Mixed crop-livestock farming systems: a sustainable way to produce beef?

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CONTEXT, AIMS

- **Mixed crop-livestock farming system: usually seen as ideal, a virtuous faming system**
- **Conceptual models, core concepts in agronomy and economics, model-based studies: MC-L advantages and potential gains highlighted**
- **Experiments: one question at the field or animal scale**
- **What about the productive, economic and environmental gains at the commercial MC-L farm scale?**

Method (1)

- Charolais suckler-cattle farms network (INRA)
  - ✓ 66 farms, years 2010 & 2011: 59 conventional + 7 organic
- 2 sort variables:
  - ✓ % Main Forage Area (MFA) in Utilized Agricultural Area (UAA)
  - ✓ % Area dedicated to the cattle (haCatt=MFA + annual crops for feed)

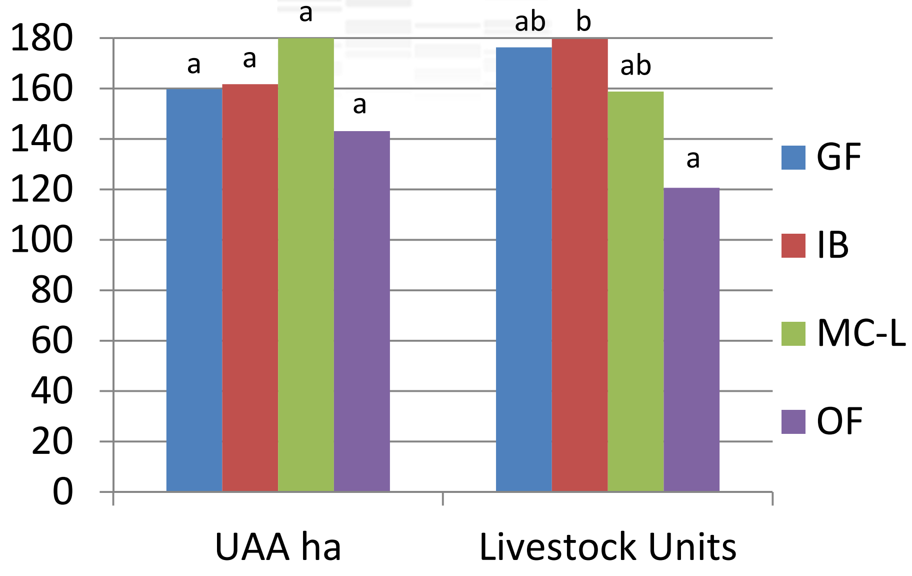
4 groups: 3 conventional 1 organic	100% Grassland Farms (GF) n=7	Integrated Beef + crops for feed (IB) n=31	Mixed crop-livestock (MC-L) n=21	Organic Farms (OF) n=7
MFA % UAA	100	89	68	87
haCatt % UAA	100	96	77	95

- Results comparisons (average 2010-2011)
  - ✓ Structure, technical, economics, environment

Method (2)

- **Techno-economic data base**
  - ✓ **Annual survey => 300 data collected / farm / year**
  - ✓ **Techno-economic appraisal => 3000 technical-economic variables / farm / year**
- **Environmental performances**
  - ✓ **Apparent nitrogen balance at the farm scale**
  - ✓ **Gross GHG emissions, carbon sequestration, net GHG emissions (LCA)**
  - ✓ **Non renewable energy (fossil energy) consumption (LCA)**
- **Analysis of results**
  - ✓ **2010 & 2011 not significantly different => pooled into a single sample for each group**
  - ✓ **Observations/group: GF=14, IB=62, MC-L=42, OF=14**
  - ✓ **Pairwise sample comparisons test: non-parametric Kruskal-Wallis**

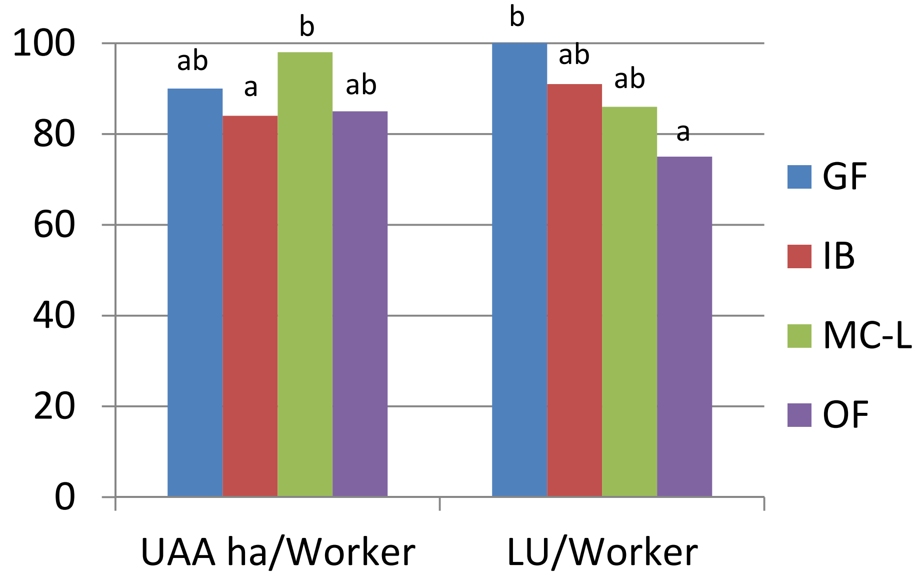
Structural factors



❖ **Farm size (ha UAA)**
- ✓ **4 groups not significantly different**

❖ **Herd size (Livestock Units)**
- ✓ **IB farms: the biggest herds**
- ✓ **OF: the smallest herds**

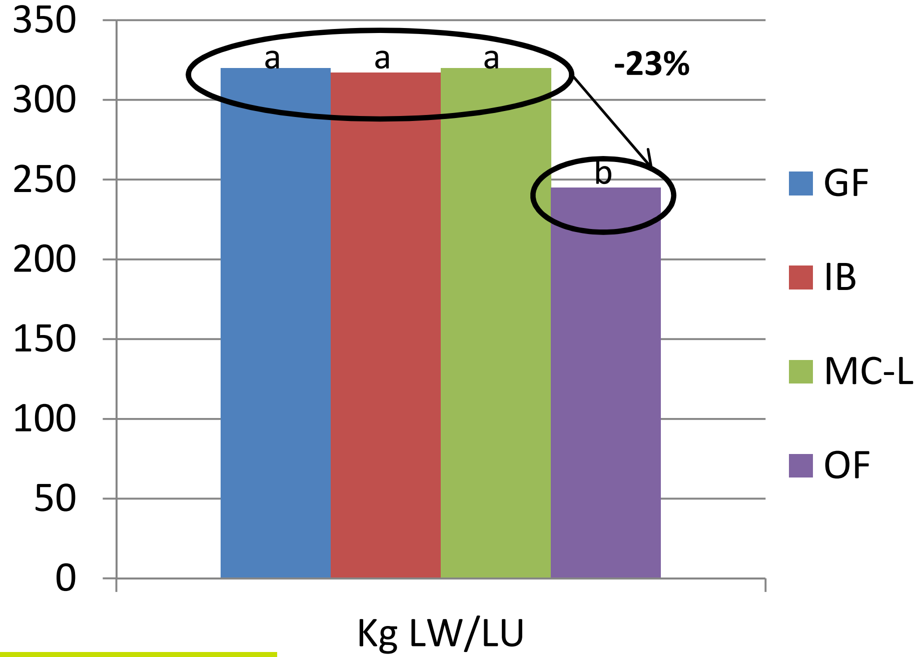
❖ **Labour productivity**
- ✓ **UAA/worker: highest on MC-L and lowest on IB and OF.**
- ✓ **LU/worker: biggest on GF and smallest on OF.**



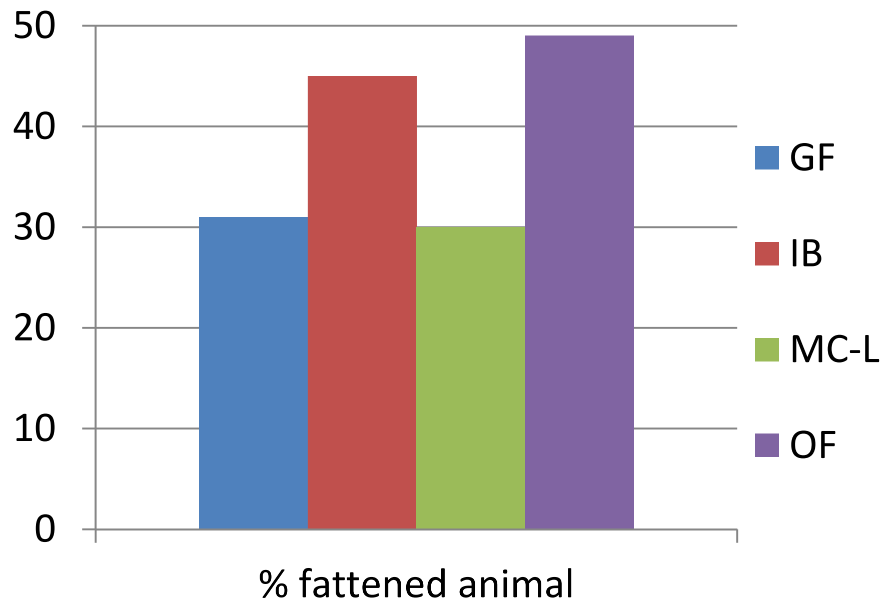
Animal performances

- **Numerical productivity**
  - ✓ **4 groups not significantly different (≈85%)**

- **Livestock productivity (kglw/LU)**
  - ✓ **OF: the lowest productivity (-23%)**



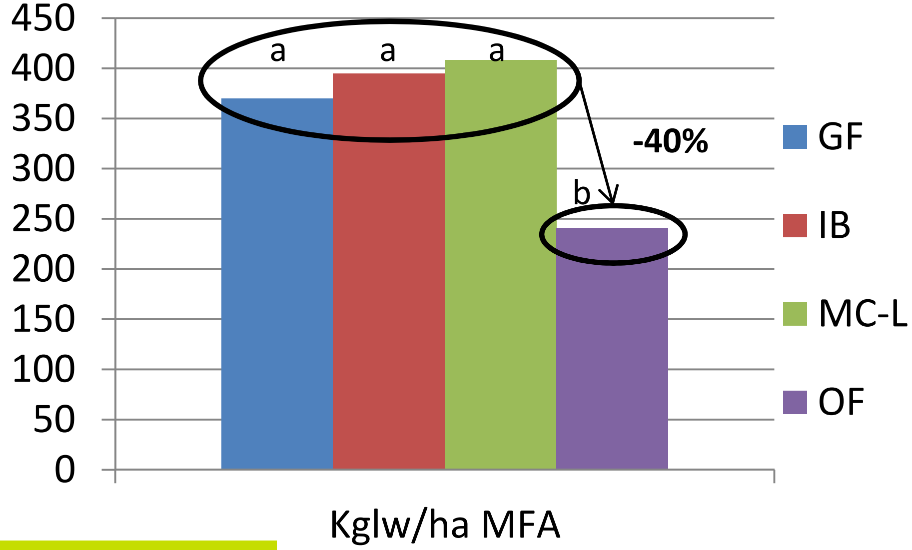
- **Type of animals sold**
  - ✓ **OF and IB fatten more males**
  - ✓ **MC-L do not fatten their males**



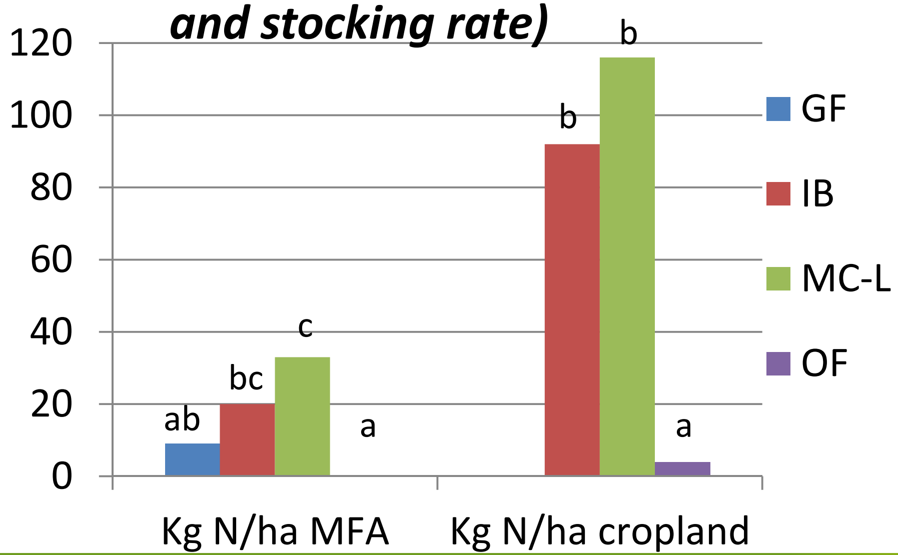
Forages area and cropland

- **Forages**
  - ✓ **Grass: staple forage for the 4 groups. Grazed and conserved grass**
  - ✓ **Conserved grass: hay for GF and OF; silage for IB and MC-L**
- **Cereal yields**
  - ✓ **5 to 5.5 t/ha for conventional (not different) ; 3.2 t/ha for OF (-40%)**

- **Live weight production / ha**
  - ✓ **Not different for the 3 conventional-system groups**

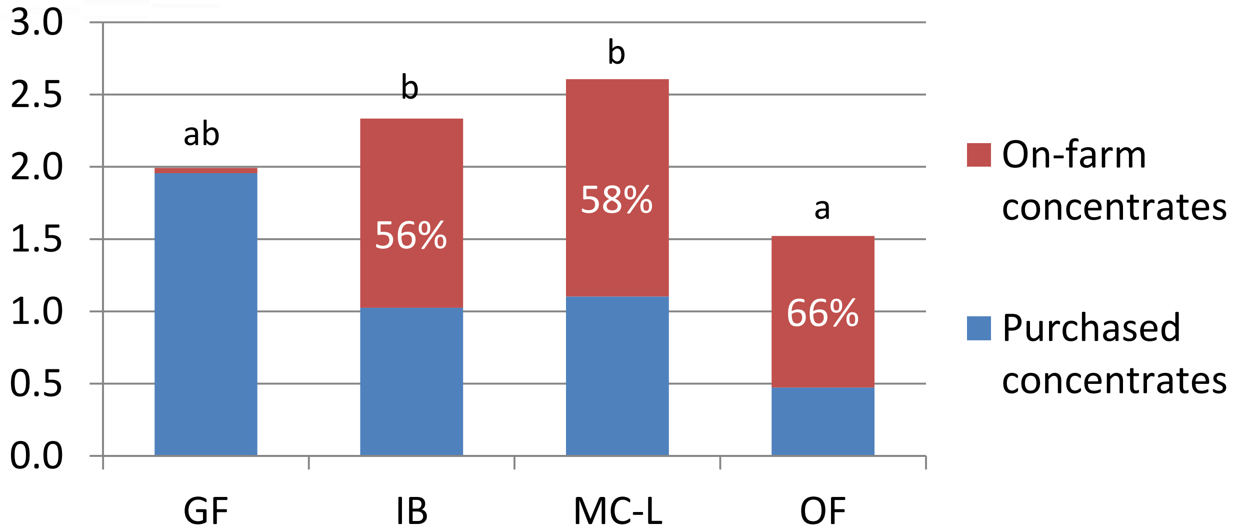


- **Mineral N / ha**
  - ✓ **MC-L uses more mineral N both on MFA and cropland *(for same yield and stocking rate)***



Feeding: concentrates

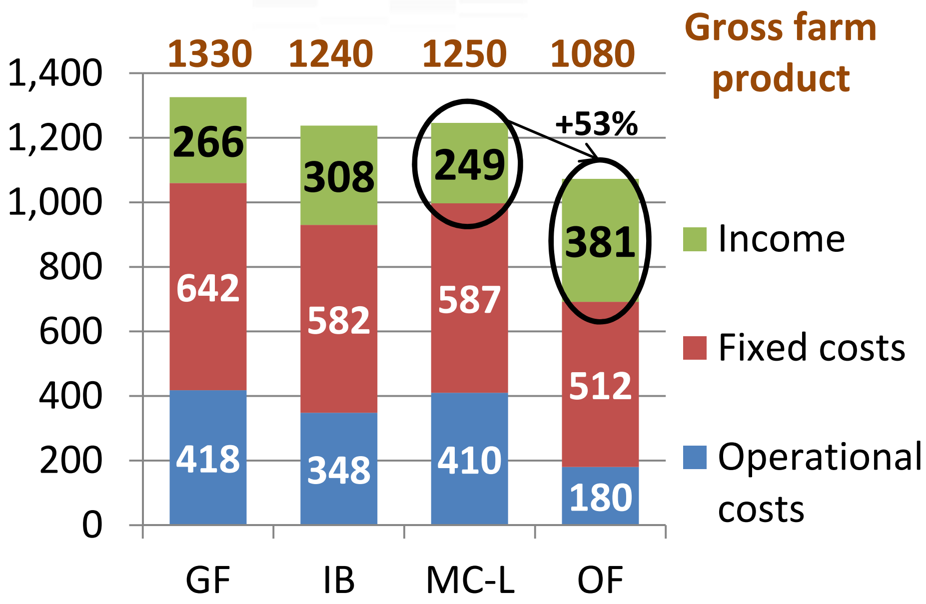
❖ Kg concentrates / Kg live weight



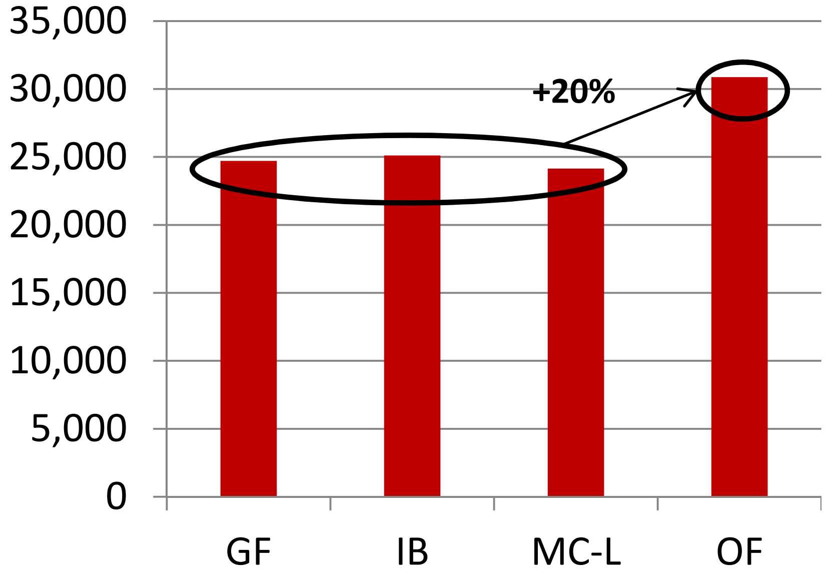
- ✓ **Despite having (theoretically) better-quality stored forage, IB and MC-L groups are the heaviest consumers of concentrate per kg of beef produced.**
- ✓ **MC-L group distributes the highest amount of self-produced concentrates and do not buy less concentrate than the IB group.**
- ✓ **The use of concentrates is more efficient for GF that have to buy in all concentrates and for OF (price of OF concentrates: +35%)**
- ✓ **OF use less concentrates**

Economic performances

❖ Economic results € / ha UAA



❖ Farm income € / worker



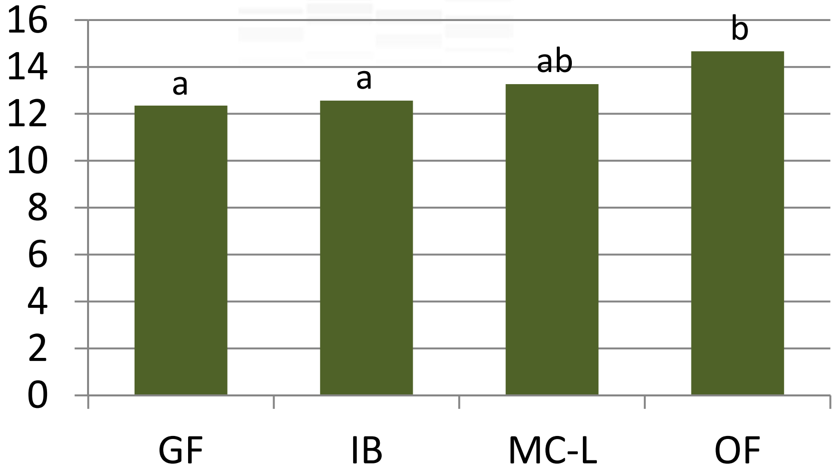
❖ **Gross farm product / ha UAA**
- ✓ **Similar across conventional groups**
- ✓ **Lowest for OF (-20%)**

❖ **Farm income / ha UAA**
- ✓ **Lowest for MC-L (costs/product=80%)**
- ✓ **Highest for OF (costs/product=65%)**

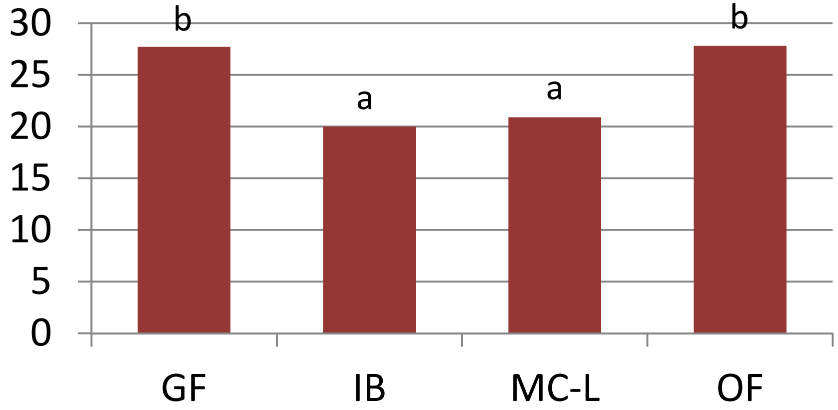
❖ **Farm income / worker**
- ✓ **20% higher on OF than on conventional systems**
- ✓ **MC-L: labour productivity offset the per ha income gap**

Environmental performances: GHG emissions

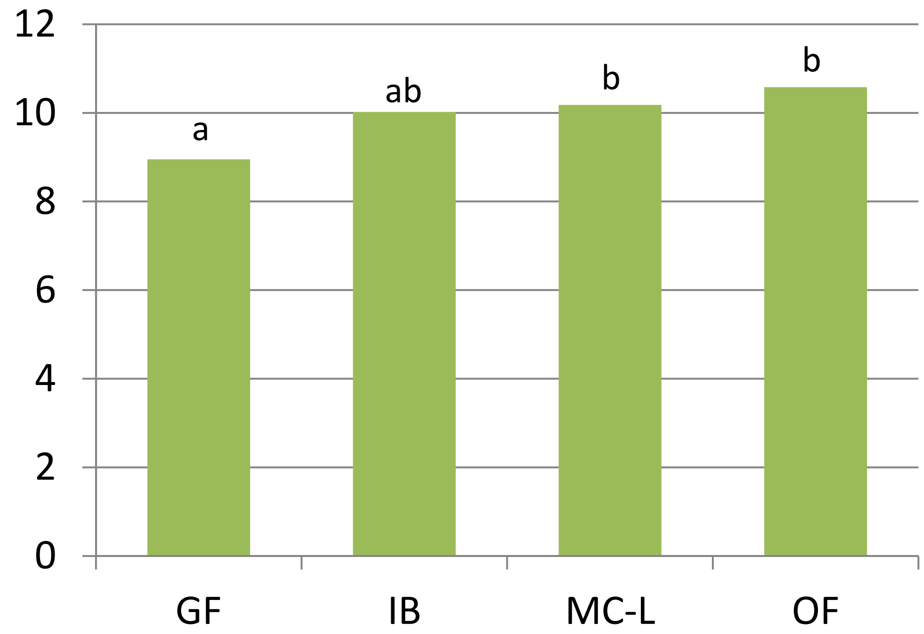
❖ Gross GHG emissions kg CO_2e /kg lw



❖ Carbon offset (% gross GHG)

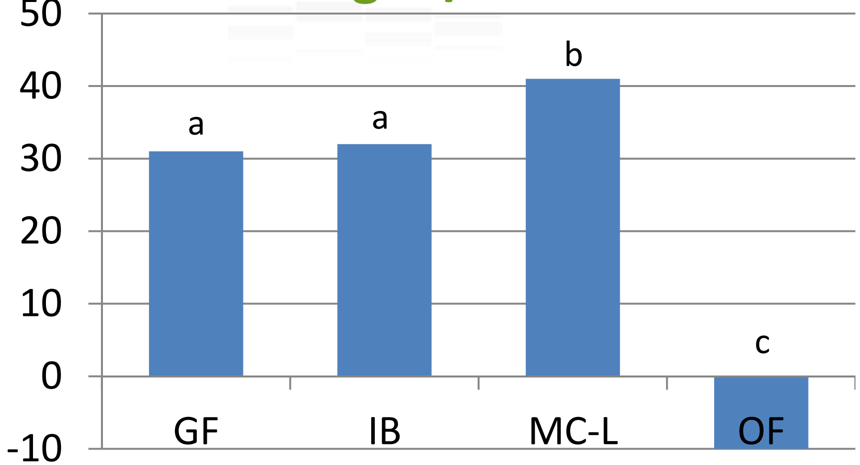


❖ Net GHG emissions kg CO_2e / kg lw

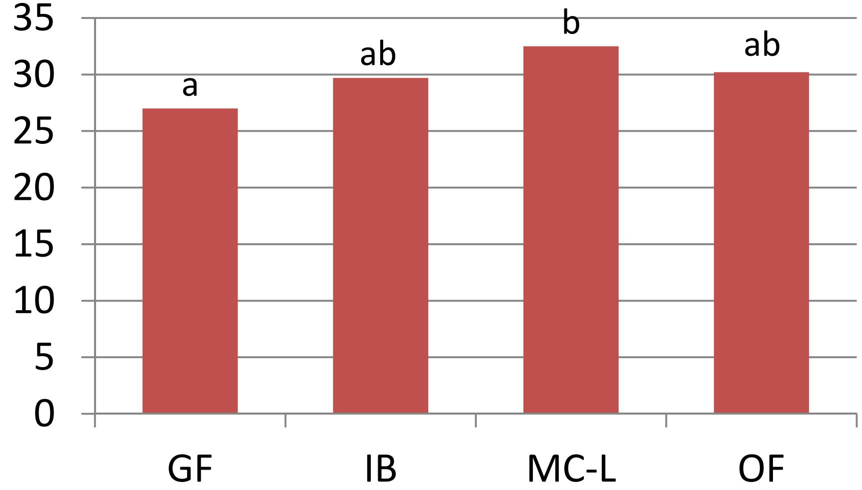


Environmental performances

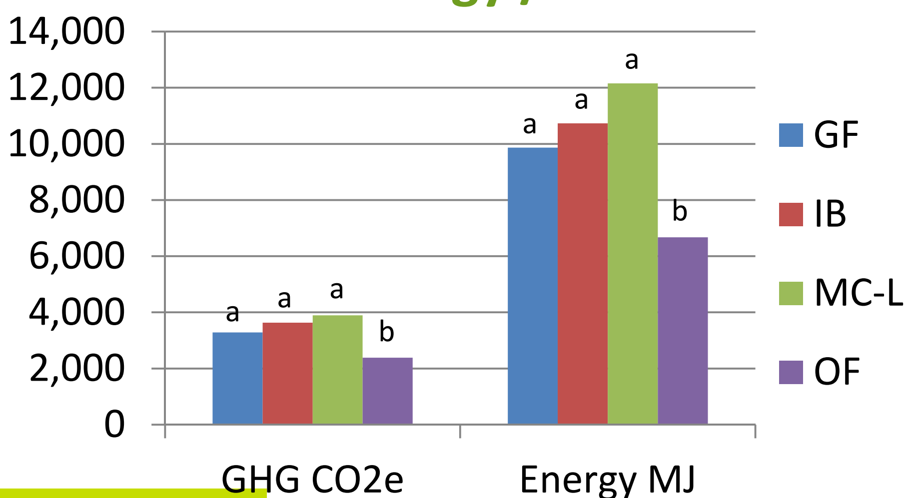
❖ N balance kg N / ha UAA

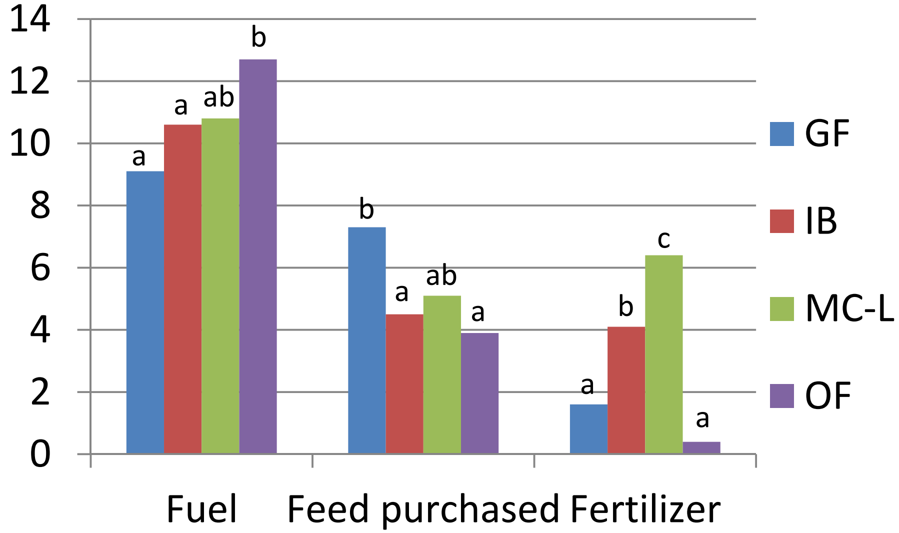


❖ Energy consumption MJ / kglw



❖ GHG and energy / ha UAA





Sum-up

- ❖ **Grassland Farms**
  - ✓ Less concentrates/LU, less mineral N/ha and same live-weight production /LU and per ha
- ❖ **Mixed crop-livestock Farms**
  - ✓ More grass silage, more mineral N/ha, less fattened animals, more concentrates and same live-weight production/LU
  - ✓ Higher mechanization costs
- ❖ **Organic Farms**
  - ✓ Lower animal productivity, lower stocking rate, but higher self-sufficiency
- ❖ **Beef Farms with cereals for feed (on-farm concentrates)**
  - ✓ Intermediate between grassland farms and organic farms

➲ **With higher labour productivity, higher inputs use, and not higher production => mixed crop-livestock farms are not more profitable and post lower environmental performances**

Discussion

Conventional beef cattle farms appear unable to translate a mixed crop-livestock strategy into economies of scope

- ❖ **Feed self-sufficiency and feed resources diversification**
  - ✓ **Economic necessity for GF and especially for OF**
  - ✓ **No productive and economic gain to produce its own concentrates for MC-L farms => energy and inputs are not quite expensive!**
- ❖ **Input efficiency and economies of scope**
  - ✓ **Organic Farms: integration of crop and livestock and good system efficiency => agroecology**
  - ✓ **Lower efficient inputs use and higher mechanization costs for large MC-L farms => economies of scale? (limits of this dogma)**
- ❖ **Encouraging a complex farming system**
  - ✓ **High labour productivity, simplification of practices => incompatible with an efficient management of complex farming systems**
- ❖ **OF and agroecology**

Conclusion

A gap between the conceptual model and the real world

- **From biophysical process to whole-farm approach**
  - ✓ **Optimisation of a biotechnical process ≠ efficiency of the system**
  - ✓ **Research, higher education, vocational training, and learning: need to long-term systemic cross-disciplinary approaches**
- **Public policy**
  - ✓ **incentives that support integrated farm production systems and efficient use of factors of production rather than incentive to further expansion (regressive subsidies with the farm size, agro-environmental scheme payments)**
- **Knowing and improving reality**
  - ✓ **Collect and data analysis: diversity of the farming systems, diversity of the territories => importance of the technical-economic performance monitoring farms networks**

Animal

Special Issue 08

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Agroecology: integrating animals in agroecosystems

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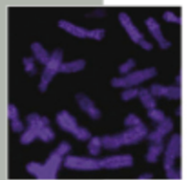

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