Empowering the Australian agri-food sector through a digital transformation of plant health by assimilating eResearch

Dr Stan Bellgard[1]

SE Bellgard[1], SG Mundree[2], Kevin Dudley[3], Anthony R. Clarke[4], Roberto Barrero[5], Matt Bellgard[6]

[1]Manaaki Whenua Landcare Research, Auckland, New Zealand, bellgards@landcareresearch.co.nz

[2]Director, Centre for Tropical Crops and Biocommodities, Queensland University of Technology (QUT), Brisbane, Australia, Sagadevan.Mundree@qut.edu.au

[3]Science and Engineering Faculty, Earth, Environmental and Biological Sciences, QUT, kevin.dudley@qut.edu.au

[4]Chair of Fruit Fly Biology and Management, School of Earth, Environmental and Biological Sciences, QUT, Brisbane, a.clarke@qut.edu.au

[5]Associate Professor, Office of eResearch, QUT, Brisbane, roberto.barrero@qut.edu.au

[6]Director of eResearch, QUT, Brisbane, matthew.bellgard@qut.edu.au

INTRODUCTION

The 4th Industrial Revolution has arrived, and what separates this industrial revolution from the preceding three is the velocity, scope, and system-level impacts. The speed of current breakthroughs has no historical precedent. When compared with previous industrial revolutions, the Fourth is evolving at an exponential rather than a linear pace. Moreover, it is disrupting almost every industry in every country. From how we purchase, what we watch, how we eat, and how we commute. The breadth and depth of these changes herald the transformation of entire systems of production, management, and governance [1]. It represents "a fusion of technologies that is blurring the lines between physical, digital and biological spheres" [1], characterised by pace, scope and impact, affecting our lives and re-shaping economic, social, cultural and human environments. This has given rise to a person-centric / client-centric, individual-level empowerment, because of the immediacy of evidence. There are many opportunities to leverage of these technologies to support and deliver food security outcomes for Australia and its APEC trade- and aid-partners.

ENABLING TECHNOLOGIES FOR PRIMARY PRODUCERS

The availability of cross-cutting technologies for farmers includes; Computational decision support tools, The Cloud, Sensors, and Digital Communication tools. Live-stock specific enabling-technologies include; Radio Frequency Identification, Automated feeding systems, and Livestock Software models. Field-based deployment of these technologies have very practical applications including: geo-location technology (DGPS, RKT), communications (Cellular, Broadband), GIS, yield monitors, precision soil sampling, sensing (proximal / remote), UAV's, auto-steering and guidance, variable rate technology, and on-board computers [2]. These technologies all represent "components" or "modules", but remain un-connected and in-operable without a quality control and assurance system to "link and bind them, and ensure their data complementarity and security, and deliver front-end harmony and inter-operability of their communication and out-put systems" [3].

FORENSIC PLANT PATHOLOGY

Forensic investigation is the gathering and analysis of all crime-related physical evidence in order to come to build a case of evidence about the relative guilt / innocence of a suspect. A similar approach is taken by plant pathologists as they search for the cause of a plant disease and attempt to characterize pathogen cycles, map the distribution and pattern of disease expression in relation to soil and climatic factors. Further information is needed for eradication and/or long-term management e.g. elucidating patho-system genetics, cataloguing evidence of disease resistance, evaluate risks associated with flow-on effects of diseases that affect animals / humans, and assessing the socio-economic impacts, while operating within the environmental, legal, social, and cultural constraints.

THE E-RESEARCH-APPROACH

Assimilating the eResearch-approach is characterized by a culture of “collaboration obsession”. The trans-disciplinary team necessary to understand the cause / effects of disease out-breaks include; Growers/Farmers/Producers to provide access to growers properties, past and current meta-data from growers’ property, and the agricultural consultants / agronomists who have the legacy knowledge associated with the grower and the region. The technical team can include; plant pathologists, entomologists, soil chemistry laboratories, plant physiologists and geneticists, microbiological laboratories, and glasshouse facilities for controlled environment experiments. Additional specialist technologies can include; chemical analytical facilities (HPLC), helium ion microscopy, metagenomics, bioinformatics / e-Research, plant breeders, industry / supply agencies, project and contract management, and a legal team support to manage IP issues. The challenge remains to provide a “real-time” synthesis of the various data streams into “decision support tools” to help farmers make the best choices when it comes to nutrition, water, pest and disease management (Fig. 1).

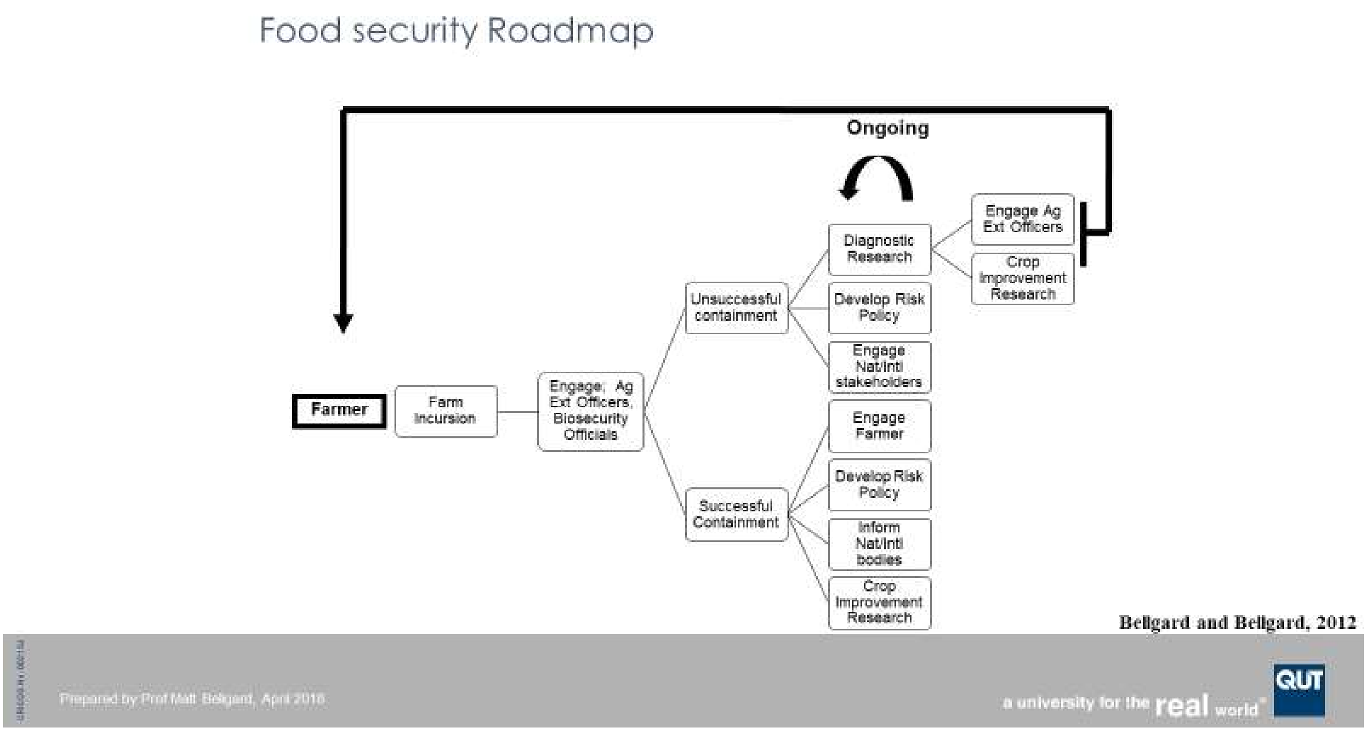

Figure 1: A flow-diagram of “knowledge-sharing” along the food security chain

THE CHALLENGE OF AGILITY IN THE FOOD SUPPLY CHAIN

The advent of next generation sequencing, robotics, automation, remote sensing, artificial intelligence and big data all mean that our sphere of influence has expanded - so we can be bold, to tackle the grand global challenge of food security through a completely different lens. These include creative, innovate and integrative approaches which integrate the most cutting edge technologies, delivered in a manner to directly engage with the growers' and end-users' increasing demands for precision and responsiveness. However, not everything can be dematerialised, none more so, than end-user engagement and customer satisfaction. This has become even more paramount as the 4th Industrial Revolution has seen the emergence of the power of the consumer in the decision-making process. Therefore, challenges must be tackled from many angles and reflect all perspectives and values to achieve social, public, cultural and political licence to operate. Plant pathology is the foundation of food productivity that underpins food security and sustainable food production to feed the world's demands for food and fibre. The age of biotechnology, digital disruption and precision farm technology has enabled plant pathology to expand horizons beyond the field compared to three decades ago. Conventional plant pathology techniques supported by chemical analysis, microscopy, genomics / next generation sequencing technology and remote-sensing technology and other components of digital / precision agriculture, will enable us to address urgent "real world" problems by implementing an agile project model with an end-user enabled focus and deliver global food security outcomes.

REFERENCES

[1] Schwab, K. the Fourth Industrial Revolution 2017. World Economic Forum, Penguin, UK.

[2] van E., H.M., J.D. Woodard, M. Glos, L.V. Chiu, T. Dutta, and A. Ristow. Digital Agriculture in New York State: Report and Recommendations. 2016. Cornell University, Ithaca, NY.

[3] Bellgard, M.I. and Bellgard, S.E. A bioinformatic framework for plant pathologists to deliver global food security outcomes. Australasian Plant Pathology 2012, DOI 10.1007/s13313-011-0099-x.