Raising the genetic potential of rainfed crops through biotechnology - opportunities and challenges.

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Abstract

Australian agronomists have pioneered the development and application of technologies for maximising the yield potential of water-limited rainfed crops. These improvements reflect good knowledge of our production systems, and the targeted interplay of genetic, environmental and agronomic management. Agronomic improvements in water-productivity have been paralleled by genetic advances in yield potential and disease resistance, as well as alterations in grain quality for sale into world markets. Growers can choose from a range of high-performing releases emanating from competing national and international breeding efforts with competition stimulating application of new technologies to enhance selection and assessment of genetically complex traits. Many traits of agronomic significance including weed competitiveness, response to sowing time, and nutrient-use efficiency are genetically determined by many alleles of small genetic effect. Rapid advances in genomics and gene technology have enabled the development of improved tools for accelerating and improving the efficiency of breeding of superior genic combinations for such traits. Beyond these conventional breeding achievements, there lie significant opportunities to further boost crop performance using transgenic approaches to introduce additional performance-enhancing genes. As well as enabling rapid deployment of disease resistance genes to respond to pathogen threats, and creating specialised product quality types, there are a number of opportunities to modify crop physiology to improve yield potential and performance. Importantly, transgenic approaches allow target trait modifications without the disruption of elite genetic backgrounds that occurs through crossbreeding, effectively providing variety upgrades. No doubt further untapped potential exists for improving the rate of genetic progress of rainfed crops which is currently well below that of irrigated crops. Opportunities here include the potential for C4 wheats and use of apomixes in hybrid development. Such improvements may involve altered crop physiology, phenology and reproductive biology, and will likely necessitate matching tailoring of agronomic management

practices. They may prove to be critical for securing the growth in grain supply needed to match rapidly increasing food demand, while adjusting to environment challenges such as climate change. The extent to which breeders will be able to deliver such improvements will critically depend on high levels of agro-industrial and community acceptance of GM food crops.