Recycling organic wastes in agriculture, a step towards bioeconomy and agroecology : an example in Paris area

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Introduction : mineral fertilization

- Development of mineral fertilization in the XX[th] century allowed a strong increase in crop production and world population
- Some drawbacks:
  - GHG emissions (N fertilizer production from fossil gas, field N_2O)
  - P and K : limited fossil resources
  - Economic burden for farmers
  - Decoupling between breeding areas and crop production areas :
    - Excess of livestock effluents in breeding areas
    - Decrease in soil fertility in arable crop areas and overuse of mineral fertilizers

Mineral N fertilizer production
Les Echos

P mining
Le Monde - Reuters

Introduction: organic wastes (OW)

- Production of OW by different activities
  - Agriculture (breeding): solid manure, slurry
  - Cities: green waste, food waste, sewage sludge…
  - (Agro)industry: papermill sludge, slaughterhouse residues…
- OW needed to be treated / valued for sanitary concerns
- Different value chains :
  - Not associated with agriculture : incineration, landfilling, home composting…
  - Application in agricultural fields, raw or after treatments (composting, anaerobic digestion…)

Introduction

- How the recycling of OW in agriculture may contribute to agroecology and bioeconomy?
  - Mineral fertilizer substitution, increased soil fertility?
  - Environmental impacts (contaminants, GHG emissions)?
  - Environment-friendly compared to alternative waste treatments?
  - Which potential at larger scales beyond field scale study?

→ Long term studies required

→ Whole value chain to study (from waste treatment to field application)

→ Specificities of each landscape to consider (soil, climate, cropping system, available OW and treatments…)

Examples of researches conducted in ECOSYS lab

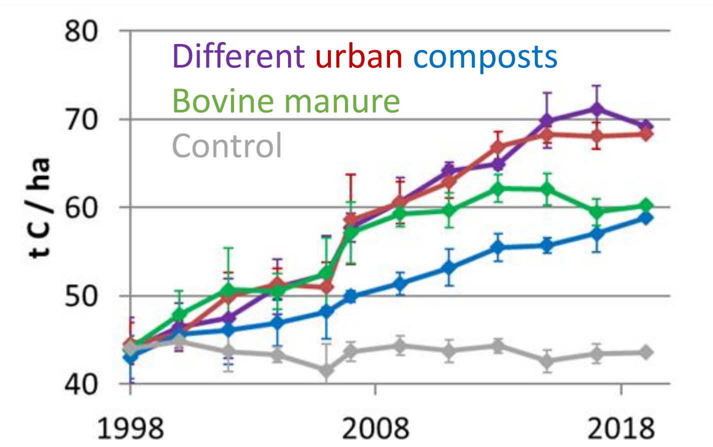
1) Long-term field experiments to assess the multiple effects of OW at the field scale

2) Source separation of human urine for the production of renewable fertilizers

3) Assessment of the potential of OW recycling at the landscape scale

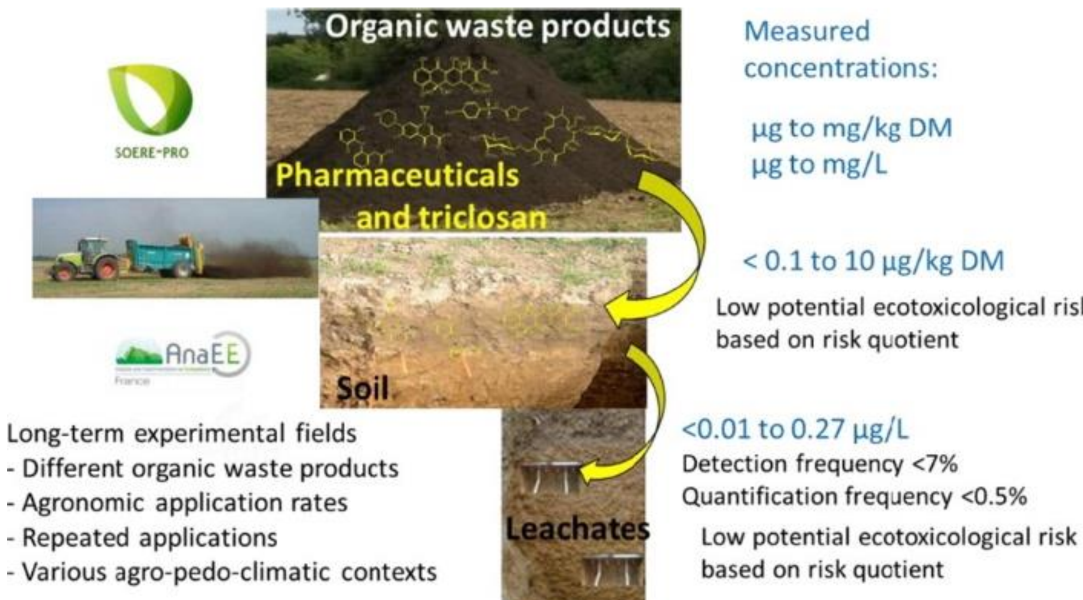
Long-term field experiments to assess the multiple effects of OW at the field scale

- Soil organic carbon increase (Chen et al., 2022, Levavasseur et al., 2020)
- Improved soil biological and physical properties *(Sadet-Bourgeteau et al., 2018, Paradelo et al., 2019)*
- Mineral fertilizer savings and improved / maintained crop yields *(Chen et al., 2022)*



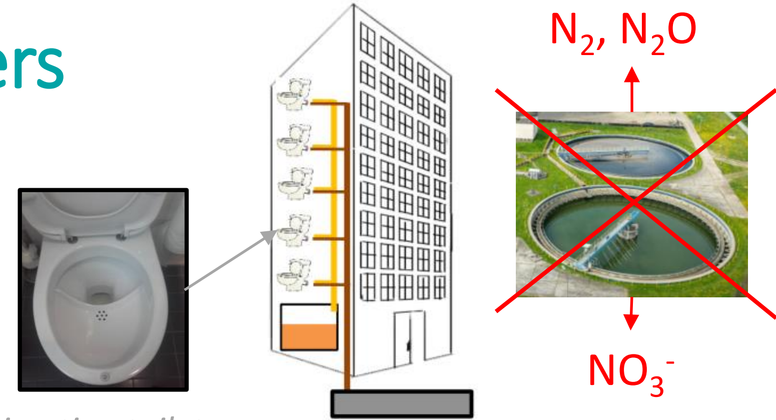
SOC stocks with repeated OW applications in QualiAgro experiment

- Monitoring of the fate and impacts of pharmaceuticals *(Bourdat-Deschamps et al., 2017)* → ecotoxicity?
- …



Human urine for renewable fertilizers

- Source separation to collect human urine :
  - Avoids N losses at the WWTP
  - Recycles N in agriculture



Diverting toilets

- Field experiments showed a high fertilizer efficiency, despite a high potential of ammonia volatilization

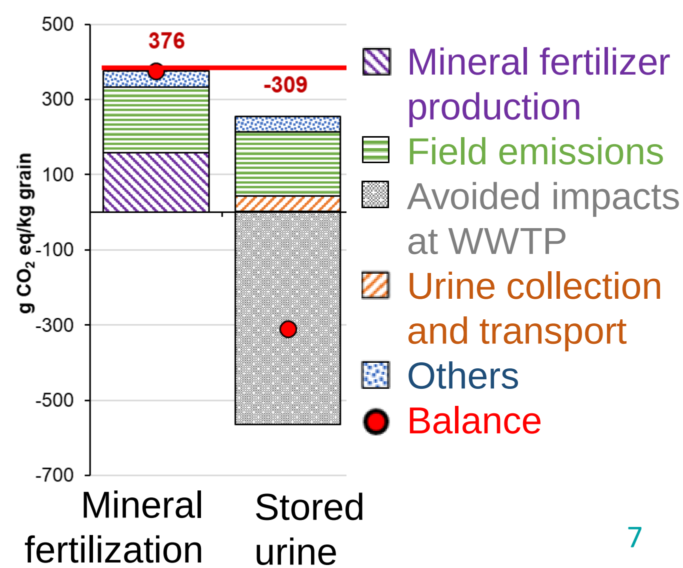
Urine application on wheat

- High improvement of the greenhouse gas balance of wheat production

- Further studies needed (urine treatments, organic contaminants…)

GHG balance of wheat production with mineral fertilization / urine

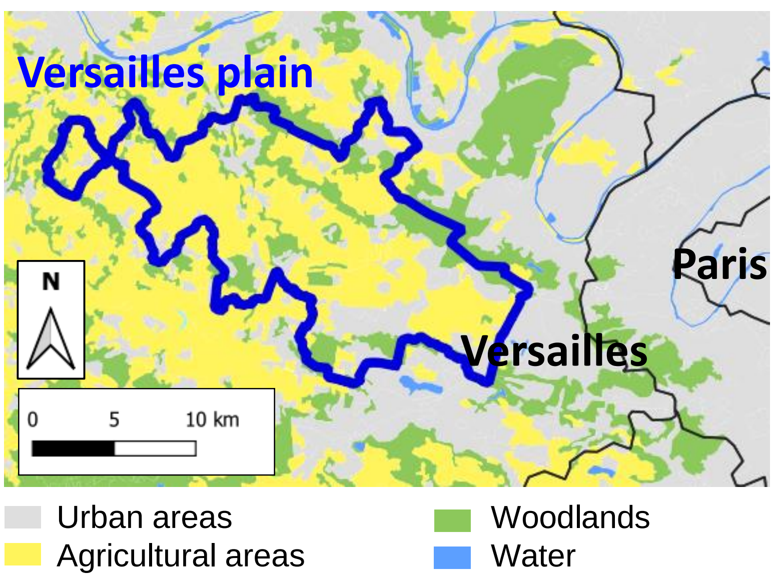
(Martin, 2020)



Potential of OW recycling at the landscape scale

- Versailles plain: 24 000 ha, located 15 km west from Paris
- Mainly agricultural areas (≈ 60%), but surrounded by urban areas
- Mainly arable crops, with high fertilizer needs
- A hub for urban OW : green waste, horse manure, sewage sludge, food wastes…
- Can OW production meet the agriculture needs (C, N, P, K)?

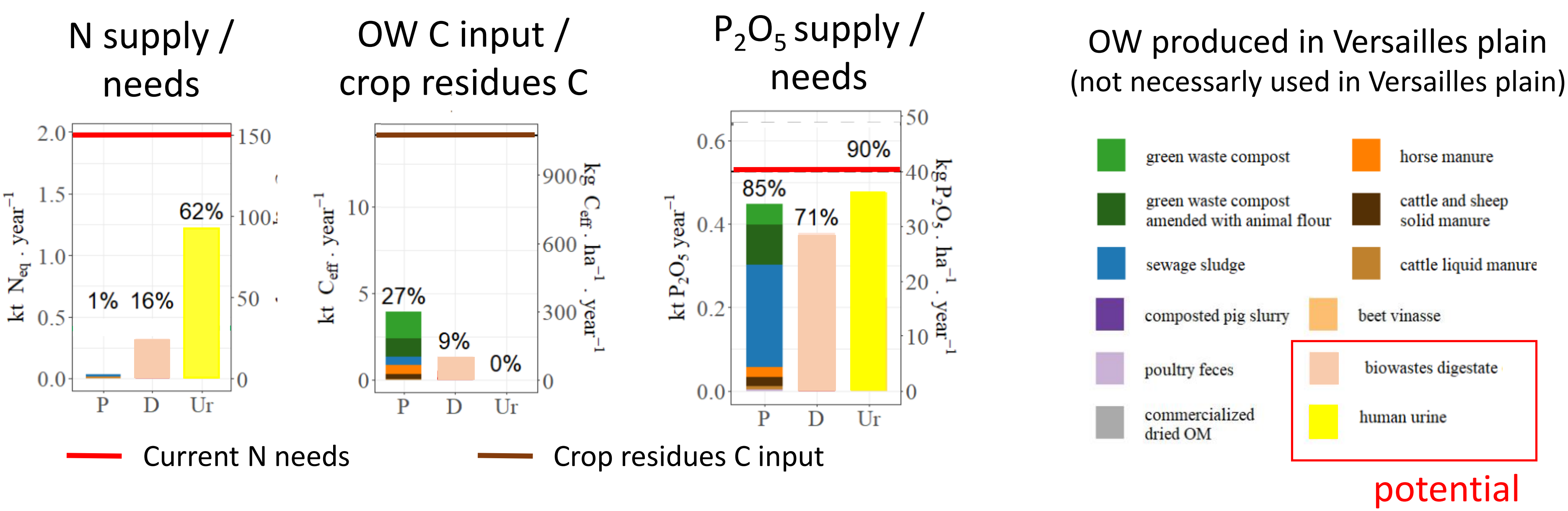
→ Inventory of current and potential OW production and use, based on stakeholders surveys and existing databases *(Moinard et al., 2021)*



Green waste composting (Sepur)

Potential of OW recycling at the landscape scale

- Phosphorus from currently produced OW ≈ P agriculture needs
- Carbon input from OW not negligible compared to crop residues C
- Current OW (composts…) not suitable for short-term N supply, but high potential of biowaste digestate and human urine



Moinard et al. (2021)

Conclusion

- Agriculture needs renewables fertilizers to sustain the current production in the future

- Recycling OW in agriculture:
  - Positive effects for agriculture (soil fertility, nutrient supply…)
  - Some drawbacks to limit (soil contamination…)
  - Each territory with its specificity in terms of OW recycling potential
  - Often the OW disposal with the best environmental balance

- OW recycling in agriculture necessary to address agroecology and bioeconomy, but:
  - Limiting the amount of OW produced should be the priority
  - Won’t be sufficient for sustainable food systems

Thanks for your attention

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