ESALQ
DEPARTAMENTO DE
Engenharia de Biossistemas

Automation, Robotics, and the Future of Agriculture

Inria-Brasil Workshop on Digital Science and Agronomy

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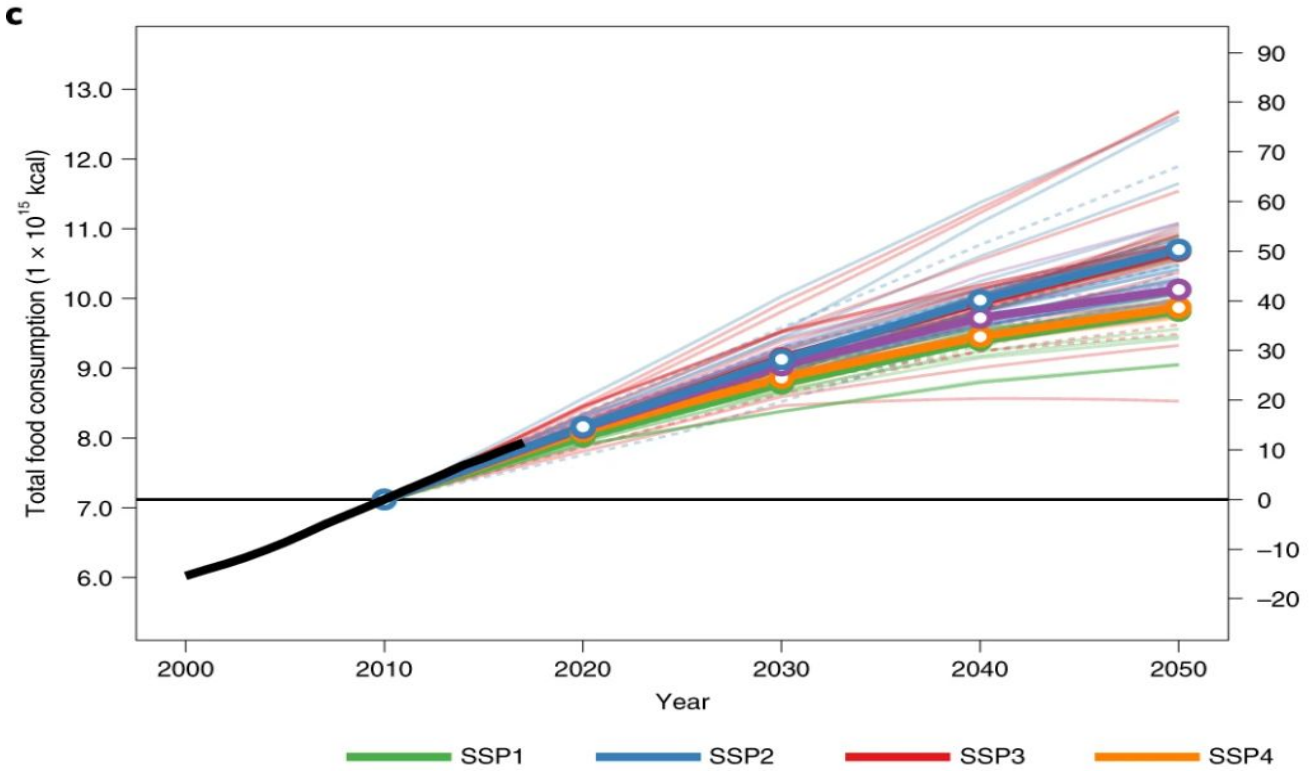
Most important messages

1. **Food demand** increase **+ Climate change** reducing yield
2. **Robotics and automation are key** to address those issues
3. **Robotics** is **on the rise,** but **important questions** exist

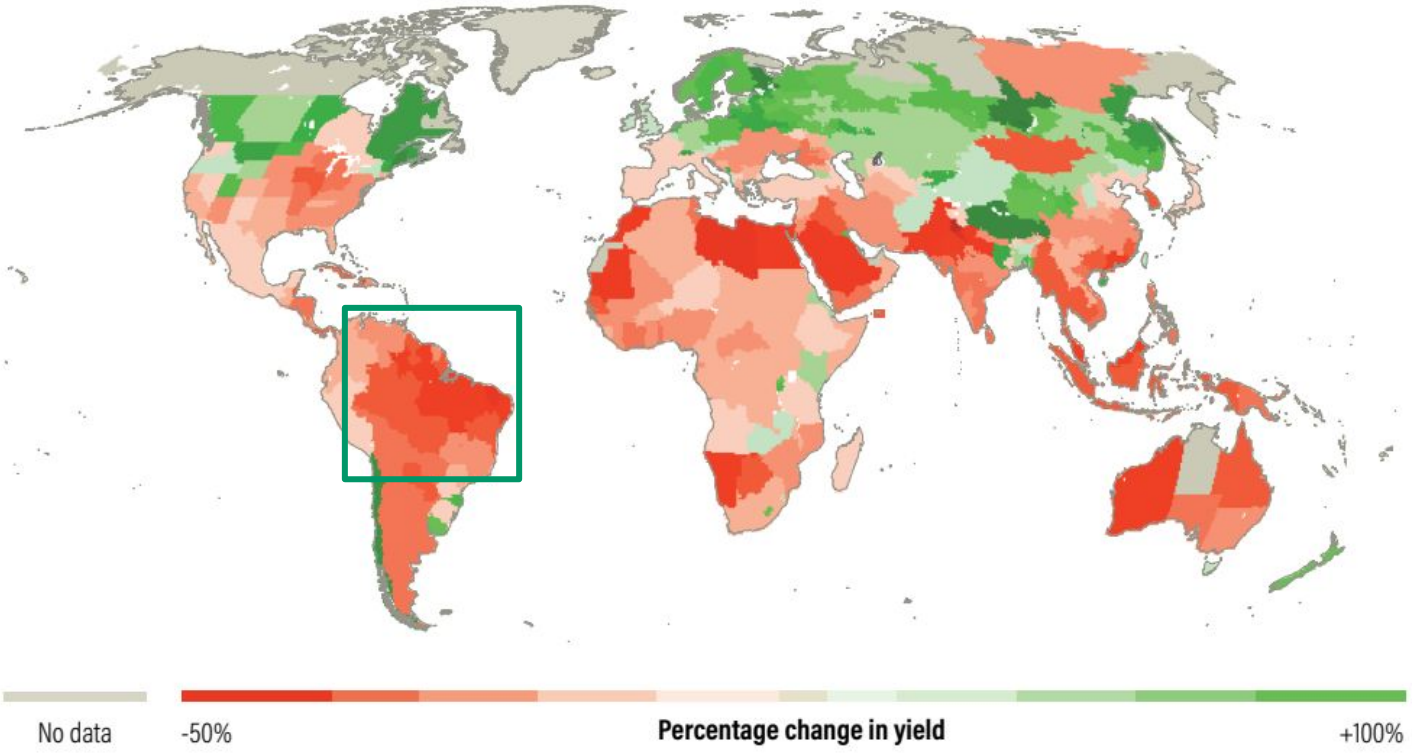
Motivations for a Digital Agriculture

Estimated food demand



Source: Van Dijk, M., Morley, T., Rau, M.L. and Saghai, Y., 2021. A meta-analysis of projected global food demand and population at risk of hunger for the period 2010–2050. Nature Food, 2(7), pp.494-501.

Figure 1-4 | Climate change is projected to have net adverse impacts on crop yields (3°C warmer world)

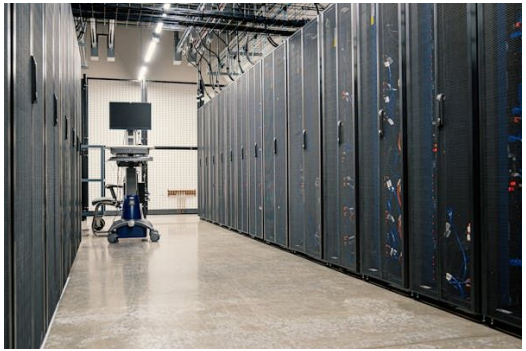


Source: https://reliefweb.int/report/world/world-resources-report-creating-sustainable-food-future-menu-solutions-feed-nearly-10?gad_source=1&gclid=CjwKCAjw5ImwBhBtEiwAFHDZxzSH_O3MHYRTX7YfD68b_Cu0az2h0cRT7Cx3uTZ1BSC2m9E2ZKFcahoCPisQAvD_BwE ; World Bank. 2010. World Development Report 2010: Development and Climate Change. Washington, DC

Main problem

Automation and robotics in Agriculture

New technologies



Cloud computing

Edge computing

Artificial intelligence

Sensors and controllers

Automation and robotics

Fontes: Perez, T., McCool, C., Bawden, O. and Kulk, J., Robotic weeding–From concept to trials. In Proceedings of the 7th Asian-Australasian Conference on Precision Agriculture, 2017, Hamilton, New Zealand, pp. 16-18. ; Perez, T., Bawden, O., Kulk, J., Russell, R., McCool, C., English, A. and Dayoub, F. Overview of mechatronic design for a weed-management robotic system. Robotics and mechatronics for agriculture, 2017, pp.23-49.

Hardware

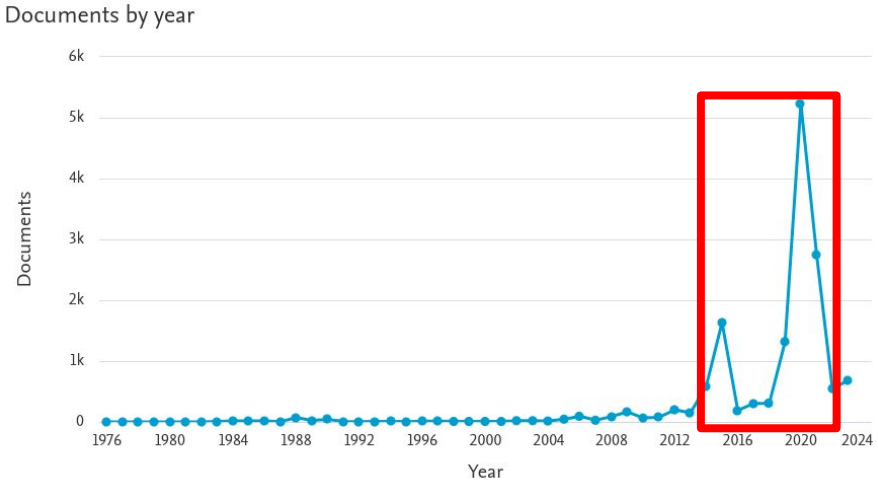
Software

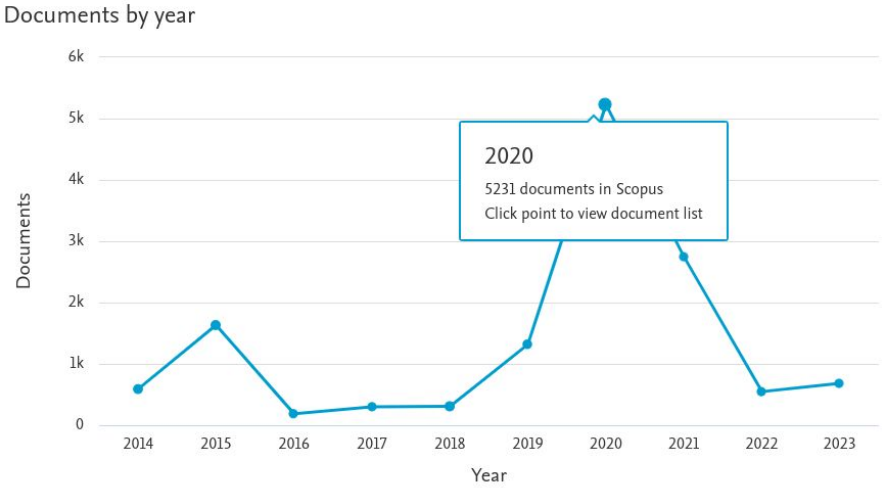
Communication

Processes

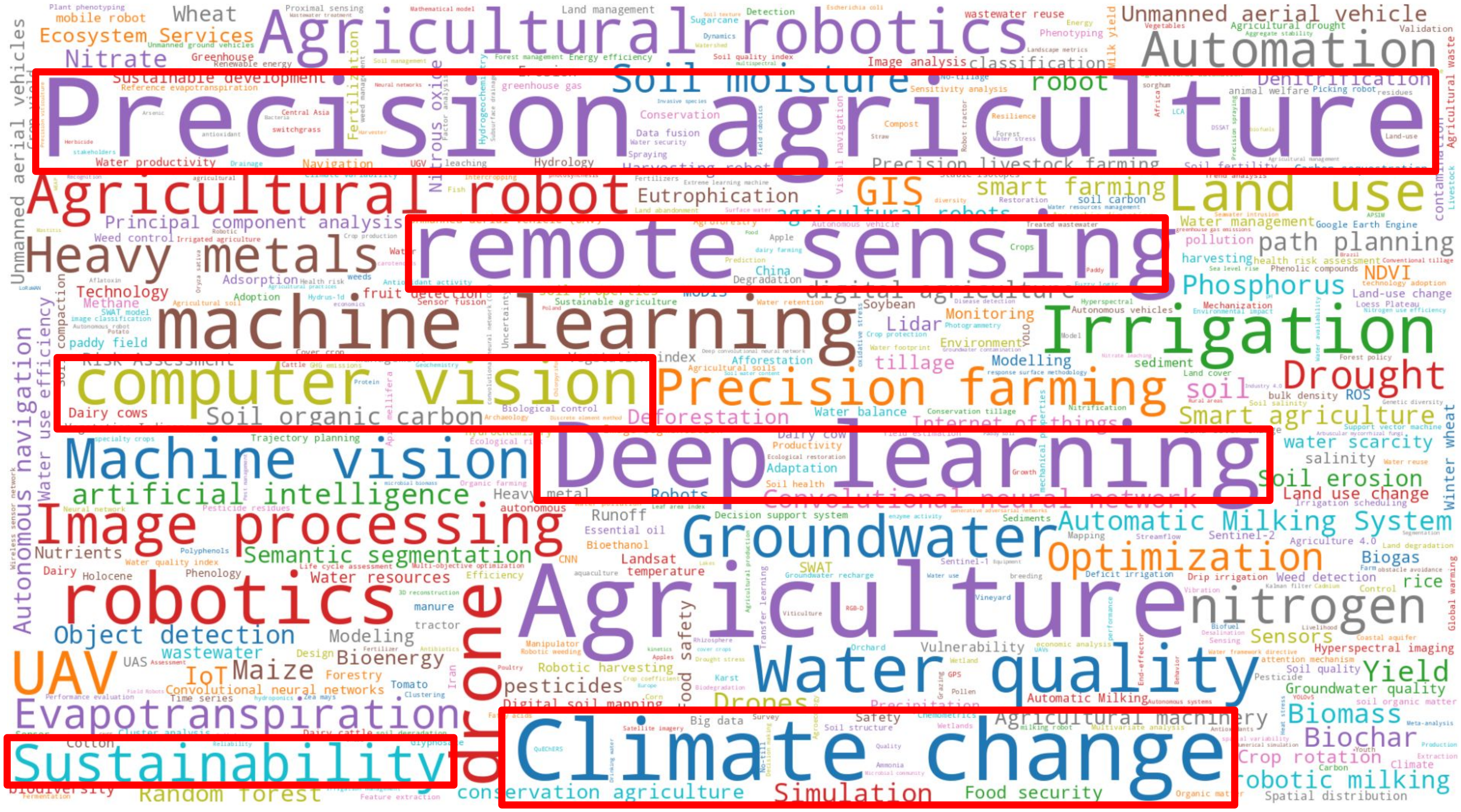
Agricultural robotics is on the rise

Significant increase in number of publications from 2012 on



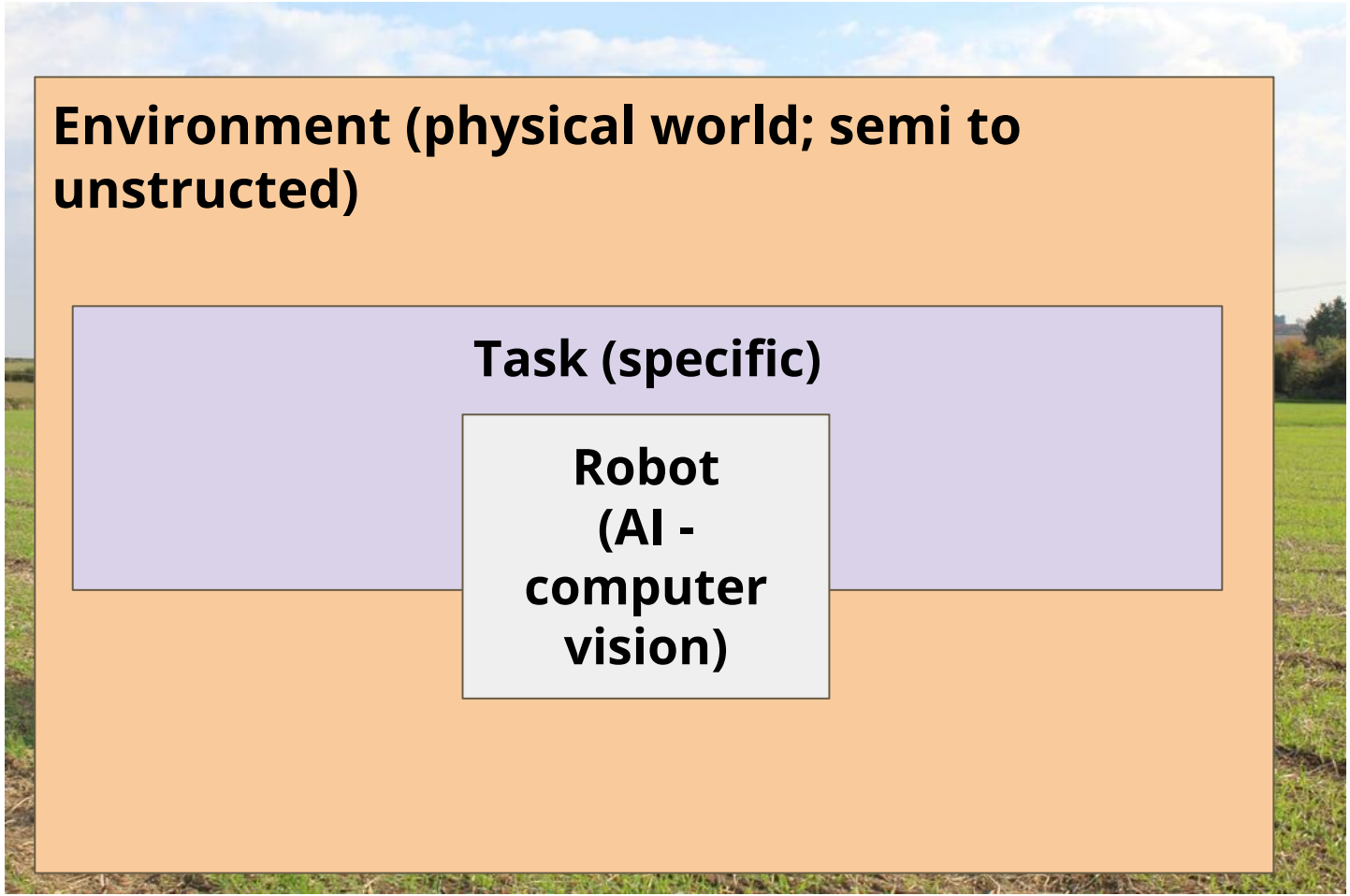


String: agricultural AND robotics
Plataforma: Scopus



(robot* OR drone*) AND (agric* OR farm*), English, 2012-2023, Peer-reviewed - 6112 docs

Based on: Mohanan, M.G. and Salgaonkar, A., 2020. Probabilistic approach to robot motion planning in dynamic environments. SN Computer Science, 1(3), p.181.
Fonte imagem: https://www.hw.ac.uk/news/articles/2023/farming-robot-to-help-care-for-crop-plants.htm



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Fonte imagem: https://www.hw.ac.uk/news/articles/2023/farming-robot-to-help-care-for-crop-plants.htm

Agricultural robotics - Main body types

Static / industrial

Mobile - Terrestrial / ground

Mobile - Aerial / drones

Sources: https://news.mit.edu/2018/robo-picker-grasps-and-packs-0220 ; Yinka-Banjo, C. and Ajayi, O., 2019. Sky-farmers: Applications of unmanned aerial vehicles (UAV) in agriculture. Autonomous vehicles, pp.107-128. ; https://mundogeo.com/en/2022/04/13/dji-inicia-ensaios-em-voo-do-drone-de-pulverizacao-agras-t30-no-brasil/ ; https://ag.dji.com/pt-br ; https://www.ieee-ras.org/agricultural-robotics-automation

Agricultural robots - Static / industrial

Soruces: https://news.mit.edu/2018/robo-picker-grasps-and-packs-0220 ;
https://www.cnbc.com/2019/05/11/root-ai-unveils-its-tomato-picking-robot-virgo.html

Agricultural robots - Mobile - Terrestrial / ground

Sources: https://www.ieee-ras.org/agricultural-robotics-automation ; https://www.hw.ac.uk/news/articles/2023/farming-robot-to-help-care-for-crop-plants.htm ; Redhead, F., Snow, S., Vyas, D., Bawden, O., Russell, R., Perez, T. and Brereton, M., 2015, April. Bringing the farmer perspective to agricultural robots. In Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems (pp. 1067-1072). ; https://www.bridgestone.com/bwsc/stories/article/2019/06/17-7.html ; https://www.nytimes.com/2020/02/13/science/farm-agriculture-robots.html ; https://www.earthsense.co/

Agricultural robots - Mobile - Aerial / drones

Computer vision for robots - Weed identification

Classification (1 weed / image)

Detection (more than 1 weed or species / image)

Segmentation (pixels in the image that belong to weed)

Sources: Perez, T. et al., Robotic weeding–From concept to trials. In Proceedings of the 7th Asian-Australasian Conference on Precision Agriculture, 2017, Hamilton, New Zealand, pp. 16-18 ; Olsen, D. A. et al. DeepWeeds: A Multiclass Weed Species Image Dataset for Deep Learning, Scientific Reports, vol. 9, no. 2058, 2 2019. [Online] ; Güldenring, R. et al. 2023. RumexWeeds: A grassland dataset for agricultural robotics. Journal of Field Robotics, 40(6), pp.1639-1656.

Weed elimination - Agbot II (QUT)

Chemical (localized)

Mechanical (localized)

Sources: Perez, T. et al., Robotic weeding–From concept to trials. In Proceedings of the 7th Asian-Australasian Conference on Precision Agriculture, 2017, Hamilton, New Zealand, pp. 16-18 ; https://www.youtube.com/watch?v=Sy1kLNp3CcU

Status in Brazil - large farms, few tasks, commodities

Mobile - Terrestrial / ground

Mobile - Aerial / drones

Sources: https://enterprise.dji.com/ ; https://www.ragricola.com.br/robo-e-utilizado-na-analise-de-solos/ ; https://www.solinftec.com/en-us/alice-ai-solix-ag-robotics-2/


Important questions
moving forward

Important questions and research interests

- When should we use robots?
- Comparison classification x detection x segmentation and decisions that can be informed
- AI applied to robotics besides vision
- Robotics for small farmers

Important questions and research interests

- How will farming systems change (availability of cheaper robots)?
- Sustainability and resil. improve?
- Interaction with heavy machinery? Replace? Cooperate? Side by side?
- How to increase their adoption?

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Thank you for your attention!

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