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Field Crop Robotics: Bibliometric Overview and Agronomic State of Art

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INTRODUCTION

Agricultural machinery automation and advances in ICT are expected to support the 4th agricultural (r)evolution of agriculture, the so-called farming 4.0. The development of robots is called to fit the technological opportunities within the evolution of farming systems to stay relevant for agriculture. National-wide reports [a,b] identified key needs to create an enabling environment by:

- explicitly considering **users' preferences and expectations** in the equipment design phase
- **training agricultural workers** to master and maximise the use of emerging technologies.

Our goal is to provide a summary of academic knowledge and market information about agricultural robotics both as an operational reference and training support

MATERIALS AND METHODS

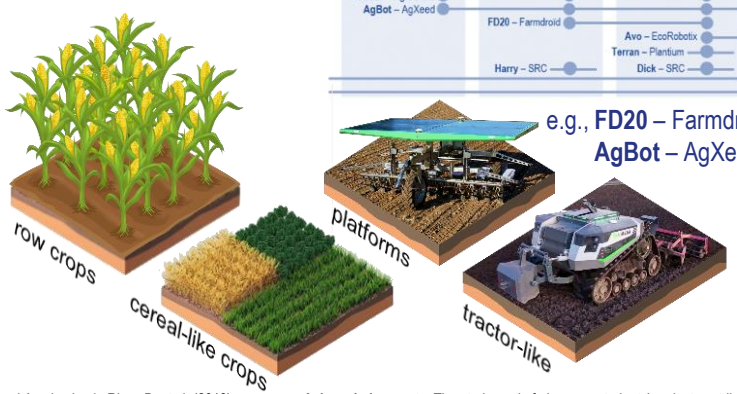
Bibliometric overview of a corpus of scientific literature retrieved on Scoups analysed with two scripts of the CorTexT.net online platform:

- ***terms extraction*** to summarize titles, abstracts and keywords in terms composed of maximum 2 words based on Natural Language Processing;
- ***network analysis*** of terms co-occurrence to provide a synthetic map of the corpus content.

Agronomic state of art. It was focused on field-crop robotics, based on an agronomic comparative grid [c] and completing existing surveys [d,e]. This market survey was realized through an online search of agricultural press articles and updated through manufacturers' communications on LinkedIn.

- Robots were classed in ***2 cropping systems*** (i.e., tillage, planting, weeding, fertilising, harvest and data scouting) that were distinguished according to the main type of planting equipment (row crops *vs* cereal-like crops).
- Following the RobAgri experts' recommendations, we distinguished autonomous ***platforms***, specifically designed for specific task(s), *vs* autonomous ***tractors***, which can fit with classical farm equipment.

Query. TITLE-ABS (**robot*** W/3 (**agric*** OR **farm***) AND NOT (pharm* OR paint* OR cloth*)) OR AUTHKEY (robot* W/3 (agric* OR farm*)) AND PUBYEAR > **1981** AND PUBYEAR < **2021**.

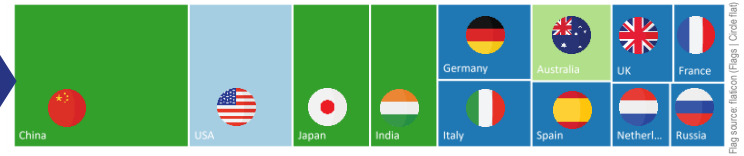


RESULTS

Scientific literature. 1,649 items, mostly from authors affiliated to Chinese or USA universities. Half of the corpus was published in the last 4 years and as conference papers. The network analysis showed **5 clusters** around: control method, image processing, interaction with the proxy environment, especially related to data collection and applications for dairy farms and fruit and vegetables. The last cluster concerned automation for crop fields and forestry.

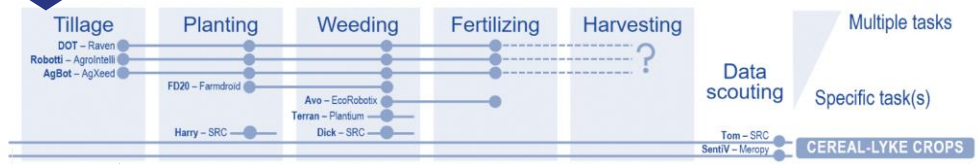
Agronomic state of art. European robots were most abundant. In total, 17 for the row cropping system and 10 for the cereal-type one. Other robots, addressing horticulture and viticulture, seemed to be soon adaptable to field crops. The higher abundance for row crops could be explained by the easier control (crop rows provide the path) and distinction of inter-row weeds.

Harvesting was the only operation that still have to be addressed with a robot.



Number of publications per affiliation, first 12 countries, coloured per world region

Co-occurrence matrix of the top 50 terms (made with CorTexT).



Robot market state of art, example for a cereal-like cropping system: lines represent individual robots, and dots identify the task(s) addressed by each robot.

CONCLUSIONS

Scientific literature on agricultural robotics is blooming, but it is still at an early stage. As such, machinery fairs and exhibitions could help at completing the state of art. Further research should especially address the rapidly emerging Chinese market, as well as the development of robot distribution and dealership.

References. [a] Bournigal J.-M. et al. (2015) *Agriculture – Innovations 2025* | [b] Lockie, S. et al. (2020) *The Future of Agricultural Technologies*. Australian Council of Learned Academies | [c] Rizzo D. et al. (2018) 'Trends in Agricultural Robots: A Comparative Agronomic Grid Based on a French Overview', p. PS7.3-05, p 81, XVe European Society for Agronomy Congress (ESA). | [d] Leroux C. & Risler J (2020) 'La Robotique En Agriculture', *Aspexit - Precision Agriculture website*. | [e] Rispens C (2021) 'Agriculture Robots List', *Duck Size website*.

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