Genetics and genomics of symbiotic nitrogen fixation in legumes: past, present, and future

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Legumes are a large and diverse family of plants that provide us with food, feed, fuel, and feedstocks for industry. They can use atmospheric di-nitrogen for growth, via symbiotic nitrogen fixation (SNF) with bacteria called rhizobia, making them key to sustainable agricultural systems. There are opportunities to increase SNF in legumes to help tackle critical challenges related to the overuse of fertiliser-N in agriculture. The last two decades have seen enormous progress in our understanding of the genetics of SNF, although this is yet to be leveraged to improve SNF in legumes. In principle, two main plant-based approaches exist to improve SNF, one involving genetic engineering and the other using existing natural variation for this complex trait. These approaches are not mutually exclusive and now is an opportune time to attempt to increase SNF in legumes via plant genetics and genomics. This presentation will briefly review current knowledge of SNF genetics before outlining potential pathways to SNF improvement in legumes. Importantly, there is a new national initiative in Australia to develop genetic resources and knowledge for predictive plant breeding to improve SNF in chickpea, lentil, field pea, fababean, lupin, and mungbean. An outline of this project will also be presented.