



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 farming 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

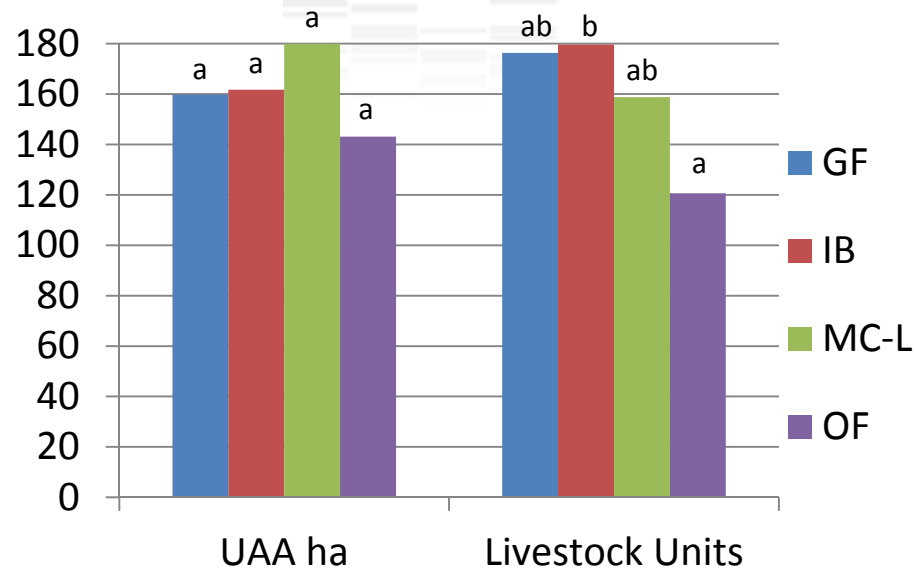
❖ Environmental performances

- ✓ 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

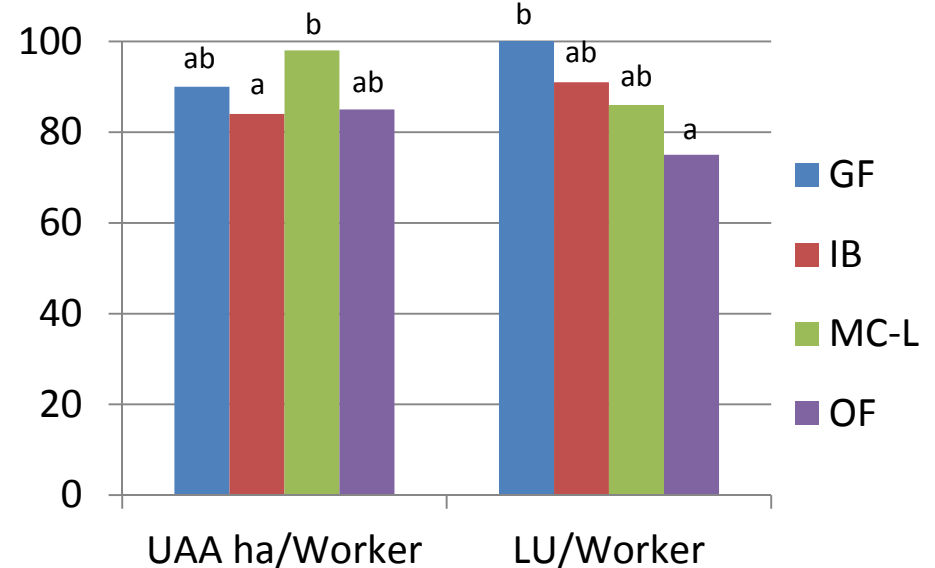
Structural factors



- ❖ **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.**



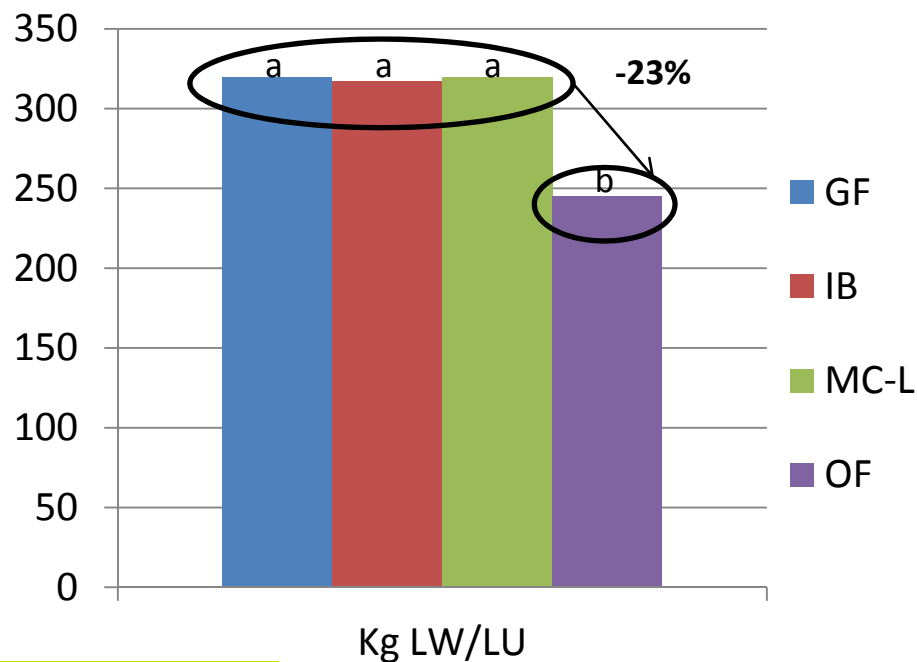
Animal performances

❖ Numerical productivity

✓ 4 groups not significantly different ($\approx 85\%$)

❖ Livestock productivity (kgLW/LU)

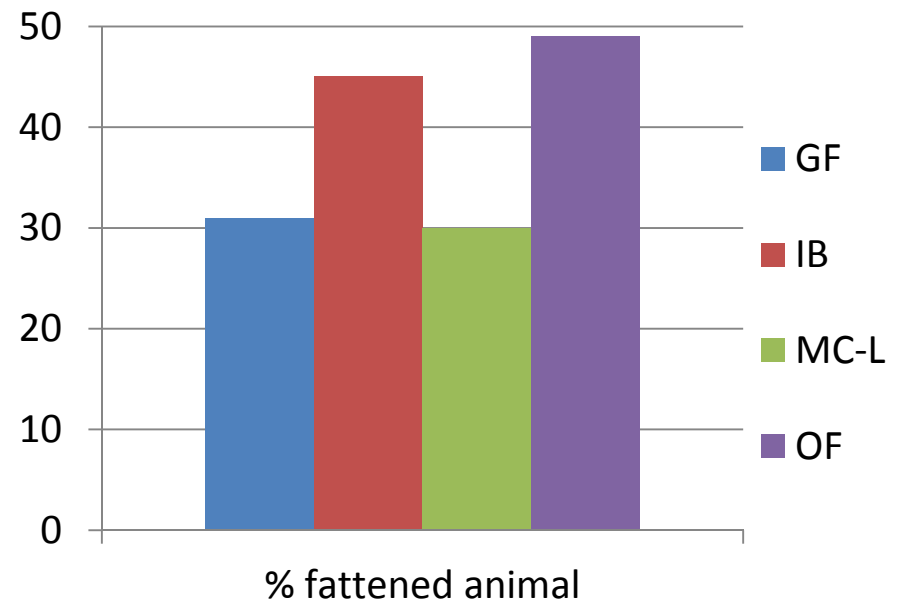
✓ OF: the lowest productivity (-23%)



❖ Type of animals sold

✓ OF and IB fatten more males

✓ MC-L do not fatten their males



Forages area and cropland

❖ Forages

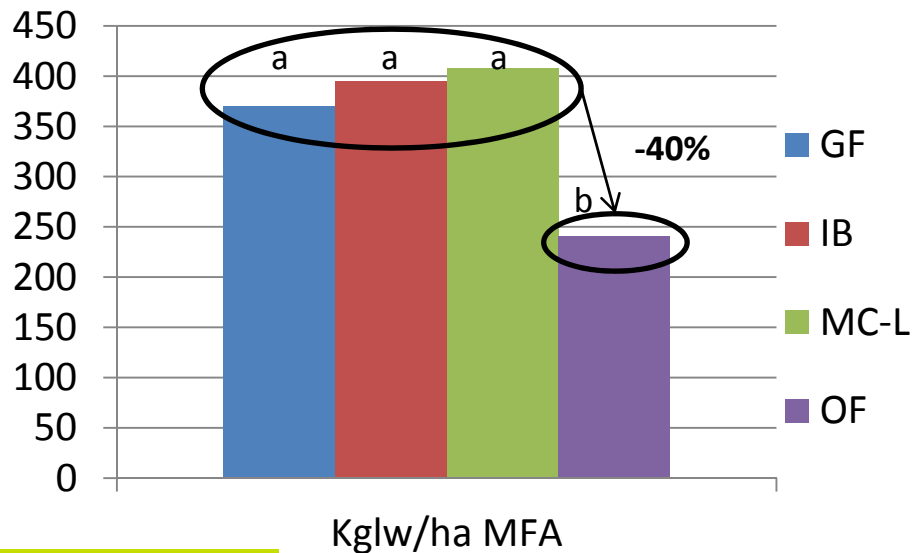
- ✓ Grass: staple forage for the 4 groups. Grazed and conserved grass
- ✓ Conserved grass: hay for GF and OF; silage for IB and MC-L

❖ Cereal yields

- ✓ 5 to 5.5 t/ha for conventional (not different) ; 3.2 t/ha for OF (-40%)

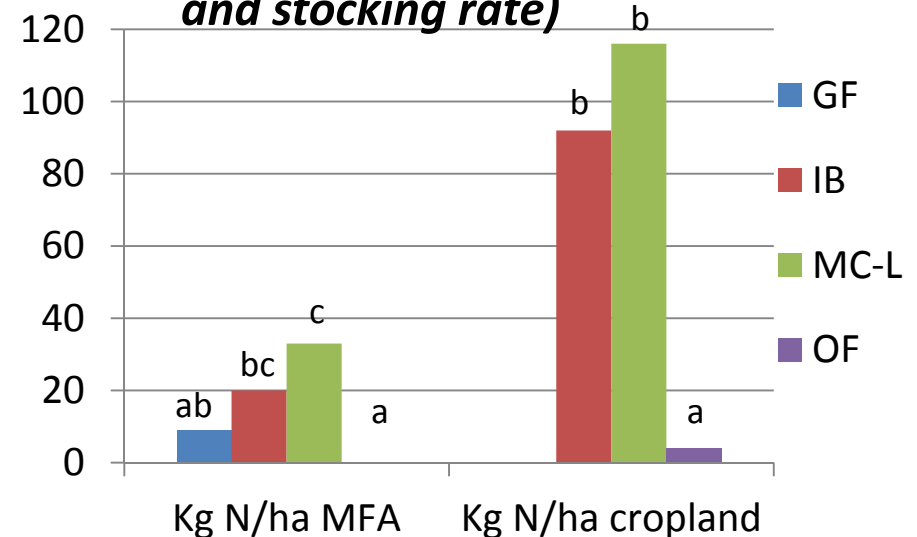
❖ Live weight production / ha

- ✓ Not different for the 3 conventional-system groups



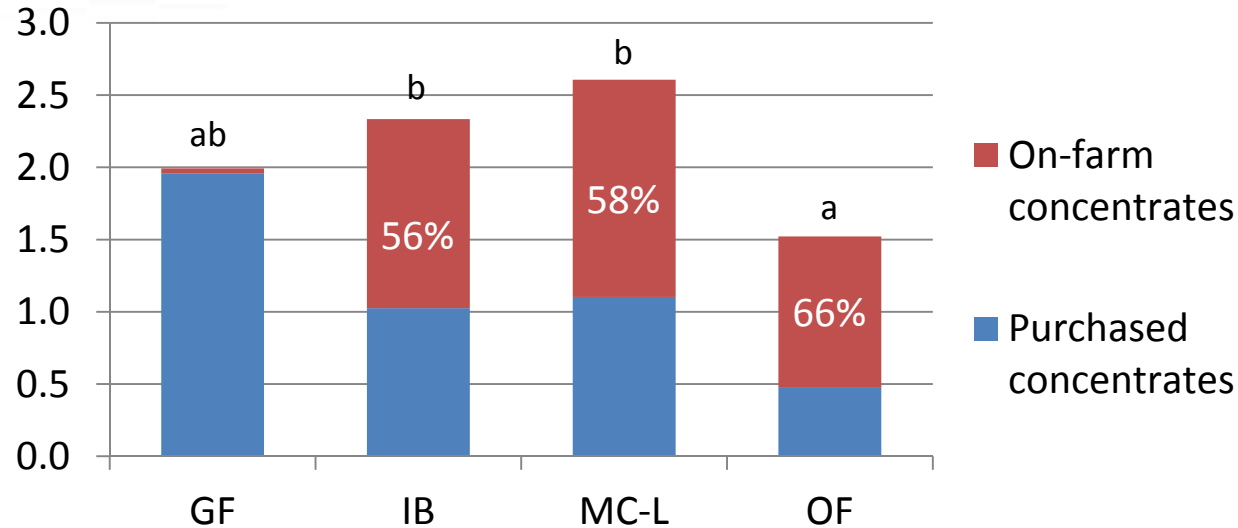
❖ Mineral N / ha

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



Feeding: concentrates

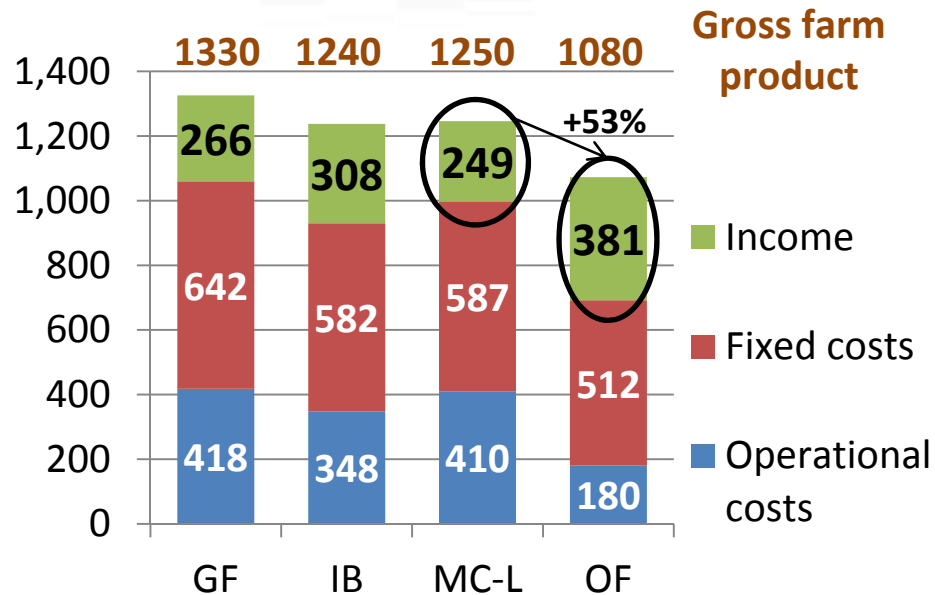
❖ Kg concentrates / Kg live weight



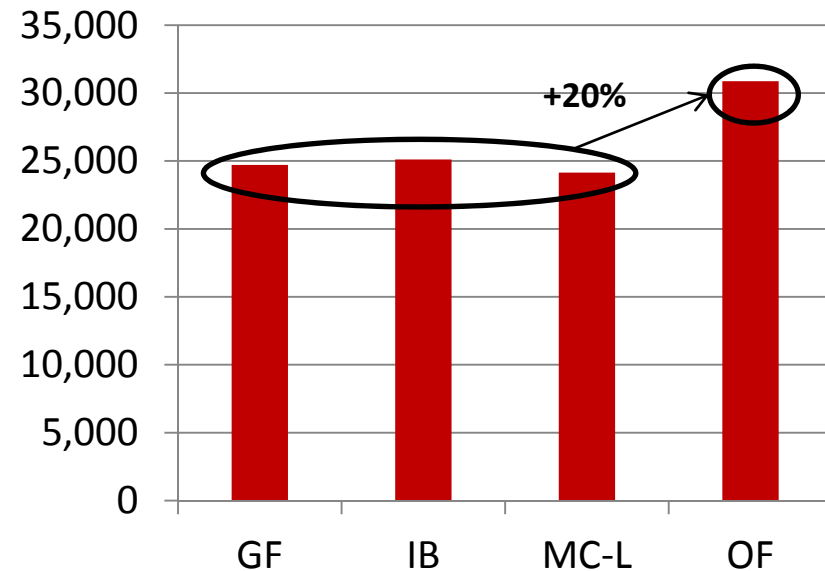
- ✓ Despite having (theoretically) better-quality stored forage, IB and MC-L groups are the heaviest consumers of concentrate per kg of beef produced.
- ✓ MC-L group distributes the highest amount of self-produced concentrates and do not buy less concentrate than the IB group.
- ✓ The use of concentrates 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

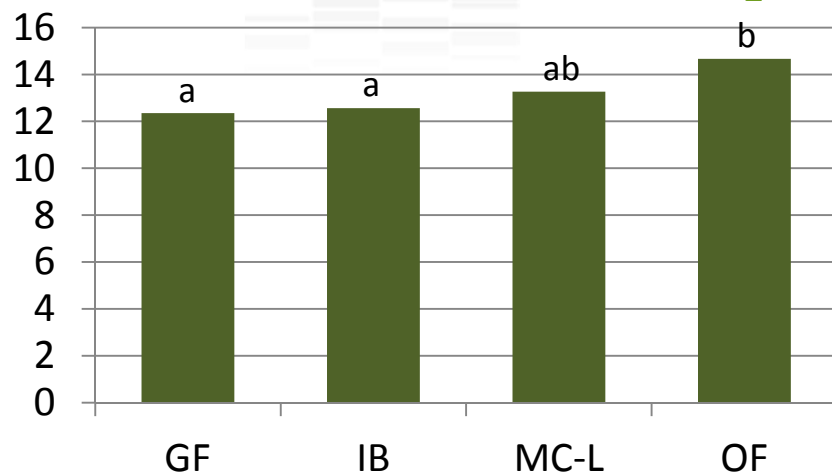
- ✓ Lowest for MC-L (costs/product=80%)
- ✓ Highest for OF (costs/product=65%)

❖ Farm income / worker

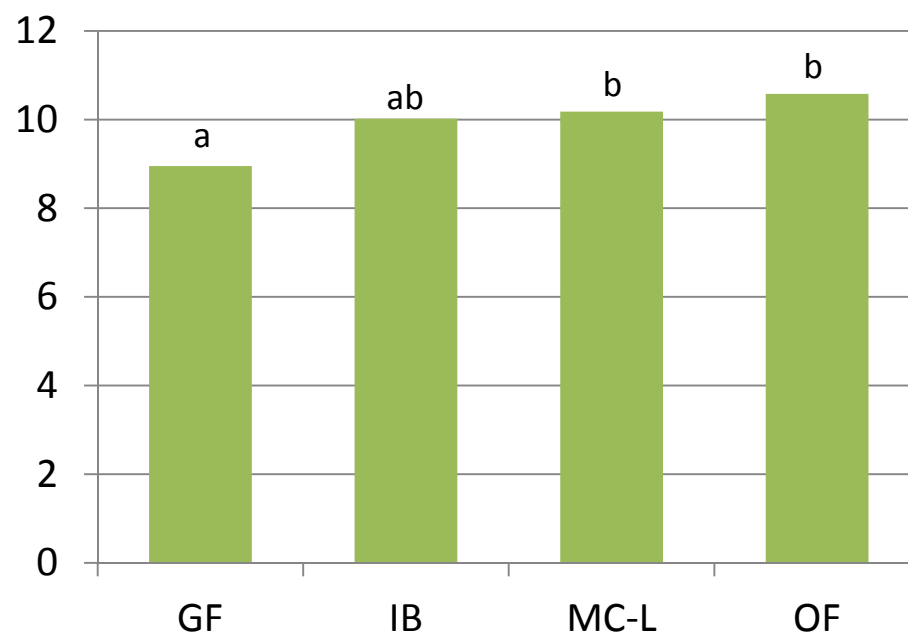
- ✓ 20% higher on OF than on conventional systems
- ✓ MC-L: labour productivity offset the per ha income gap

Environmental performances: GHG emissions

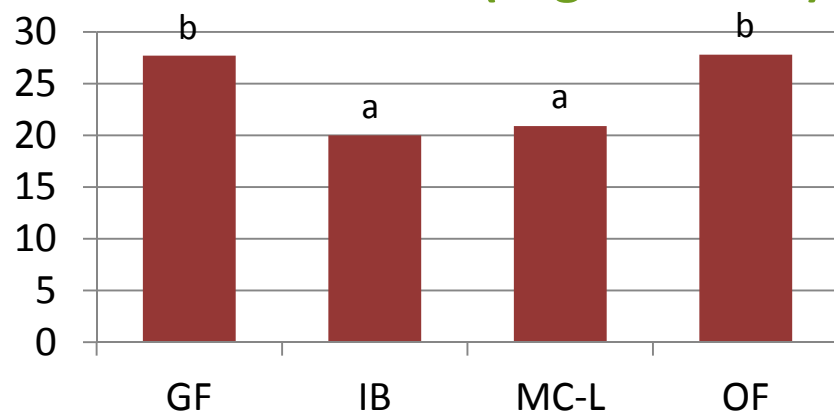
❖ Gross GHG emissions kg CO₂e /kg lw



❖ Net GHG emissions kg CO₂e / kg lw

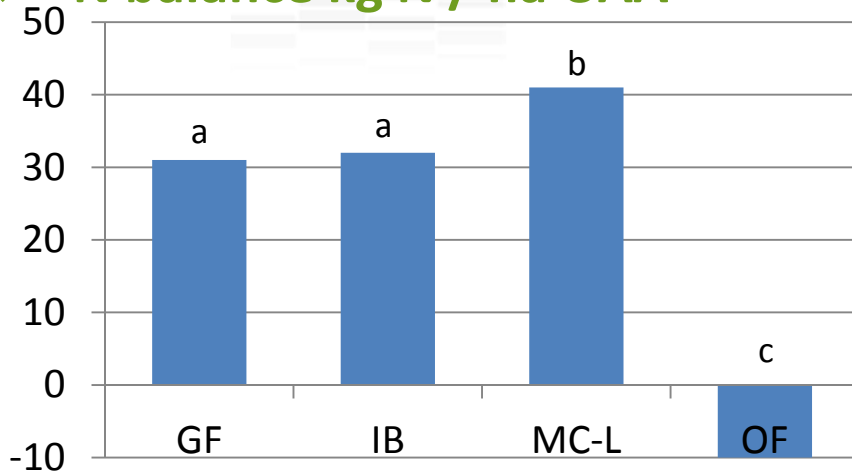


❖ Carbon offset (% gross GHG)

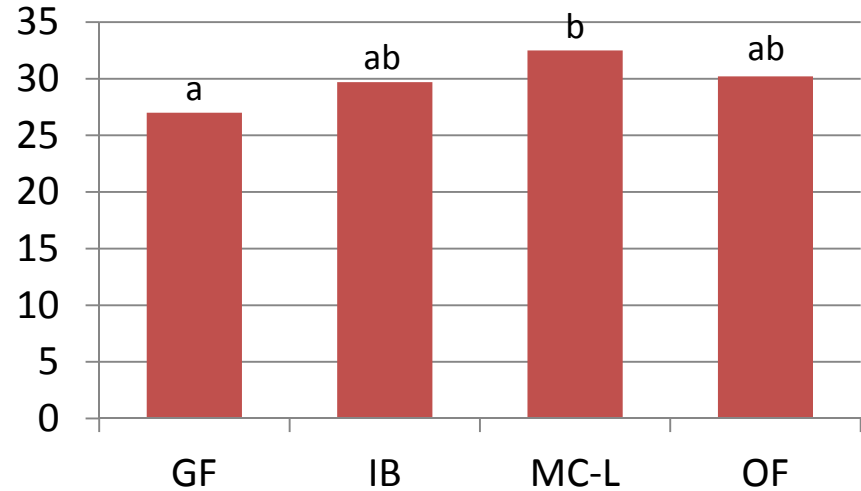


Environmental performances

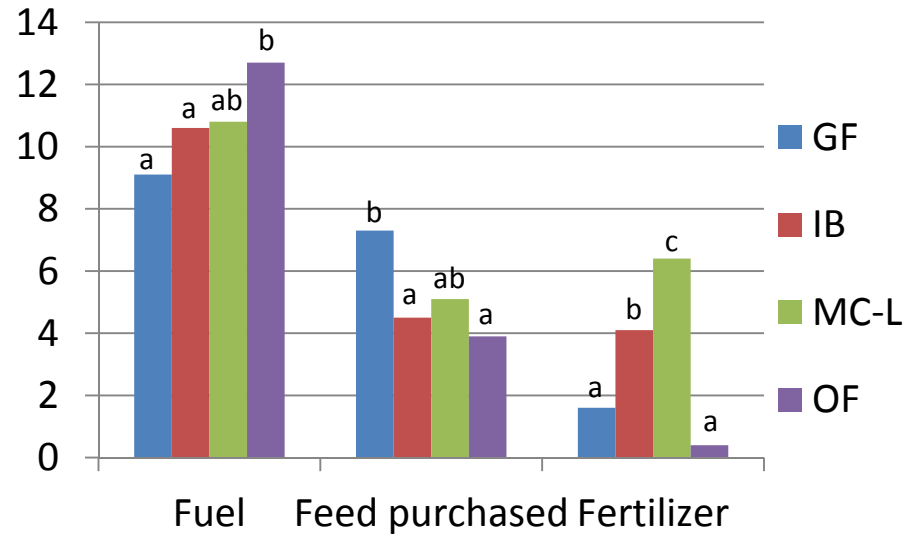
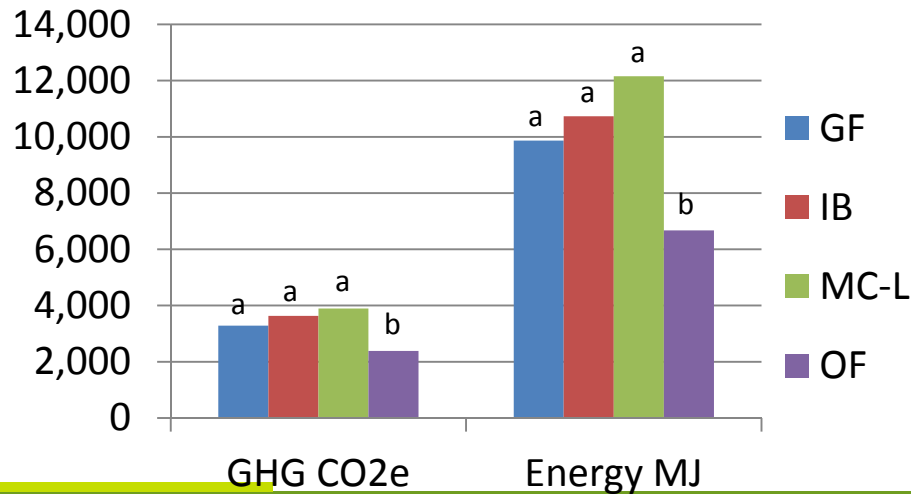
❖ N balance kg N / ha UAA



❖ Energy consumption MJ / kg lw



❖ 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 \neq 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

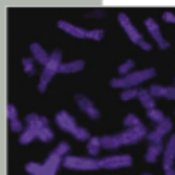
- ✓ Collect and data analysis: diversity of the farming systems, diversity of the territories => importance of the technical-economic performance monitoring farms networks



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Agroecology: integrating animals in agroecosystems

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