

Horizon Scanning Series

The Future of Precision Medicine in Australia

Agriculture

This input paper was prepared by Professor Dave Edwards (The University of Western Australia)

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Many of the technologies developed in the field of personal medicine are also applicable to other biotechnology areas including agricultural and environmental research, and access to these technologies has enhanced Australia's ability to compete in these areas.

The growth of DNA sequencing technology has been driven by the potential for applications in human health, though the benefits are also being reaped in agriculture and environmental research. Australia plays a major role in sequencing the genomes of several crop species including wheat and canola, many of which are larger and more complex than the human genome (1-5). These advances are supported by access to DNA sequencing capability either locally or through national infrastructure such as the Australian Genome Research Facility (AGRF). The recent extension of the Illumina X TEN system hosted by the Garvan Institute, to non-human samples enables the application of this high throughput data generation system for crop and environmental genomics.

Genotyping systems are used routinely for large scale analysis of genetic variants associated with heritable human disease, and the same technology is applied for crop improvement as well as environmental diversity analysis. Custom genotyping arrays have been developed for most major crops, with Australian researchers contributing to their development as well as being major users, collaborating with international consortia and supported by major industry partners including Bayer CropScience, Monsanto, Advanta and Syngenta.

Recent advances in genome editing, the ability to 'cut and paste' the genetic blueprint without the need to add foreign DNA, is being developed for a wide range of biomedical applications including correcting genetic abnormalities and offering potentially innovative cures for cancers. These advances are also being applied to revolutionise the crop breeding cycle, with the potential to develop new varieties within 5 years, compared to 7-12 years for traditional breeding or an average of 13 years for genetic engineering approaches (6). While there remains some uncertainty around the regulation and user acceptance of this technology in Australia, crops are already being developed for the US market which are indistinguishable from conventionally bred varieties and which do not contain transgenic material (7).

The final overlap between personalised medicine and agricultural or environmental applications is their reliance on bioinformatics. As the cost of data generation has dropped, the limitation of the ability to apply this big data explosion to biology and medicine has been lack of experienced researchers in bioinformatics. Bioinformatics is a relatively new and evolving field of research which spans the disciplines of biology, mathematics and computer science. Australia is a leader in crop and environmental bioinformatics and is positioned to expand this important growth industry (8). As bioinformatics is cross disciplinary, researchers regularly transition between biomedical, environmental and agricultural research, and general support for bioinformatics training in Australia is an effective mechanism to promote the broader biotechnology industry.

References

1. Hane J, Ming Y, Kamphuis L, Nelson M, Garg, G, Atkins C, Bayer P, Bravo A, Bringans S, Cannon S, Edwards D, Foley R, Gao L, Harrison M, Huang W, Hurgobin B, Li S, Liu CW, McGrath A, Morahan G, Murray J, Weller J, Jian J and Singh K. (2017) A comprehensive draft genome sequence for lupin (*Lupinus angustifolius*), an emerging health food: Insights into plant-microbe interactions and legume evolution. *Plant Biotechnology Journal*. 15 (3): 318-330
2. Golicz AA, Bayer PE, Barker G, Edger PP, Kim HR, Martinez PA, Chan CCK, Severn-Ellis A, McCombie R, Parkin IAP, Paterson AH, Pires JC, Sharpe AG, Tang H, R. Teakle GR, Town CD, Batley J, Edwards D. (2016) The pangenome of an agronomically important crop *Brassica oleracea*. *Nature Communications* 7:13390
3. International Wheat Genome Sequencing Consortium. (2014) A chromosome-based draft sequence of the hexaploid bread wheat (*Triticum aestivum*) genome. *Science* 345:1251788
4. Chalhoub B, Denoeud F, Liu S, Parkin IAP, Tang H, Wang X, Chiquet J, Belcram H, Tong C, Samans B, Corr ea M, Da Silva C, Just J, Falentin C, Koh CS, Le Clainche I, Bernard M, Bento P, Noel B, Labadie K, Alberti A, Charles M, Arnaud D, Guo H, Daviaud C, Alamery S, Jabbari K, Zhao M, Edger PP, Chelaifa H, Tack D, Lassalle G, Mestiri I, Schnell N, Le Paslier M-C, Fan G, Renault V, Bayer PE, Golicz AA, Manoli S, Lee T-H, Thi VHD, Chalabi S, Hu Q, Fan C, Tollenaere R, Lu Y, Battail C, Shen J, Sidebottom CHD, Wang X, Canaguier A, Chauveau A, B rard A, Deniot G, Guan M, Liu Z, Sun F, Lim YP, Lyons E, Town CD, Bancroft I, Wang X, Meng J, Ma J, Pires JC, King GJ, Brunel D, Delourme R, Renard M, Aury J-M, Adams KL, Batley J, Snowdon RJ, Tost J, Edwards D, Zhou Y, Hua W, Sharpe AG, Paterson AH, Guan C and Wincker P. (2014) Early allopolyploid evolution in the post-Neolithic *Brassica napus* oilseed genome. *Science*. 345: 950-953
5. Montenegro JDM, Golicz AA, Bayer PE, Hurgobin B, Lee HT, Chan CCK, Visendi P, Lai K, Dole el J, Batley J, Edwards D. (2017) The pangenome of modern hexaploid bread wheat. *Plant Journal*. (accepted February 2017)
6. Scheben S and Edwards D. (2017) Genome editors take on crops. *Science*. 355 (6330): 1122-1123
7. CRISPR/Cas crops – bringing together genomics and genome editing. *New Phytologist*. (accepted June 2017)
8. Schneider MV, Griffin PC, Tyagi S, Flannery M, Dayalan S, Gladman S, Watson-Haigh N, Bayer PE, Charleston M, Cooke I, Cook R, Edwards RJ, Edwards D, Gorse D, McConville M, Powell P, Wilkins W and Lonie A. (2017) Establishing a distributed national research infrastructure providing bioinformatics support to life science researchers in Australia. *Briefings in Bioinformatics*. (accepted June 2017)