Talk at Prix Technologies Numériques 2025

Smart farms for different agricultural practices?

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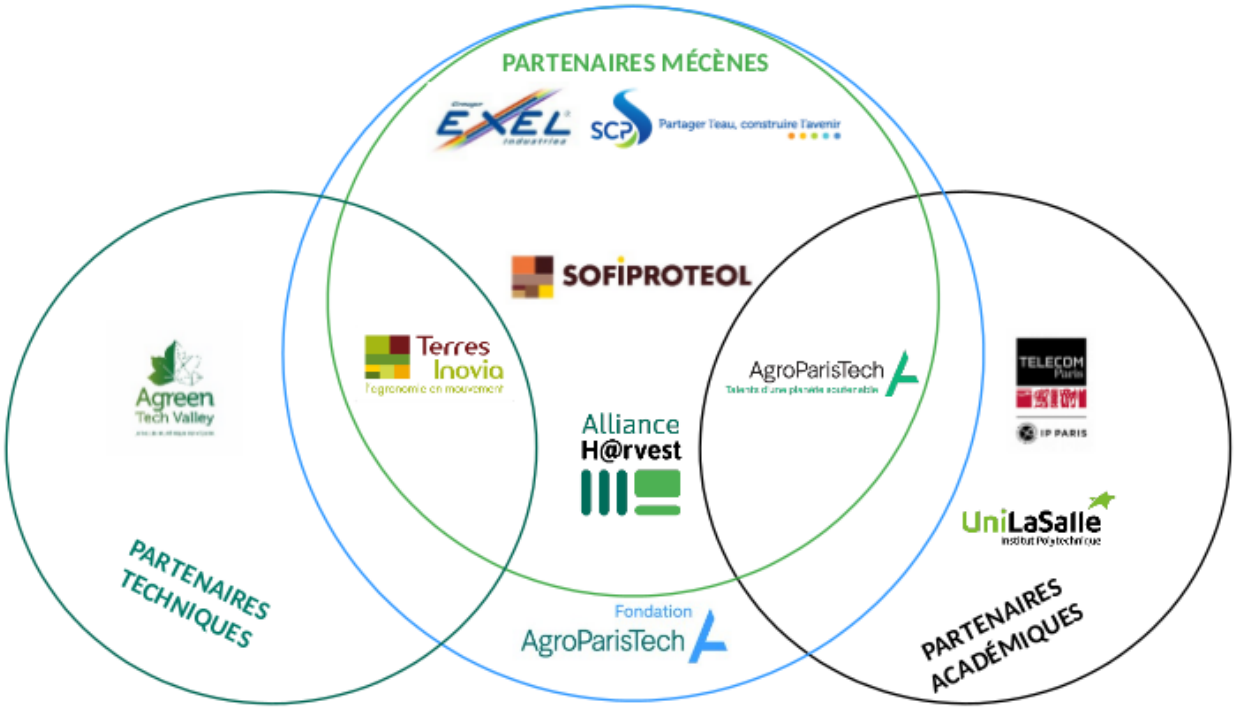
Harvest chair



Goal

Analyze and evaluate digital technologies leading to a more resilient and sustainable food production

Chair's activities

- Thoughts on teaching tracks
  - Convince students for digital agriculture
- Help to set up research projects
  - Example: Twinfarms
- Annual research symposium
  - 2024: "Future sensors: opportunities for next-generation agriculture"
  - 2025: "Agriculture and data sciences"
  - 2026: "Strategies for using digital tools"

Twinfarms project

- PEPR : "Agroécologie et Numérique" (lead: INRIA)
- Starting date: Feb 1st, 2025 for 48 months
- Budget: 3M€
- Partners: AgroParisTech, Telecom Paris, UniLasalle, Agricultural institutes (for use cases), some start up

Goals: Digital twin for different types of farms

- Design of decision-making algorithms
- Evaluation of different farms' configurations
- Promote agro-ecological transition

Some use cases

- Crop irrigation: joint multi-farms irrigation optimization
- Grass management in livestock farm for fertilizer and carbon fingerprint trade off
- Early diseases' detection in vineyards
- Livestock effluent trade off between fertilization and energy production
- Multi-criteria evaluation for farms in transition

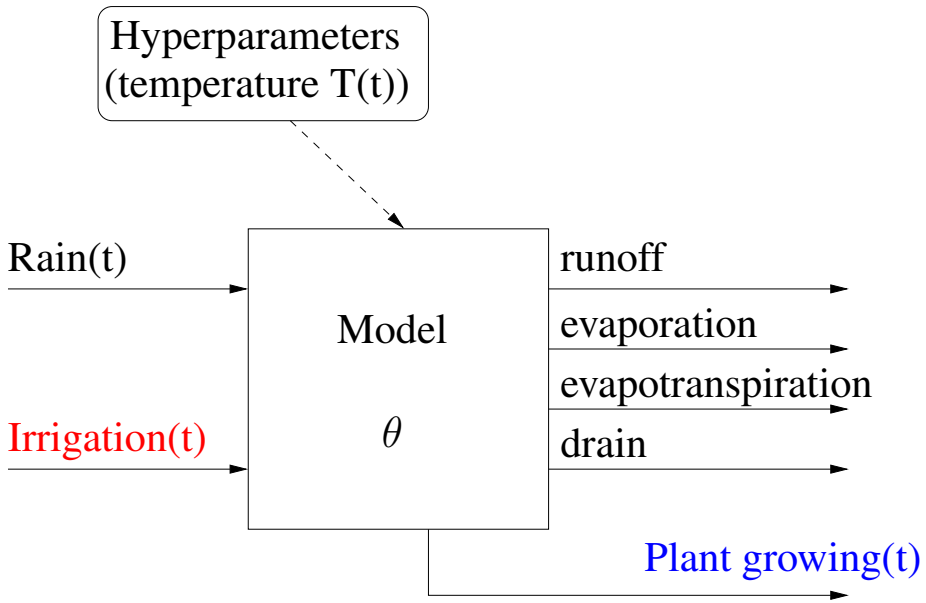
Crop irrigation

- Many mathematical models
  - Optirrig toolbox
- Few data for training
- Some collected data for monitoring (Sentinel satellite, Weather forecast, Soil properties)

Approaches for optimal irrigation policy

- Model-driven: if stationary $\rightarrow$ Markov-Decision process
- Data-driven: here, hybrid technique such as Physically-Informed Neural Network (PINN) in Reinforcement Learning setting

Crop irrigation (cont'd)



$$
\begin{aligned}
\dot{s}(t) &= -\phi(t)k_1 K_p(s(t)) \\
&- (1-\phi(t))k_1 K_s(s(t)) \\
&+ k_2 u(t) \\
\dot{b}(t) &= \phi(t) K_p(s(t))
\end{aligned}
$$

with $s(t)$ soil moisture, $b(t)$ plant biomass, and K_p plant transpiration, K_s soil evaporation

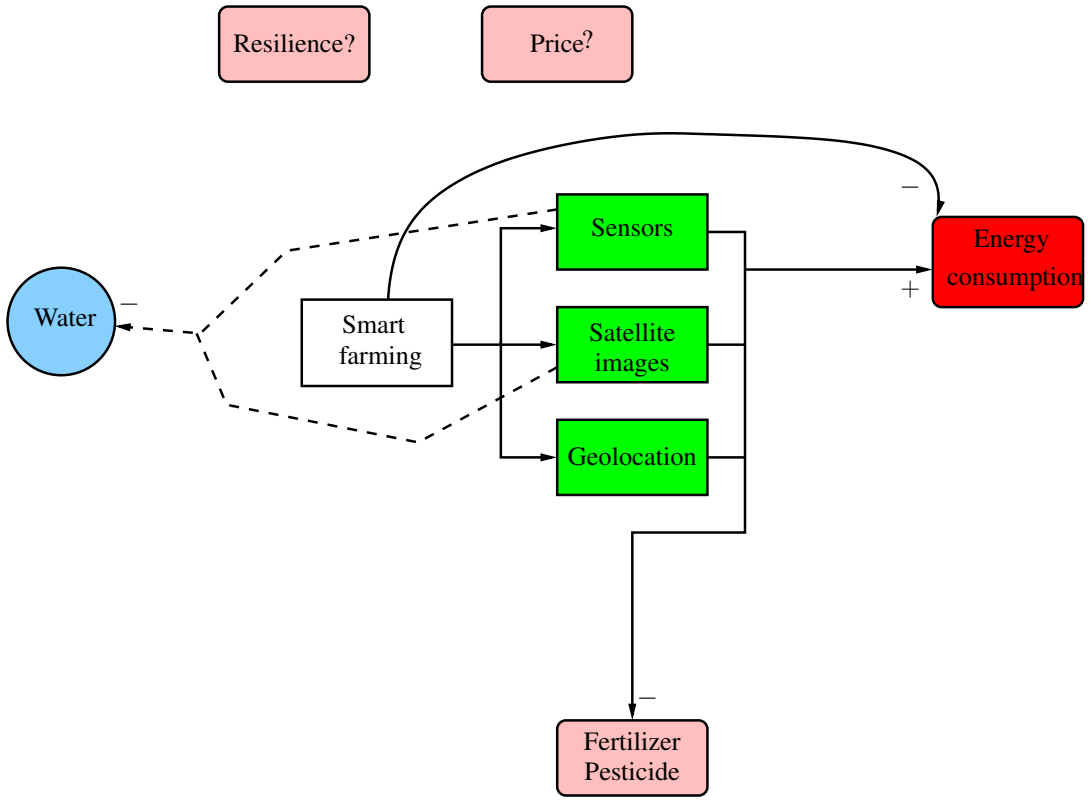
- Main novelty: multi-plots and even multi-farms
- Additional constraint: equipment management
- Optimization: water management with minimum yield

source: R. Chenevat et al., "Optimal structures of crop irrigation strategies with state constraints", Jnl of Optimization Theory and Applications2025

Chart for Smart farming

Today, the reasoning is

- First, increase of yields
- Second, fertilizer/water decrease but failure of Ecophyto plan



source: http://www.ofb.gouv.fr ; J. Oui, "Produire une faute -conforme-. Outils numériques et normes environnementales en agriculture", Sociologies Pratiques, 2024

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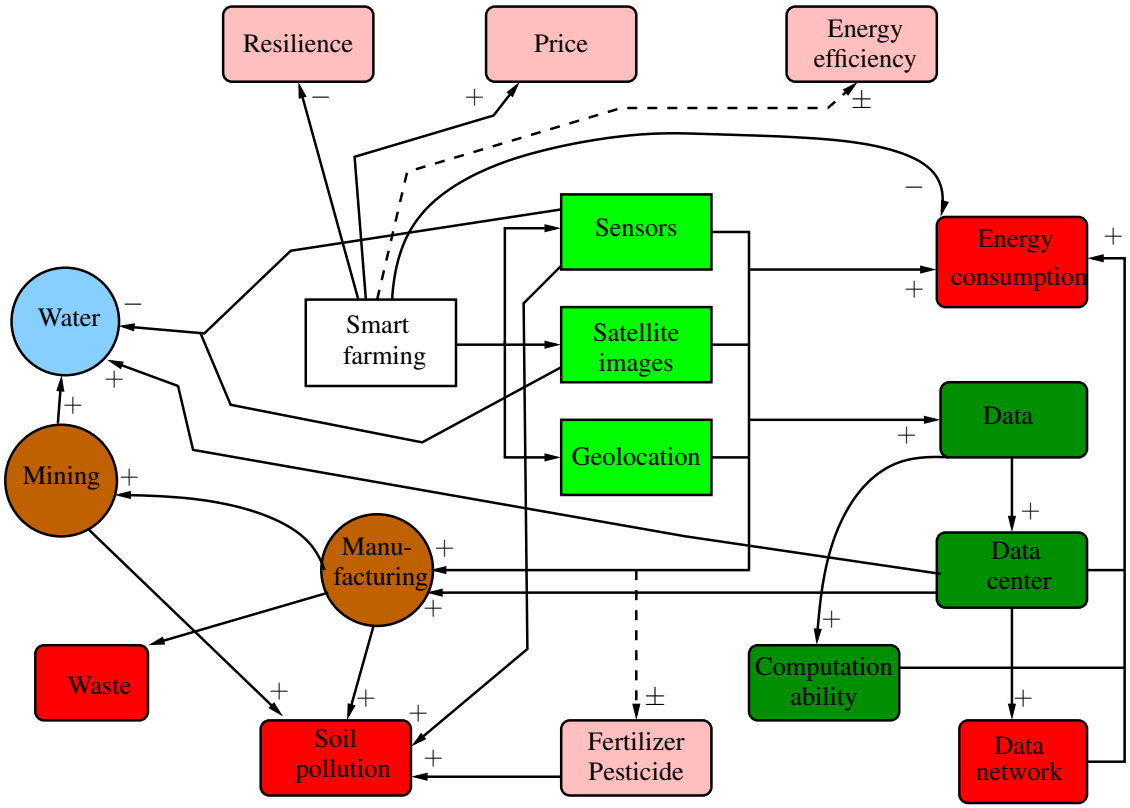

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