HAL open science

Environmental assessment of contrasting French organic vegetable farms

Antonin Pepin, Kevin Morel, Philippe Jeanneret, Marie Trydeman Knudsen, Hayo van Der Werf

To cite this version:

Antonin Pepin, Kevin Morel, Philippe Jeanneret, Marie Trydeman Knudsen, Hayo van Der Werf. Environmental assessment of contrasting French organic vegetable farms. LCA FOODS: 13th International Conference on Life Cycle Assessment of Food, Oct 2022, Lima, Peru. hal-03930547

HAL Id: hal-03930547

https://hal.inrae.fr/hal-03930547

Submitted on 9 Jan 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

LCA FOODS 2022, 12 October 2022

Environmental assessment of contrasting French organic vegetable farms

Antonin Pépin *, Kevin Morel, Philippe Jeanneret, Marie T. Knudsen, Hayo van der Werf
Contact: *antonin.pepin@ctifl.fr*

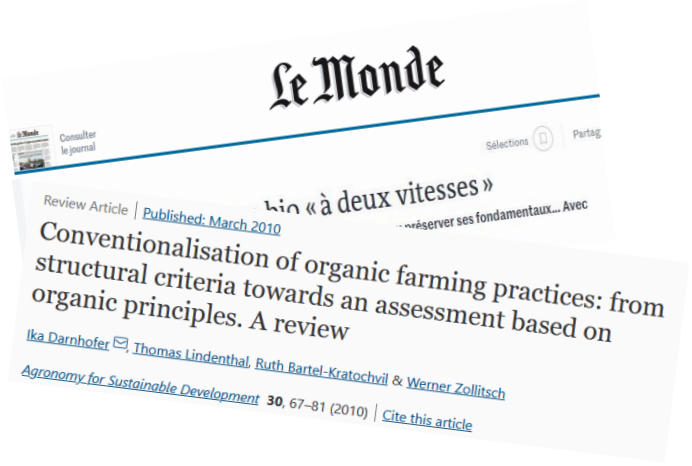
13th International Conference on Life Cycle Assessment of Food

Context

- Diversity of organic vegetable farms (Pépin et al., 2021)
- What are the environmental performances of organic vegetable farms that are contrasted by their agroecological functioning?
- How to assess and compare environmental impacts of organic vegetable farms within the LCA framework, considering their complexity ?

Agroecological organic

Low input
Biodiversity-based
Systemic approach



"Conventionalised" organic

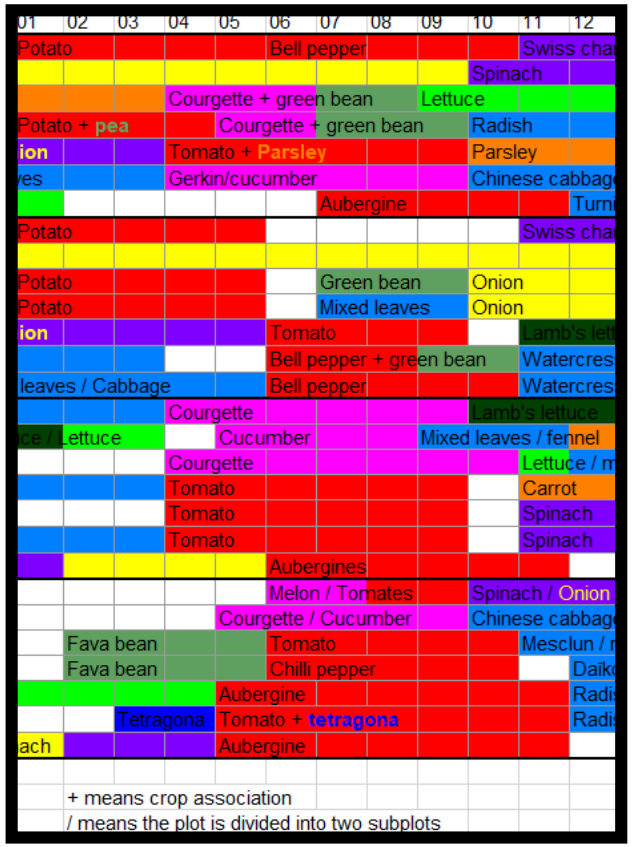
Input-based
Crop approach

LCA FOODS
13th International Conference on Life Cycle Assessment of Food

Method: Farming system approach of LCA

Inputs

All inputs and operations are estimated for the entire farm



Output expressed per kg (and €)

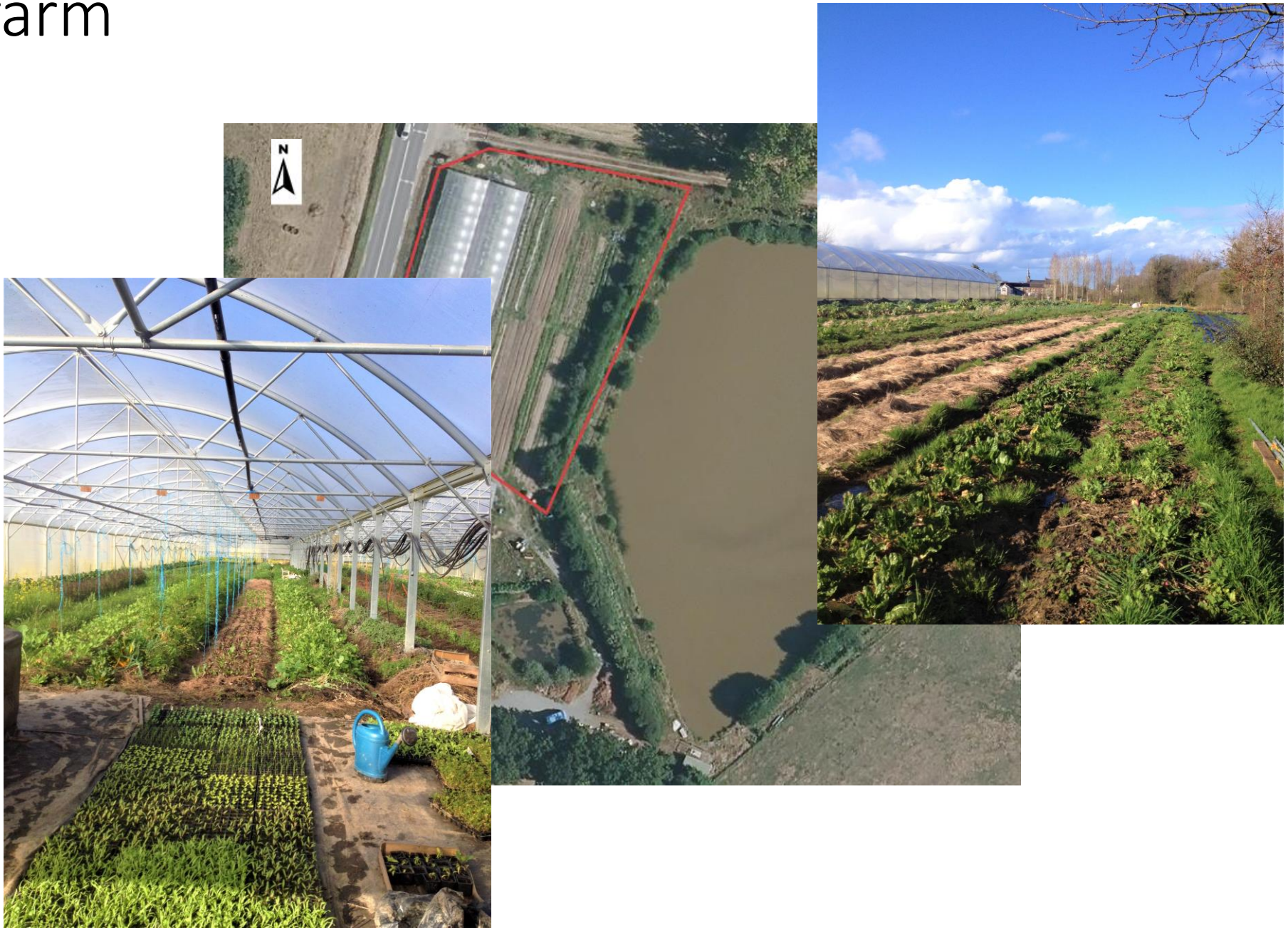
The output is the total production of vegetables

→ Comparison of 3 contrasting farms

LCA FOODS
13th International Conference on Life Cycle Assessment of Food

MF: microfarm

	Microfarm (MF)
Outdoor	0.16 ha
Tunnel	0.12 ha
No. of veg.	35
Yield	35 t/ha/yr
Agroecology	Agroeco ++ Inputs -



LCA FOODS
13th International Conference on Life Cycle Assessment of Food

SP: specialised in sheltered production

	Microfarm (MF)	Sheltered production (SP)
Outdoor	0.16 ha	0 ha
Tunnel	0.12 ha	2.0 ha
No. of veg.	35	6
Yield	35 t/ha/yr	67 t/ha/yr
Agroecology	Agroeco ++ Inputs -	Agroeco - Inputs ++

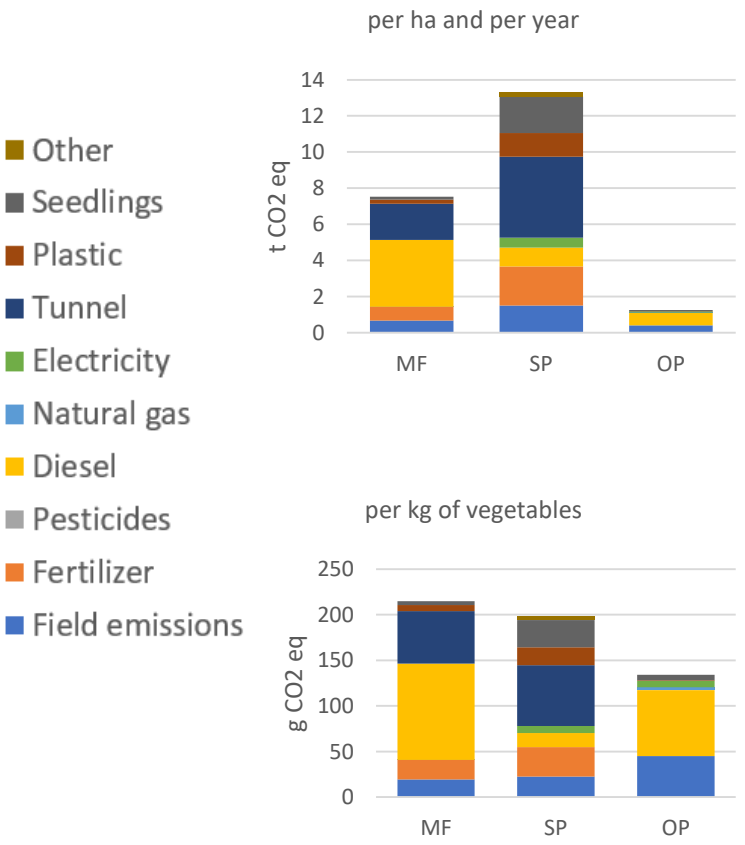
LCA FOODS
13th International Conference on Life Cycle Assessment of Food

OP: specialised in outdoor production

	Microfarm (MF)	Sheltered production (SP)	Outdoor production (OP)
Outdoor	0.16 ha	0 ha	17.5 ha
Tunnel	0.12 ha	2.0 ha	0 ha
No. of veg.	35	6	20
Yield	35 t/ha/yr	67 t/ha/yr	9 t/ha/yr
Agroecology	Agroeco ++ Inputs -	Agroeco - Inputs ++	Agroeco + Inputs +

Climate change

Greenhouse gas emissions
Method: IPCC
Unit: kg CO_2 eq.



Total values

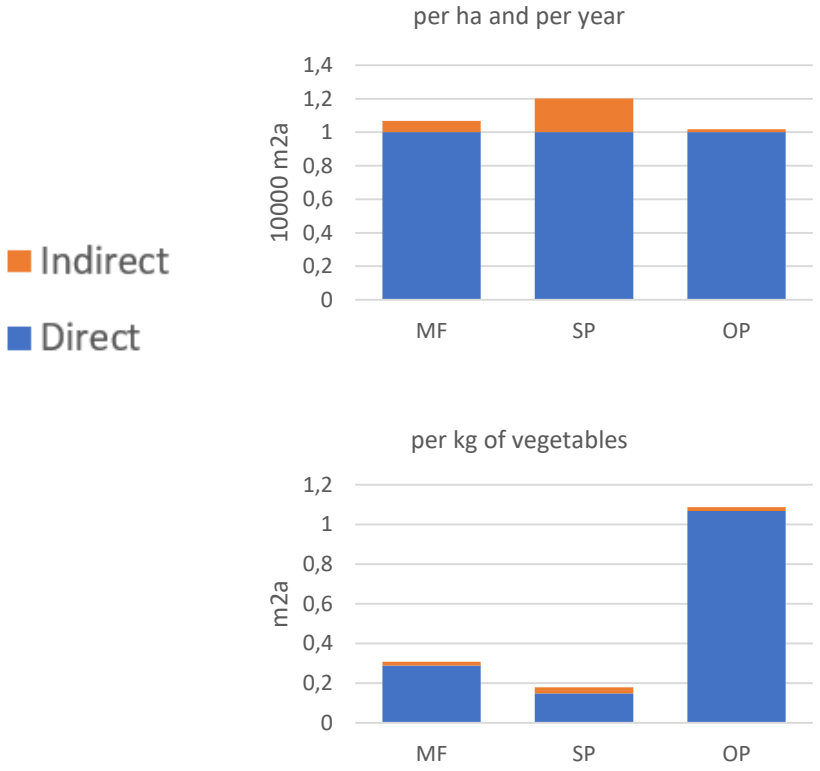
- Ranking depends on functional unit
- Per ha, OP << MF << SP
- Per kg, OP < MF & SP, but smaller differences
- Higher productivity per ha does not fully compensate the higher impact of SP

Contribution analysis

- Microfarm (MF):
  - Diesel 49% (irrigation + tractor)
  - Tunnel 27% (steel + plastic)
- Sheltered farm (SP):
  - Tunnel 34% (steel + plastic)
  - Fertiliser 16% (fabrication)
  - Seedling production 15% (gas heating of nursery)
- Open field farm (OP):
  - Diesel 54% (tractors)
  - Field emissions 34% (N_2O)
- Different environmental profiles → different hints for eco-design / redesign

Land competition

Land occupied by the system
Method: CML-IA non-baseline
Unit: m^2a

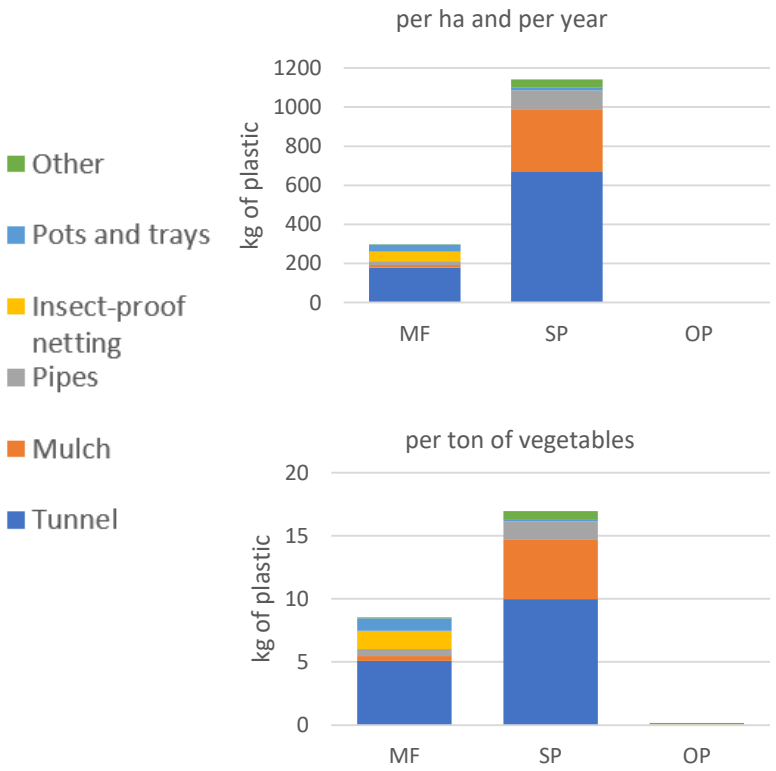


- Per ha, same impact: little indirect land
- Per kg, OP has the largest impact
  - 1 cycle/year
  - Lower yields
- Trade-off: land competition vs. climate change

LCA FOODS
13th International Conference on Life Cycle Assessment of Food

Plastic use

Method: the sum of plastic used on the farm or contained in its inputs
Unit: kg of plastic

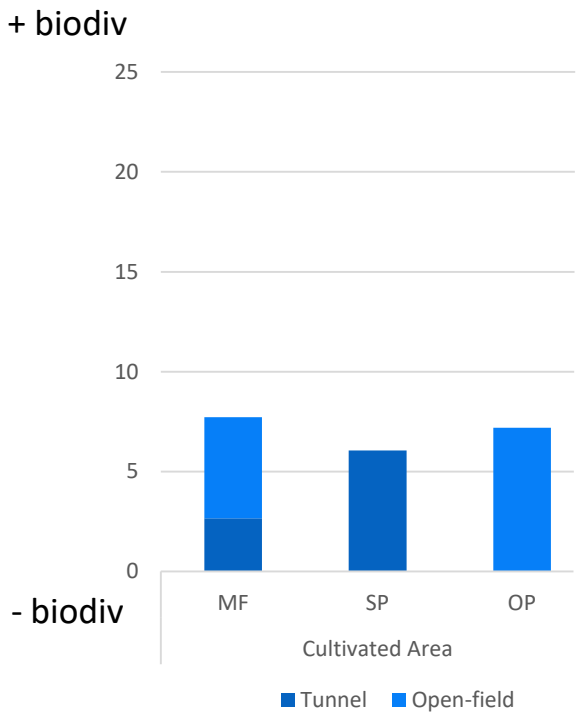


- Growing concern in horticulture
- SP >> MF >> OP
  - Tunnel (SP & MF)
  - Single-use plastic (mulch, pipes) (SP)
  - Reusable plastic (MF)
  - Scale issue?
- Indicator combining all types of plastic and uses (single-use, hardware, in/out of soil, etc.)
  - Probably not the same impact
  - Indicator to be improved
- Not an LCA indicator: use, not impact
  - Microplastics in soil and water

- Plastic pollution in LCA: emerging topic
  - Recognising the long-term impacts of plastic particles (Gontard et al., 2022).
  - Create LCA indicators for plastic pollution (Lavoie et al., 2021; Saling et al., 2020; Woods et al., 2021).

Biodiversity

SALCA-BD (Jeanneret et al., 2014)
An expert system based on scientific literature
Based on a detailed inventory of farming practices



- On cultivated areas, small differences: MF & OP > SP
  - Sensitivity of SALCA-BD within organic ?
- On whole farms, including semi-natural areas: SP > MF > OP
  - Large fields → low field perimeter:area ratio (OP)
  - Large area of ruderal areas between tunnels (SP)
- Importance of semi-natural areas (hedges, extensive grassland, etc.) for biodiversity
- Question of spatial farm boundaries (MF)

Conclusion

System LCA approach

- A response to the challenge of complexity
- Corresponds to agronomic systemic approach
- Corresponds to data availability
- Complicates estimating impacts of a given vegetable, as in a "product LCA" (allocation issues)…
- …but which, in any case, does not correspond to the rationale of the farms : the carrot needs the lettuce and vice-versa !

LCA of organic farming

- Impact of organic fertilisers
  - Fertiliser emission modelling
  - Fertiliser manufacturing data
  - Fertiliser production
  - Multifunctional composting operation: choices for allocation
- Plant-protection products
  - Biocontrol treatments
  - Insects for biocontrol/pollination
  - Need for references

Montemayor et al. (2022)

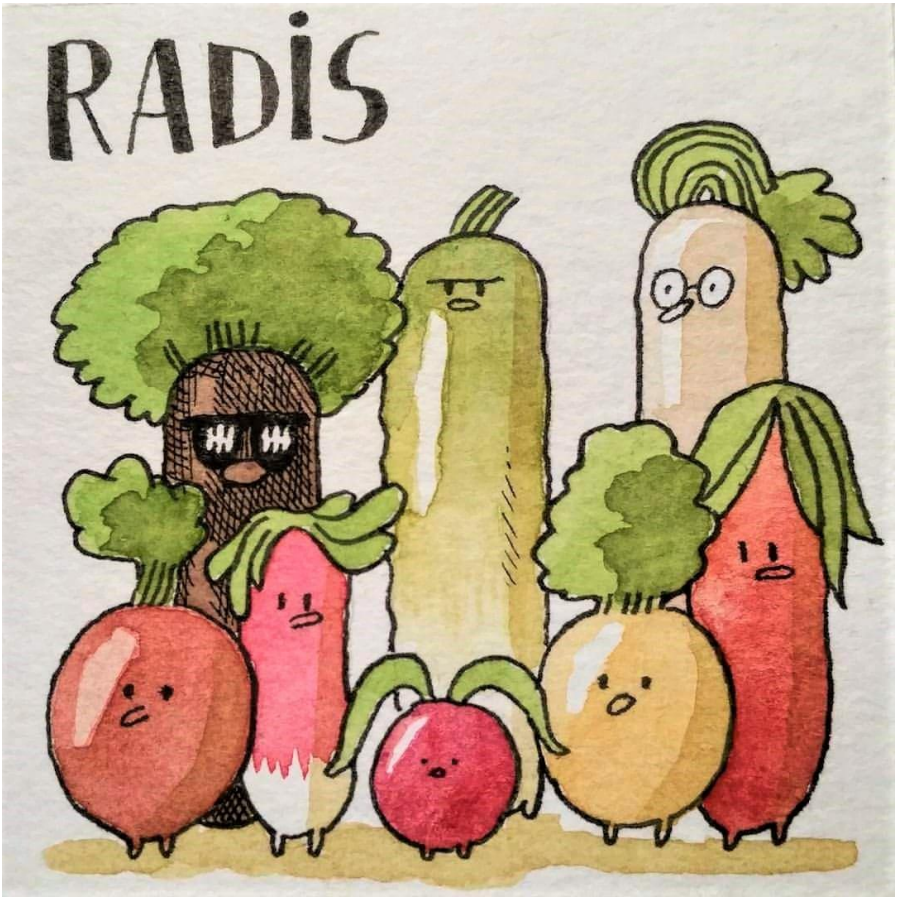
Conclusion: environmental impacts

- No clear ranking of the farms, depends on the indicator and the FU
  - Climate change & plastic: inputs
  - Land occupation: yield
  - Biodiversity: semi-natural areas, field size

→ Find the best trade-off
Design of farming systems

- Complementarity of the systems
  - Vegetables / Markets
  - Responses to different environmental issues
  - Matter of choice : vision of farming

- Farm-specific effects / case study
  - MF: diesel vs. electric pump
  - SP: plastic tunnel vs. glasshouse
  - OP: use of plastic mulch



Guillaume Long

Thank you !

LCA FOODS
13th International Conference on Life Cycle Assessment of Food