd of 50 milking ewes
- diverse lambing date
- diverse milk potential
- 3 rations during lactation
- animals managed in 1 batch





4. Responsible/ Responsive LFS

scenario of
stability

scenario of
change

uncertainty

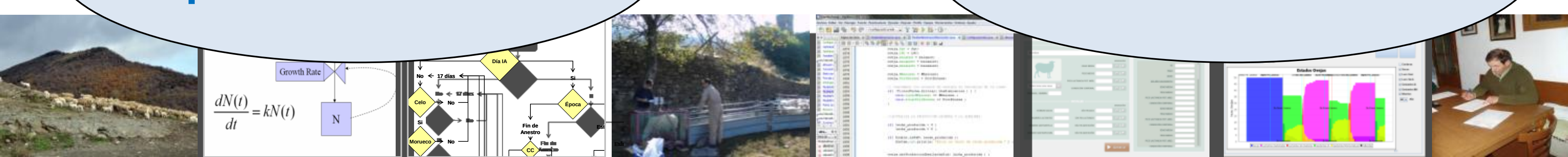
control of the environment
(physical & socio-economic)

efficiency
productivity

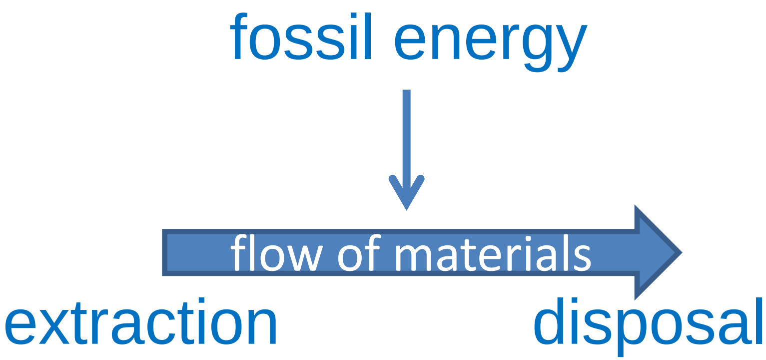
specialization

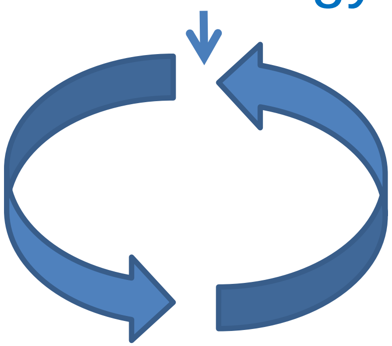
adaptation
resilience

diversification



New system design (paradigm)





- Linear
- Non-renewable
- Global
- Specialized
- Input-based

- Circular (blue)
- Renewable
- Local/ regional
- Diversified
- Knowledge-based