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Global Broadacre Crop Challenges in Delivering Smart Agri-robotic Solutions

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Introduction

Threats to global food security have been widely publicised, including population growth, ageing farming populations, meat consumption trends, climate-change effects on abiotic and biotic stresses, and the environmental impacts of agriculture. Furthermore, with increasing pest, disease, and weed tolerance, traditional crop genetic and protective chemistry technologies of the 'Green Revolution' are under increasing strain [1]. To alleviate the burden of these challenges, efforts have been made to automate and robotize aspects of the farming process. This drive has typically focused on higher-value sectors, such as horticulture and viticulture, which have historically relied on seasonal manual labour to maintain produce supply [2].

Furthermore, there are strong political drivers and policy instruments in place to reduce chemical usage and environmental impact. For example, as of January 2014, the EU's 'Sustainable Use of Pesticides' directive (Directive, 2009) requires that non-chemical methods of plant protection be prioritised whenever possible. These drivers point to the need for fundamental changes to global agricultural systems.Weaknesses in the selective breeding and crop protection chemistry solutions that underpinned the first 'Green Revolution' of the late twentieth century have been addressed in recent decades by Integrated Pest Management (IPM) strategies such as intercropping and beneficial insects (Barzman et al., 2015) [3].

Adoption of these Smart Technologies in arable agriculture is beginning to accelerate in those higher value, but comparatively lower volume, sectors where labour costs are dominant. These are primarily areas where crops, such as horticulture or soft fruit production, have traditionally been tended on an individual level. These industries are early adopters of smart systems, driven in many cases by a scarcity of available human resources to selectively tend and harvest crops [4].

While the authors have previously reported on the potential and general principles of robotics technologies for agri-food production, particularly for UK high-value crops (Duckett T., 2018), this article provides a new analysis addressing the needs of broadacre agriculture. This is then illustrated with three case studies and recommendations that are applicable to all sectors of global agriculture in order to achieve widespread adoption of these Smart Technologies. A paradigm shift in their capabilities will be required to enable their transition from specialty crops to bulk crop production, such as cereals, maize, or canola (oil seed rape).

Addressing these sources of variability would necessitate smart agrisystems that self-evolve at a faster rate than nature's pests, pathogens, and weeds do in the face of climate change. That is, machine learning systems that can autonomously identify any emergent tolerance to current preventative treatments and then flag them to operators while also attempting to mitigate the impacts by predicting the trend in those tolerance changes and spontaneously adjusting the timing, location, or concentration of the existing interventions to mitigate the impacts. Using AI to continuously learn and predict the evolutionary processes of pests, pathogens, and weeds. However, delivering the required plant-by-plant interventions will not be accomplished solely through brute-force engineering [5].

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Description

As a result, the weed bank within a field can be mapped to millimetre accuracy early in the crop's growth and then verified again later in the season using robotic units. Based on that information, if minimum till farming is used to avoid significantly disturbing and redistributing the weed seed bank, a post-harvest weed control programme may be expedited prior to drilling for the following season. Again, robotic systems provide the opportunity to carry out that programme, either as an attachment to a traditional tractor toolbar or as an independent unit.

Conclusion

The Agri-Food sector faces significant challenges that conventional approaches to agri-product development cannot address. These threats will worsen unless action is taken soon to put in place the infrastructure required to mitigate the effects. The emerging fields of bespoke agricultural sensing, AI, and robotic manipulation may provide a portion of the solution, but for broadacre crops, this will require seamless integration with more traditional biological and chemical approaches.

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Conflict of Interest

There are no conflicts of interest by author.

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