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DIGGING INTO RESEARCH

Future technologies in disease control

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"The agriculture industry in North America will take the first steps towards a dramatic change of direction during the next decade. The much anticipated shift to autonomous field equipment will eliminate the need for the enormous and expensive pieces of farming equipment currently used for every aspect of agricultural field work on the Canadian prairies and across North America."

Those are the words of Bruce Gossen, AAFC Saskatoon, and Mary Ruth McDonald, U of Guelph, from an invited symposium presentation at a joint meeting of the Canadian Phytopathological Society and the Quebec Society for the Protection of Plants held in Quebec City, QC, on 19 June 2018. The following is a summary of their presentation and their view of how new technologies might enhance natural biological control and disease management, and reduce reliance on synthetic pesticides.

"We see the coming shift to small modular equipment as an opportunity to re-introduce natural biological control and biodiversity into extensive farming operations. Small, modular equipment could be used to facilitate more complex crop rotations, intercropping, strip cropping, companion planting and even patchwork plantings in large fields. Also, the shift to small modular equipment will dramatically reduce the incentives for removing hedgerows, potholes and other small non-farmed areas within and adjacent to fields. Maintaining or even increasing non-farmed area in fields would enhance the populations and diversity of pollinators (Vickrucka et al. 2019) and beneficial insects, and possibly also provide benefits for soil health.

The shift to small modular equipment will be driven by economics (Lowenberg-DeBoer et al. 2019). Autonomous seeders, drones, sprayers and harvesters can work night and day, stop in place when conditions become unfavourable, resume when conditions improve, and call for the producer only when unexpected situations are encountered or a decision is required. Small, interchangeable pieces of equipment have the (as yet untapped) potential to be more cost effective and environmentally friendly than today's juggernauts.

Small, modular equipment is eminently well suited for use in a system of small fields (even a patchwork system) that could make better use of crop rotation and natural biological control to manage pests and diseases. This improvement, together with improvements in drones, sensors, artificial intelligence and weather forecasts, could facilitate early detection and treatment of hotspots of diseases and insects. Combining crop rotation and resistance-deployment strategies with small fields, improved scouting and optimized application of pesticides could shift the balance back towards biological diversity and natural biological control within fields. This may not only reduce pesticide use, but also improve the efficacy and efficiency of both synthetic and biological pesticides and further reduce reliance on synthetic pesticides.

Focused, timely application of biological pesticides, used to supplement the natural biological control already occurring in a patchwork field arrangement of multi-line crops, have the potential to dramatically reduce the agriculture industry's reliance on synthetic pesticides. This is important because synthetic pesticides have become an increasingly important component of the extensive agriculture system on the Canadian prairies.

Gene editing and marker-assisted selection could be combined to rapidly develop multi-lines of highly desirable cultivars that differ only in the resistance genes they carry to the important diseases present in a region. Multi-lines and quantitative resistance have been shown to provide effective reduction in disease without shifting the pathogen population towards 'super strains' that could overcome all of the resistance available. These approaches might be highly suitable for field crops against important diseases such as blackleg of canola or stripe rust on wheat.

Many of the technological advances that we propose as likely to occur in the short to medium term will require continued improvement in computing power and analysis to be realized. Even though Moore's law of rapidly increasing computational speed appears to finally be nearing its limit, sustained progress appears likely. Continued improvement in computing capability, taken together with improvements in artificial intelligence, power storage and the efficiency of solar energy

capture and utilization, will almost certainly drive robotics forward even more quickly in the future than the rapid pace we see today.

This progress, coupled with artificial intelligence applications to ease the adoption of the new technologies, will ensure that their use will be commonplace and routine sooner rather than later. It is likely that human operators are going to be required for many years as an integral part of the agricultural system. However, even more than today, growers in the future are going to be data managers and maintenance specialists rather than equipment operators.

This presentation outlined a scenario for the future of extensive agriculture in North America in which technological change is harnessed to reduce the industry's reliance on synthetic pesticides and simply-inherited genetic resistance. Many other scenarios are possible. We invite readers to assess this vision of the future critically, but with an aliquot of cautious optimism."

This paper is based on an invited symposium presentation at a joint meeting of the Canadian Phytopathological Society and the Quebec Society for the Protection of Plants held in Quebec City, QC, on 19 June 2018.

Bruce D. Gossen & Mary Ruth McDonald (2020): New technologies could enhance natural biological control and disease management and reduce reliance on synthetic pesticides, Canadian Journal of Plant Pathology

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