Environmental assessment of contrasting French organic vegetable farms

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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

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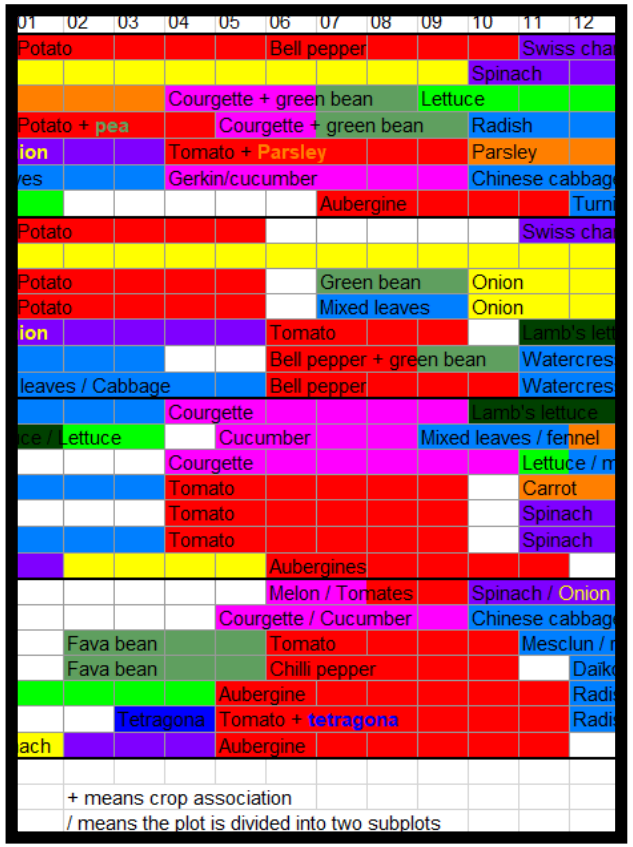
Method: Farming system approach of LCA

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

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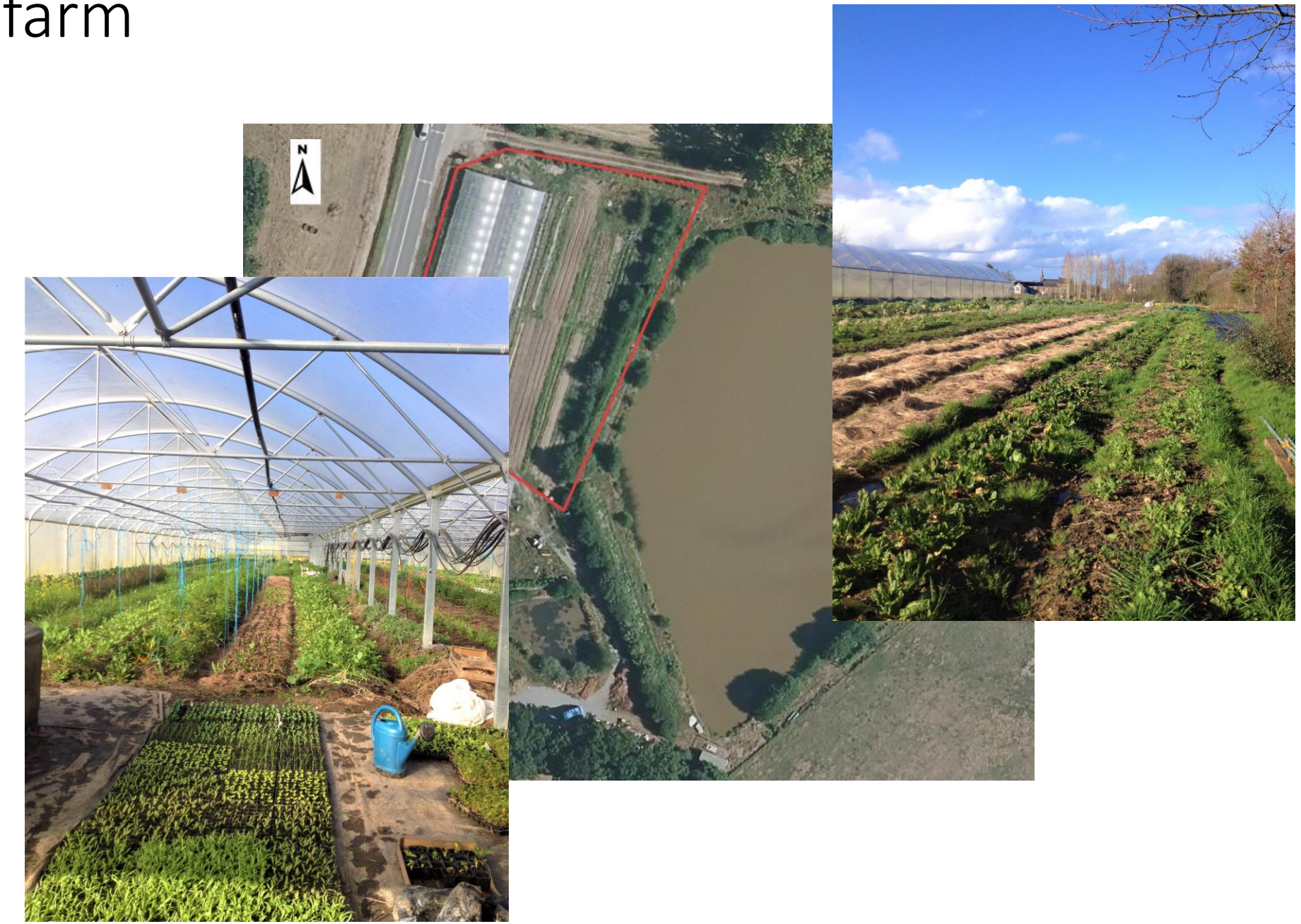
MF: microfarm

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



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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 ++

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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 +

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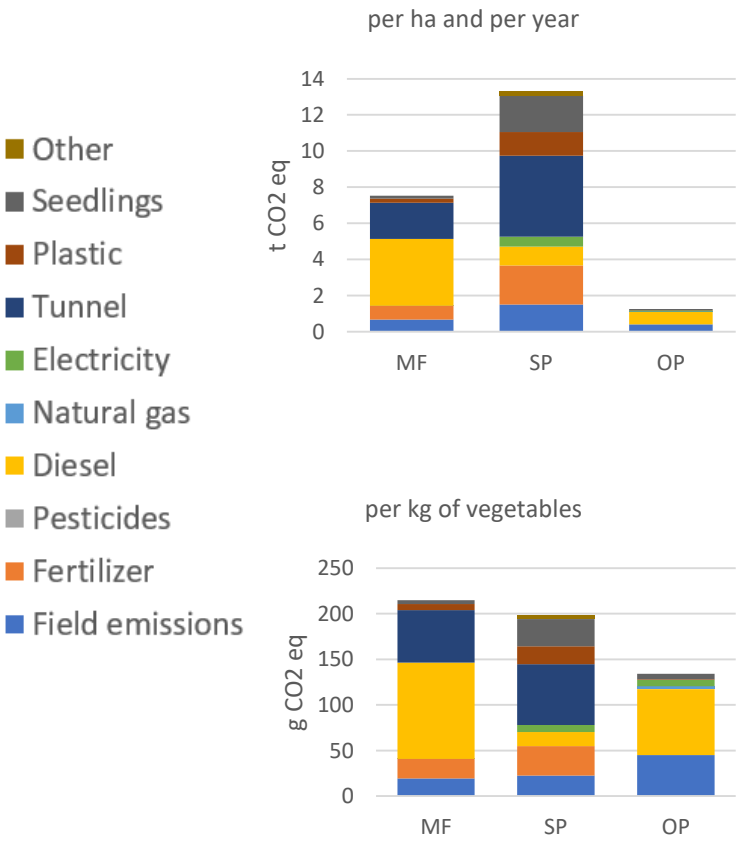
Climate change

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

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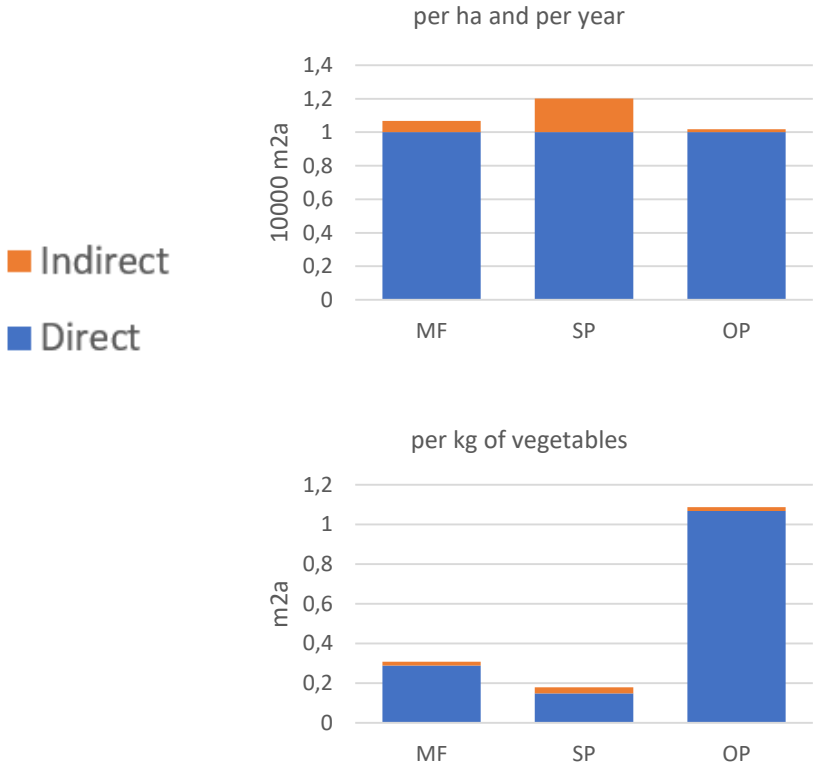
Land competition

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

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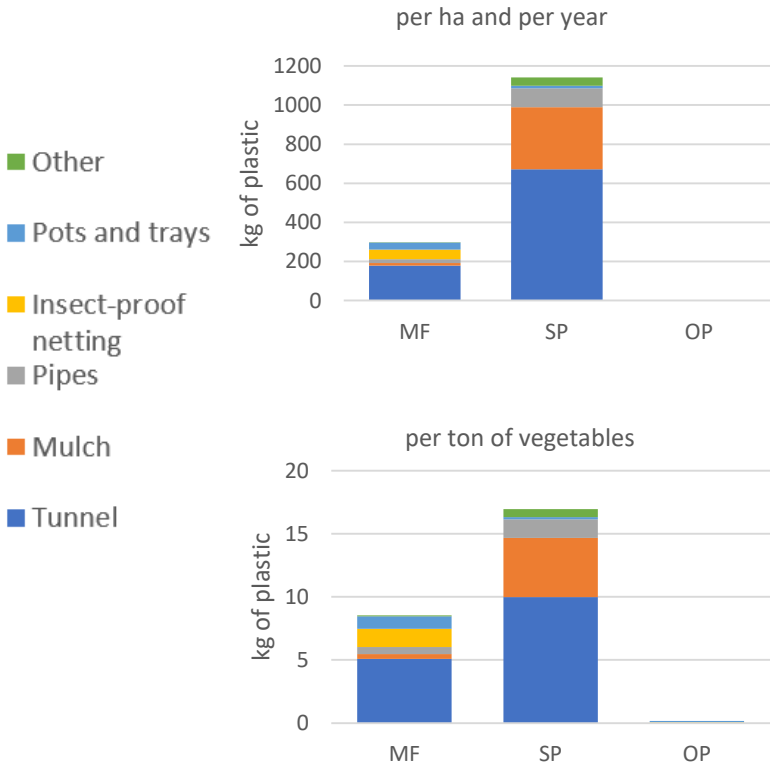
Plastic use

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).

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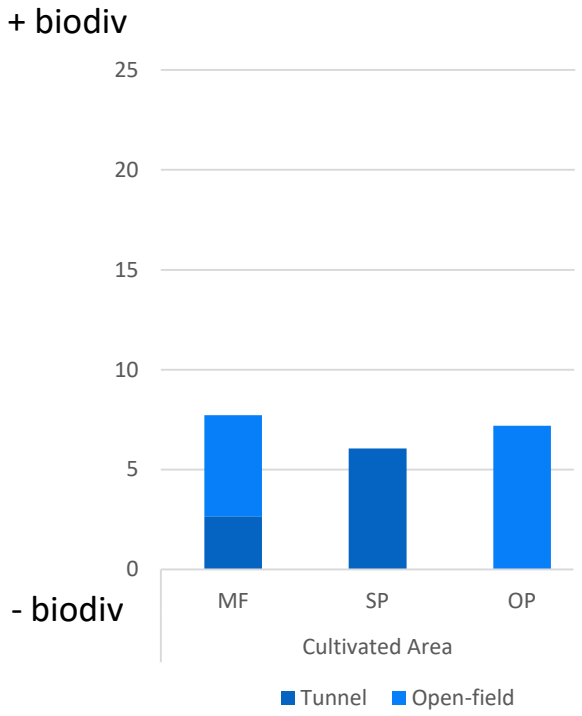
Biodiversity

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

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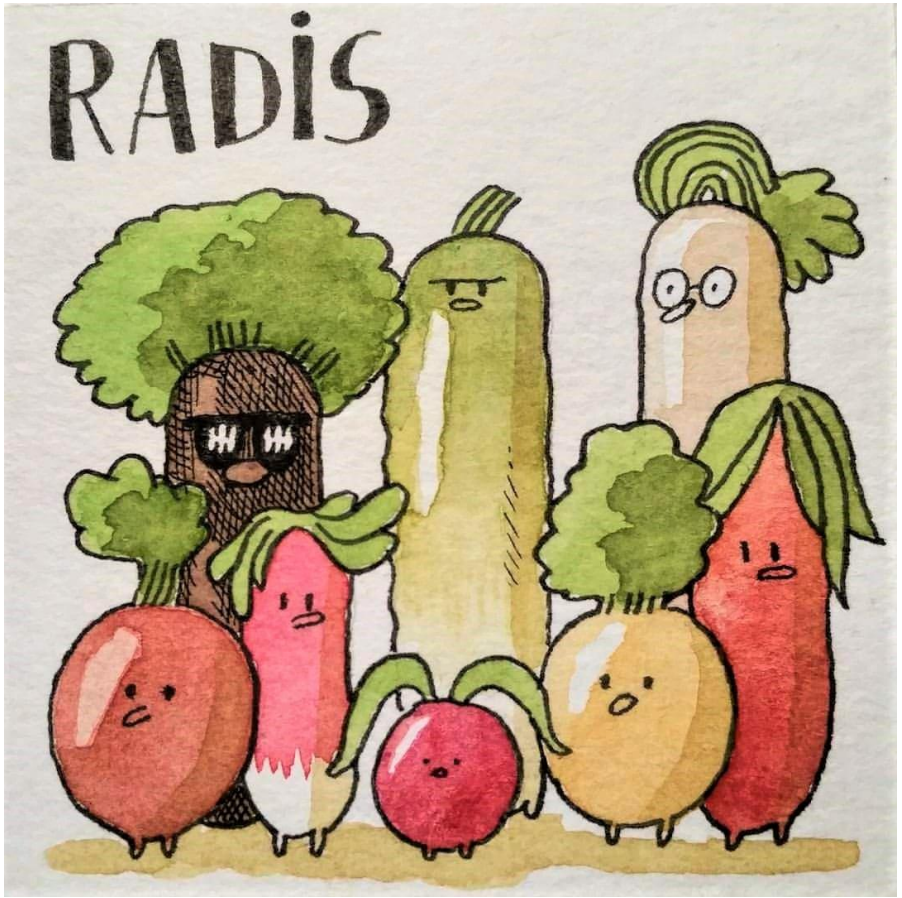

Guillaume Long

Thank you !

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