If the Future of Sustainable Agriculture Is Digital, Then It Should Be Self-Obviating

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Lock-in in digital agriculture

Lock-ins: "*situations where an innovation is blocked as a result of the economic and technological strategies implemented by different stakeholders – known as the sociotechnical system – coming together in such a way as to prevent any destabilization or change, even if the innovation could be widely beneficial*".

Path dependency: [1-3]
Adoption relies on historical events or contingent phenomena rather than rational evaluation.

***Economies of scale*:** [1]
The efficiency and the appeal of digital agriculture increase with the number of users.

***Organizational and cognitive effects*:** [1-3]
When knowledge on certain farming practices is more accessible than knowledge on their alternatives.

Self-obviating digital agricultural systems (SODAS)

SODAS are the agricultural application of the permacomputing concept of self-obviating systems: "*a means to evaluate and build computing systems which are designed to assist in the flourishing of humans and the biosphere, promote community and inclusion, minimize resource use, and optimize the lifespans of computing devices by using them less and becoming self-sufficient and sustainable where possible*", which is inspired from [4].

General self-obviation

Edge self-obviation
When SODAS reduce the number of sensors by learning how to estimate data from other sensors or from other data sources.

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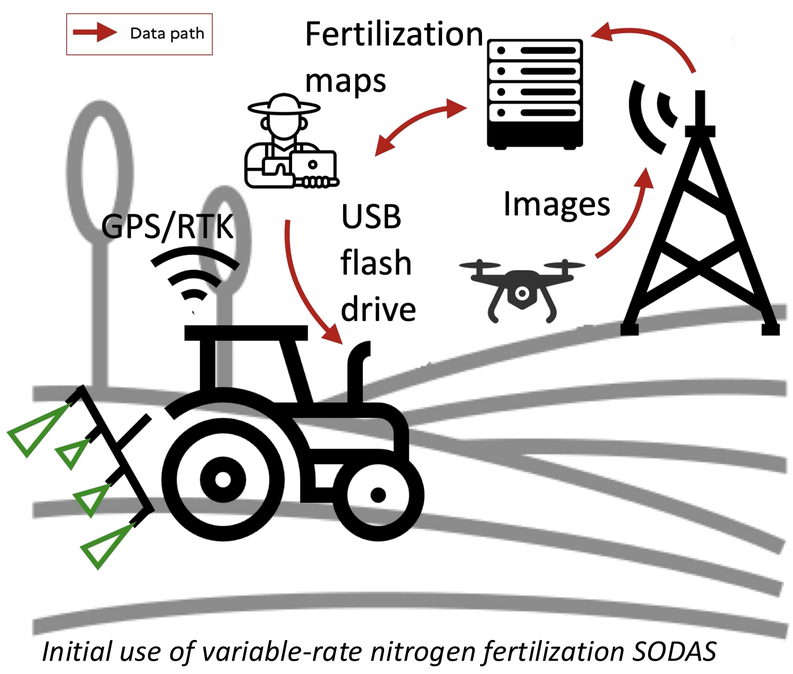
Decentralizing self-obviation
When SODAS stop using a centralized calculator by replacing it with a computing power closer to the farm.

When designing digital agriculture technologies, we should not think of them as permanent.

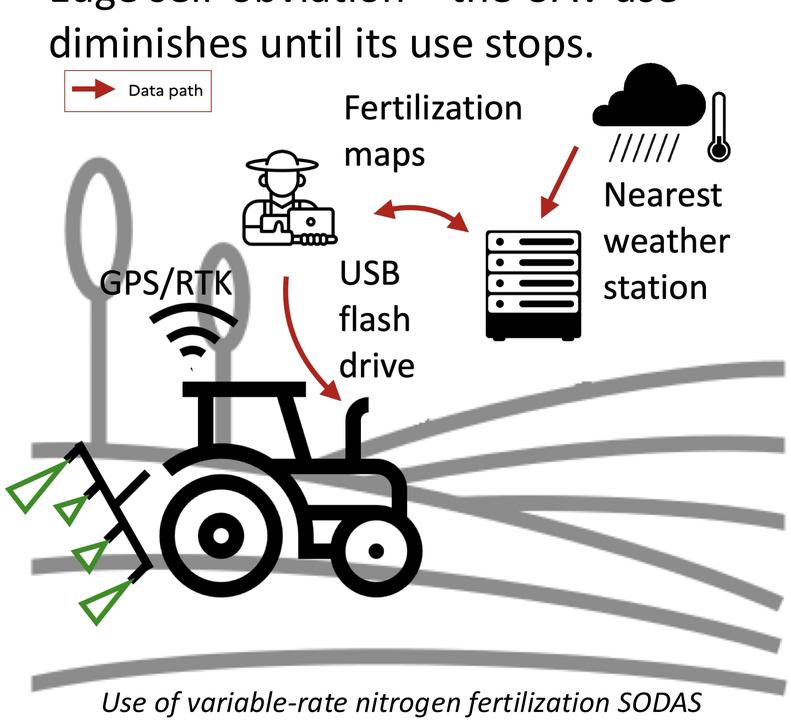
An illustrative example of SODAS



Initial use of variable-rate nitrogen fertilization SODAS

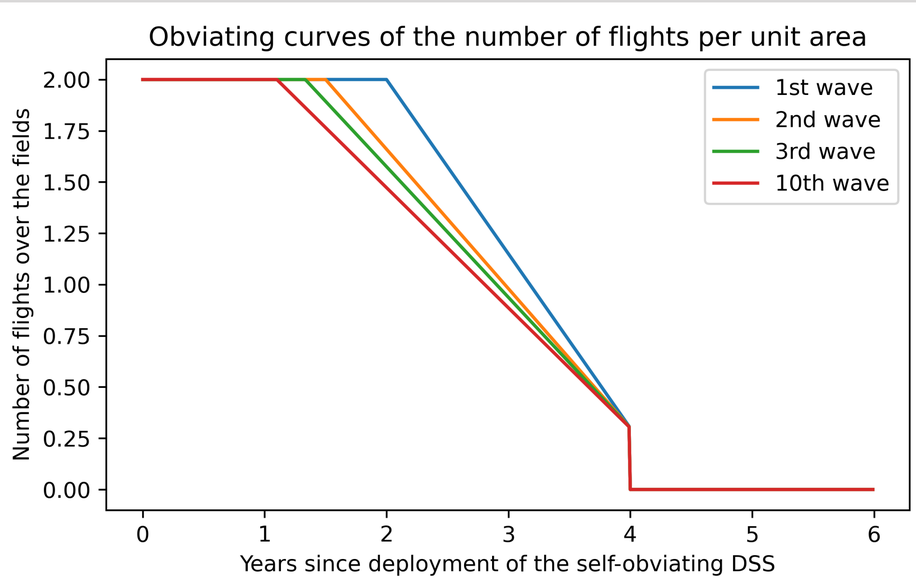
Variable-rate nitrogen fertilization decision-support system:

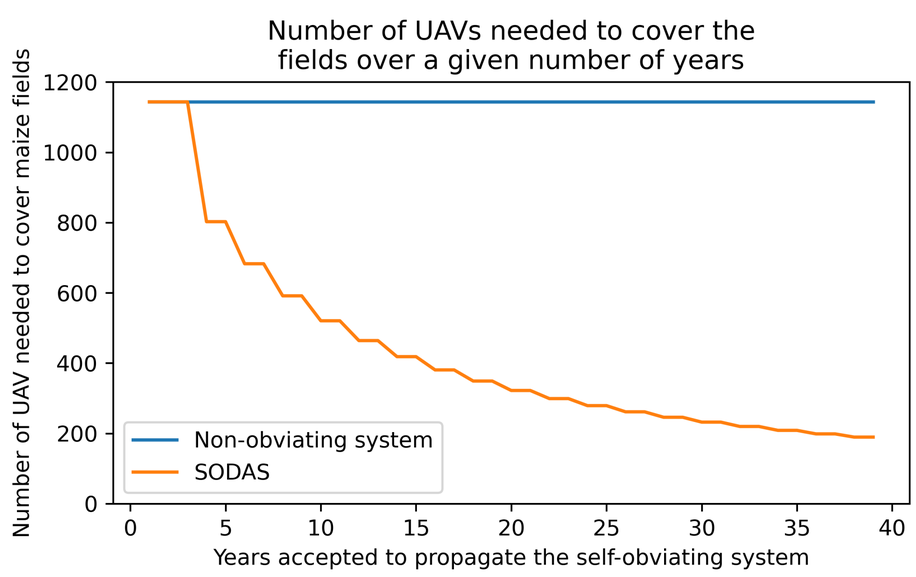
- Fertilization maps from UAV NVDI images
- Initial environmental assessment.
- Sharing through agricultural intermediaries.
- Edge self-obviation – the UAV use diminishes until its use stops.

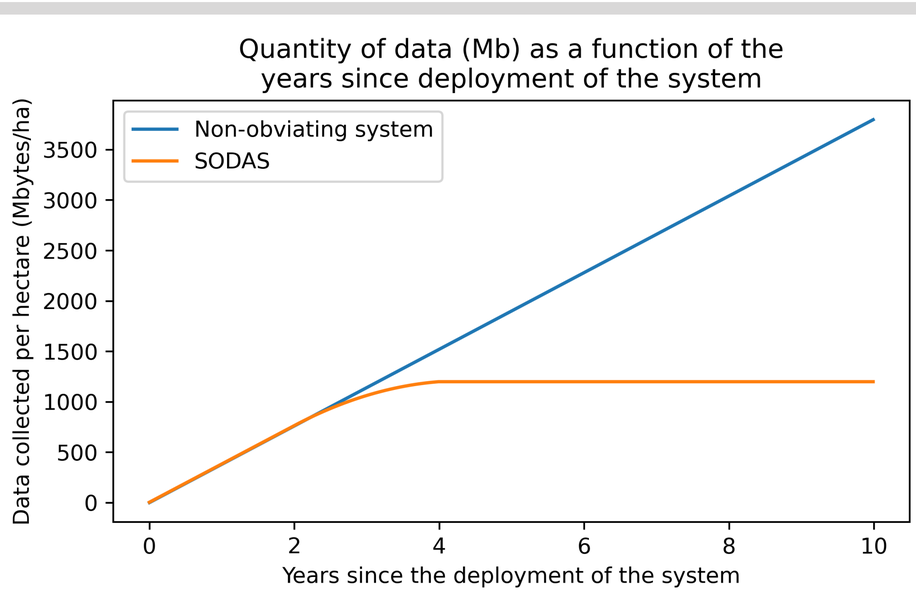


Use of variable-rate nitrogen fertilization SODAS after edge self-obviation

Results of estimation for corn fertilization







Total area for the scenario:

$$S_{corn} = 2.573\ Mha$$

General assumptions:

- Perfect UAV sharing.
- UAV cover $S_{\text{day}} = 150\ ha$ per day
- Use of the DSS stays the same for every crop in the fields.
- UAV used twice in crop growth.
- UAV can only be used for 15 days to help fertilizations in a region.

$$S_{fert} = S_{day} \times 15 = 2250\ ha$$

Number of UAVs for the non-obviating case:

$$n_{non-obv} = \frac{S_{corn}}{S_{fert}} = 1144$$

SODAS assumptions:

- Initial assessment always positive.
- UAV intervenes for a four-year period, then every four years.
- The number of flight starts decreasing $1 + \frac{1}{wave}$ years after the beginning of a wave.

Number of UAVs for the self-obviating case after 10 years:

$$n_{obv} = 521\ (-54\%)$$

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[4] B. Tomlinson, J. Norton, E. P. S. Baumer, M. Pufal, and B. Raghavan, "Self-obviating systems and their application to sustainability," in IConference 2015 Proceedings, 2015.

https://hal.science/hal-05749066v1
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