69th Annual Meeting of the European Federation of Animal Science
Dubrovnik, Croatia, 27th to 31st August 2018

Relationship between resource use, efficiency and sustainability of sheep-crop farming systems

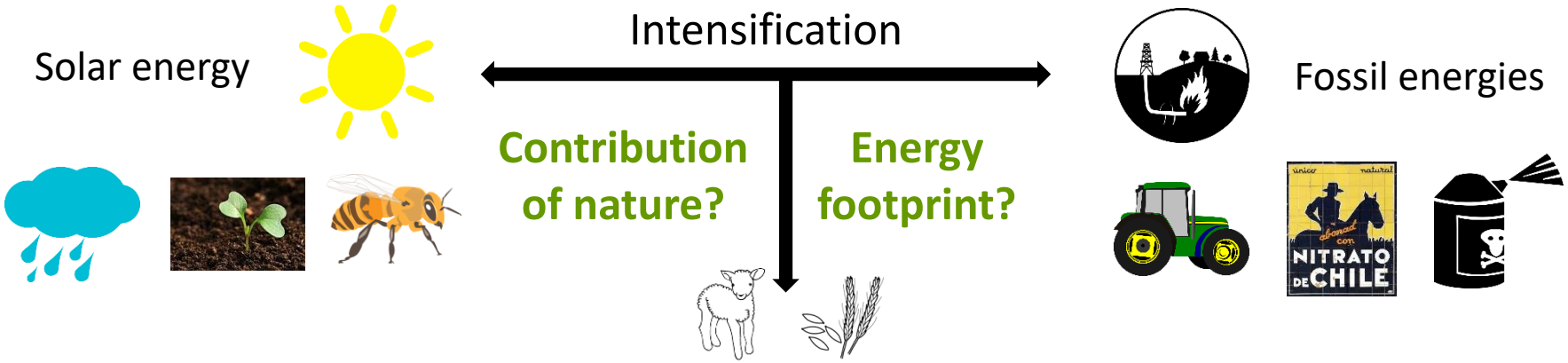
Tamara Rodríguez-Ortega, Alberto Bernués, Ana Mª Olaizola

Universidad Zaragoza
1542

cita
CENTRO DE INVESTIGACIÓN Y TECNOLOGÍA AGROALIMENTARIA DE ARAGÓN

Introduction

- "Agriculture is a primary activity by which human societies channel renewable energy flows into products that support social welfare" (Rydberg and Haden, 2006).



EMERGY: Energy of the same form (solar emjoules) invested to make a product or service considering the quality of the different energies involved.

- **Objective: To evaluate the emergy flowing in representative Mediterranean sheep and sheep-crop farming systems with diverse degrees of specialization, integration and intensification of production.**

Material and methods: **data collection**

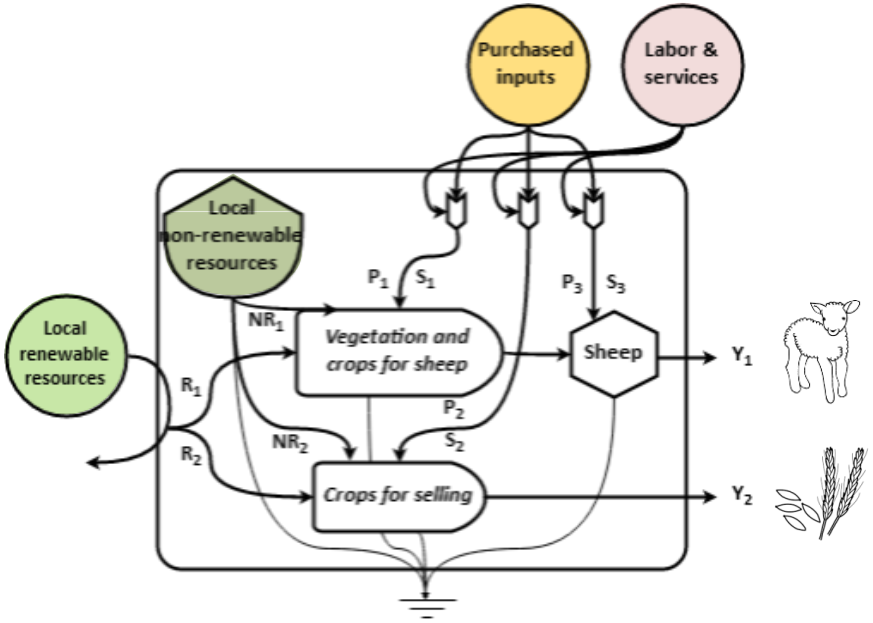
10 sheep and mixed sheep-crop farms in Aragón (Northeast Spain), from previous farm typologies

- **Initial survey (2014)**:
  - family structure and labor
  - agricultural and pasture area
  - flock dynamics
  - products and destination of production
  - farm equipment

- **Monitoring during agronomic year 2014-2015**, every 2-3 months with forms:
  - crop management (inputs, doses, time of operation, fuel consumption, harvests)
  - animal feeding (grazing calendar & indoor rations) per batch
  - reproduction management
  - self-consumptions and exchanged products
  - work for third parties, hired labor and machines

Material and methods: **emergy analysis**

1. Emergy diagram:



2. Emergy tables:

	Amount (unit/yr)		Transformity (sej/unit)		Solar emergy (sej/yr)
Local renewable resources	6.75 E13 J/yr	x	2.59 E04 sej/J	=	1.75 E18 sej/yr
Local non-renewable resources	7.69 E11 J/yr	x	1.24 E05 sej/J	=	9.53 E16 sej/yr
Purchased inputs	…	x	…	=	…
Labor & services	…	x	…	=	…
Yields	3.24 E04 kg/yr		**9.23 E13 sej/kg**		**Σ** = 2.99 E18 sej/yr

3. Emergy indicators:

- Efficiency = (&/or) / (+ + +)

- Intensity = (&/or) / area x time

- Sustainability = Self-sufficiency / Environmental stress

- Self-sufficiency = (&/or) / (+)

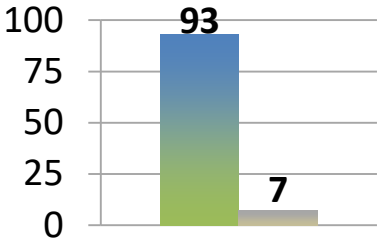
- Environmental stress = (+) / (1)

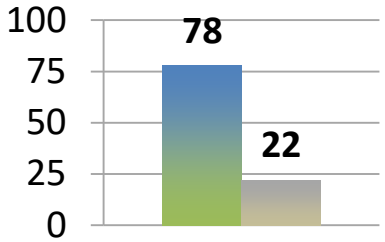
Results: diversity of farming systems

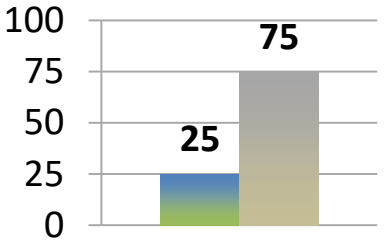
	Specialized sheep-mountain pastures (S-MP) system	*Fully-integrated mixed sheep-permanent crops (S-PC) system*	*Partially-integrated mixed sheep-arable crops (S-AC) system*
Crop harvest (kg DM)	8.922	68.738	373.592
Self-consumption (%)	100	100	35
Sales (%)	**0**	0	**65**

Feeding strategy (% of year):

- Grazing
- Indoor

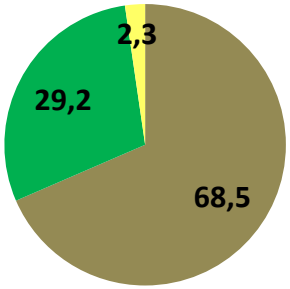


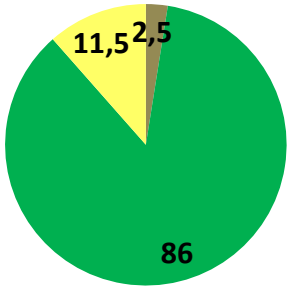


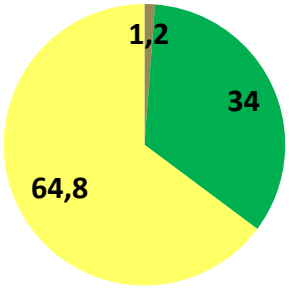


Grazed pastures (% of year):

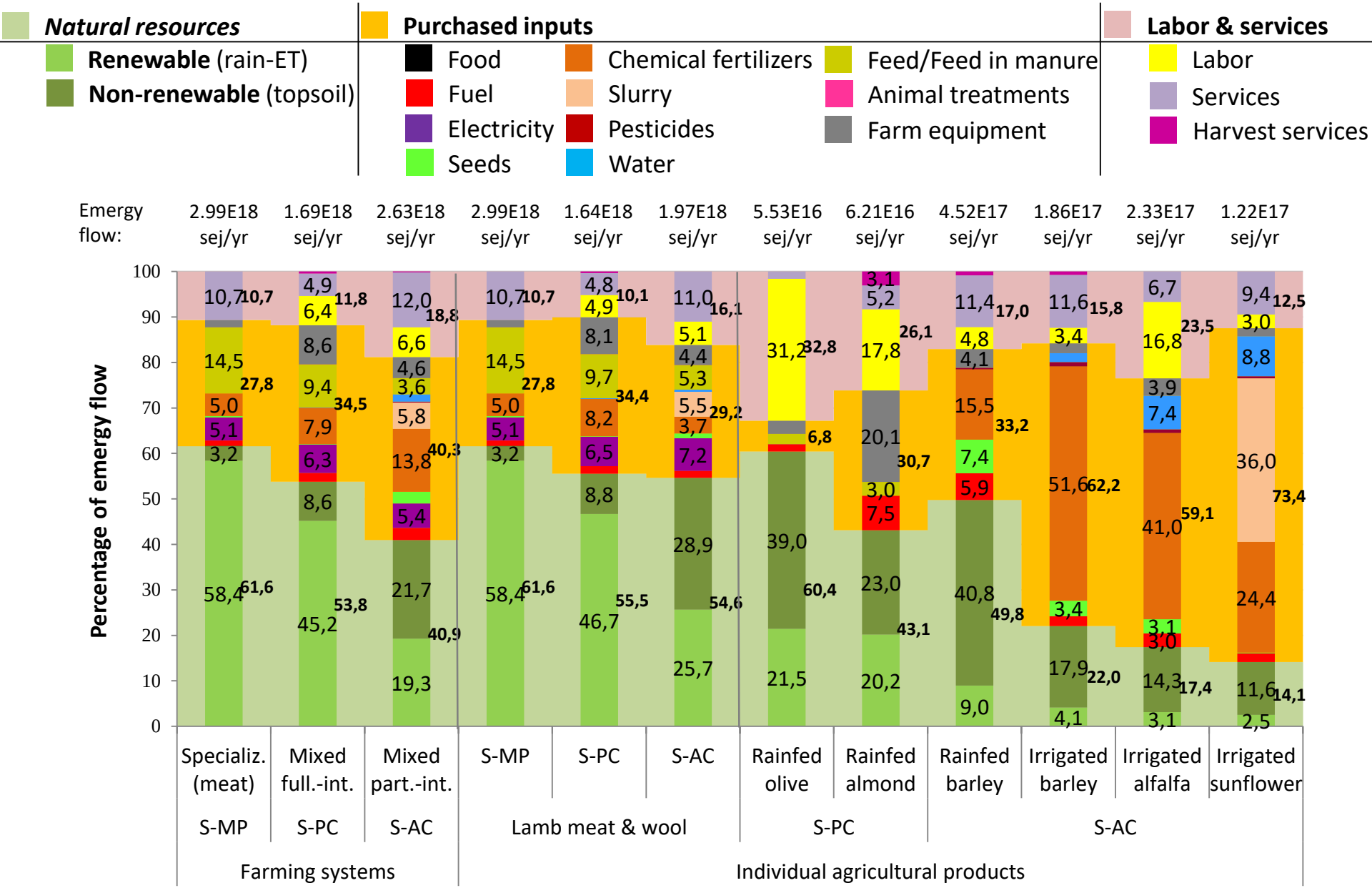
- Semi-natural vegetation
- Forages
- Stubbles





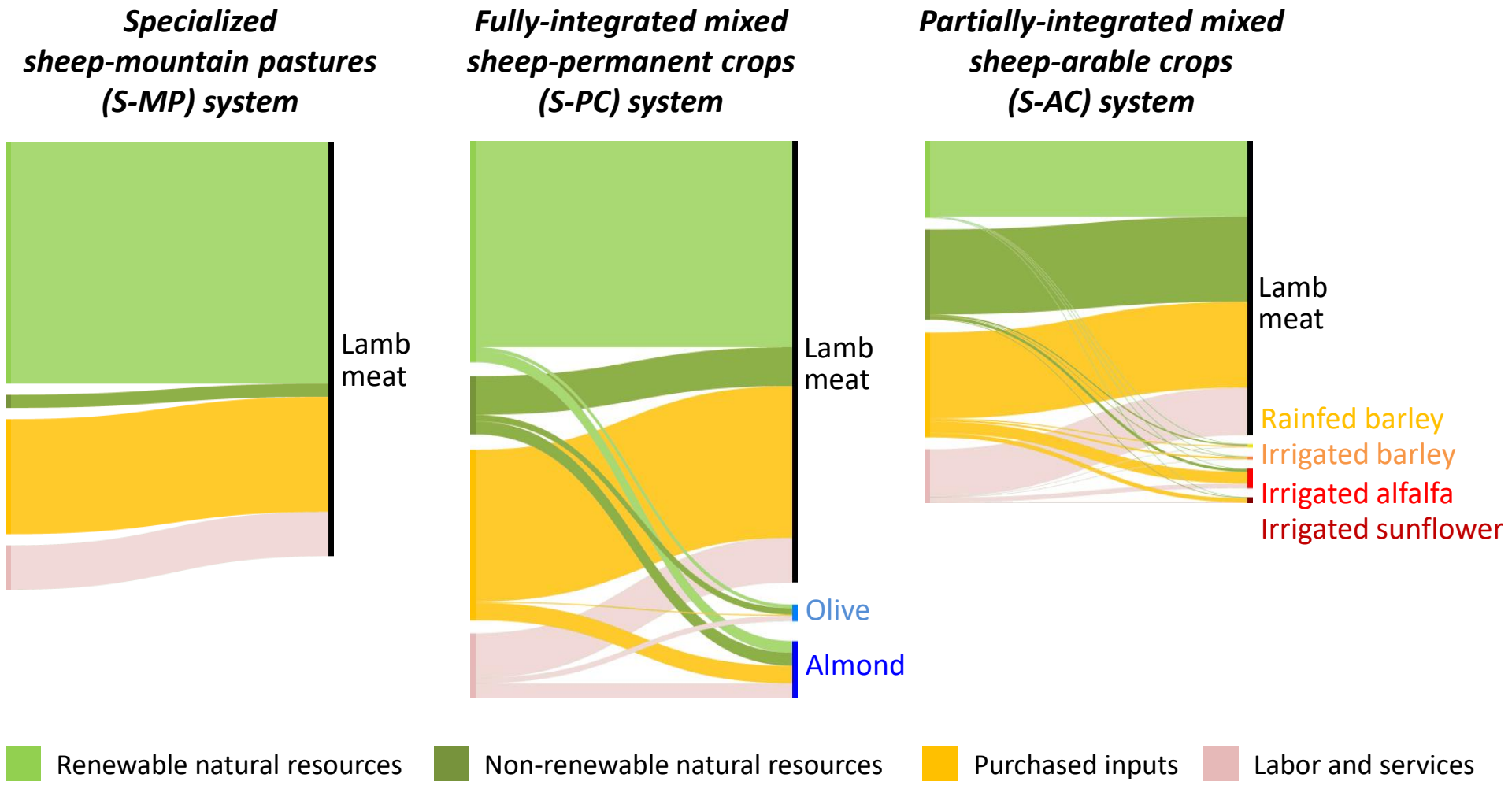


Results: **Input composition of emergy flow** (emergy/year)



Results: Emergy embeded on agricultural products

Solar emjouls (sej) per J of product:



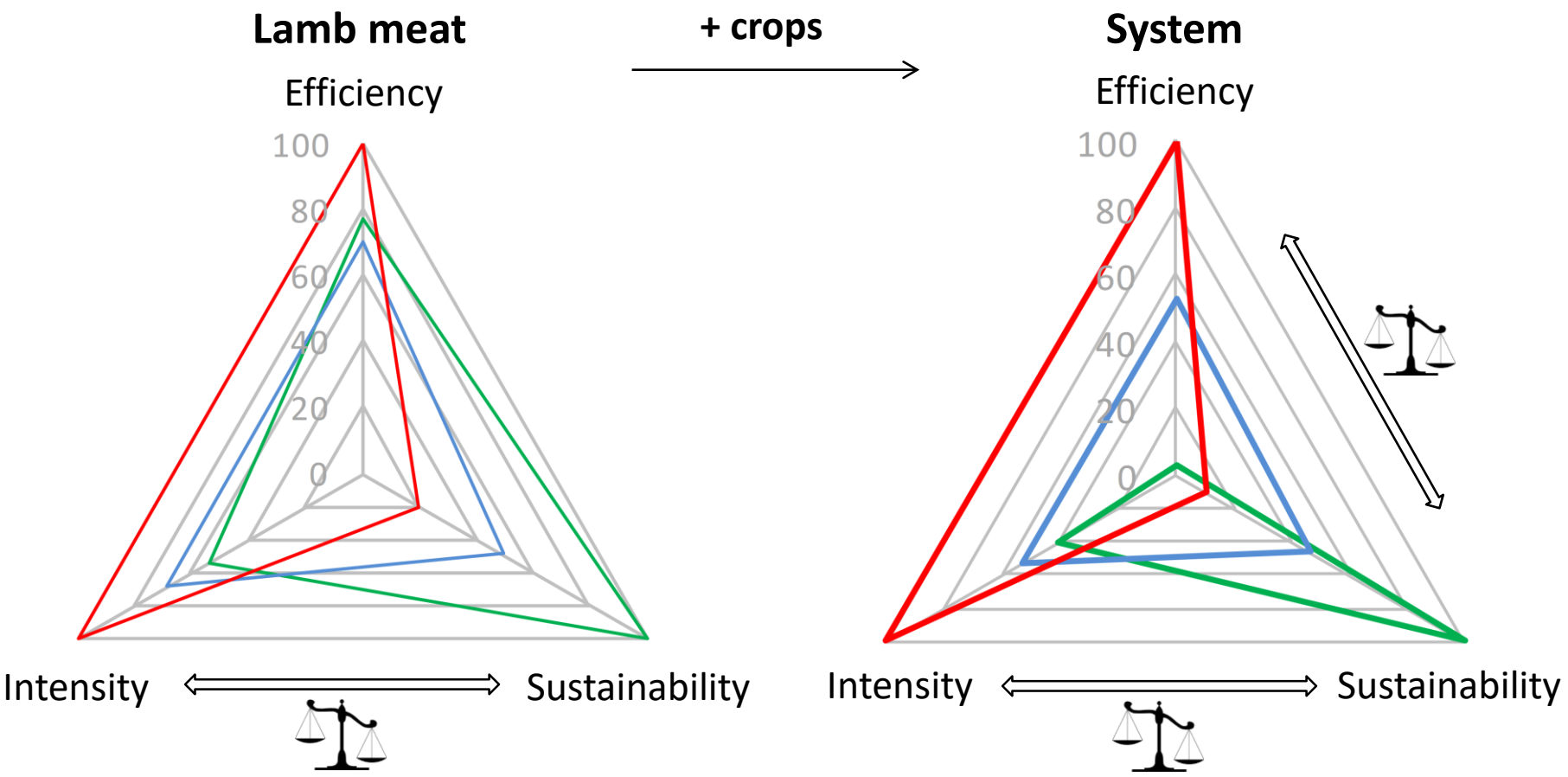
Results: **Emergy footprint of lamb meat,** but what about **composition?**

Emergy per kg of lamb meat sold (live weight):

	Specialized sheep-mountain pastures (S-MP) system	***Fully-integrated mixed sheep-permanent crops (S-PC) system***	***Partially-integrated mixed sheep-arable crops (S-AC) system***
	9.23E+13 sej/kg	9.83E+13 sej/kg	6.95E+13 sej/kg
Units: %	11	10	16
E+13 sej/kg	**1,02**	**0,98**	**1,11**
	28 **2,58**	34 **3,34**	29 **2,01**
	03 **0,28**	09 **0,88**	29 **2,02**
	58 **5,35**	47 **4,62**	26 **1,81**
	↓ efficiency (high external feed during lactation due to dry spring)	**↓↓ efficiency** (high mortality)	**↑ efficiency**

Renewable natural resources | Non-renewable natural resources | Purchased inputs | Labor and services

Results: Trade-offs on production models



Specialized sheep-mountain pastures (S-MP) system

Fully-integrated mixed sheep-permanent crops (S-PC) system

Partially-integrated mixed sheep-arable crops (S-AC) system

Conclusions

1. The **production system** determines the **origin and quantity of resources** that are incorporated in agricultural products.

2. **Intensification** (higher inputs of non-renewable resources allowing more production in smaller spaces and faster times)**, while yielding more product per unit of emergy input** (i.e. higher efficiency)**, also results in** products having lower self-sufficiency and higher environmental stress, thus contributing to **lower sustainability**.

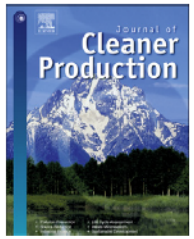
3. **Footprint indicators (e.g. emergy) need to be complemented with other indices** to get a more holistic view of agricultural production.

Thanks for your attention

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro



Does intensification result in higher efficiency and sustainability? An emergy analysis of Mediterranean sheep-crop farming systems

T. Rodríguez-Ortega [a, c, *], A. Bernués [a, c], A.M. Olaizola [b, c], M.T. Brown [d]

[a] *Centro de Investigación y Tecnología Agroalimentaria de Aragón (CITA), Zaragoza, Spain*
[b] *Departamento de Ciencias Agrarias y del Medio Natural, Universidad de Zaragoza, Zaragoza, Spain*
[c] *Instituto Agroalimentario de Aragón– IA2 - (CITA-Universidad de Zaragoza), Zaragoza, Spain*
[d] *Department of Environmental Engineering Sciences, University of Florida, Gainesville, USA*

Universidad Zaragoza 1542

UF UNIVERSITY of FLORIDA

cita CENTRO DE INVESTIGACIÓN Y TECNOLOGÍA AGROALIMENTARIA DE ARAGÓN

Material and methods: **emergy analysis**