Increasing plant adaptive range

We have seen previously how there is great variation between species in their adaptation to environmental variation. There is also great variation within species. This variation is utilized by plant breeders to extend the adaptive range of species, and to increase their productivity. Breeders do this by producing cultivars (bred varieties) of species with certain adaptive and agronomic features. So, for example, there are now cultivars of phalaris and lucerne available for farmers to use that are have higher winter growth rates than older cultivars.

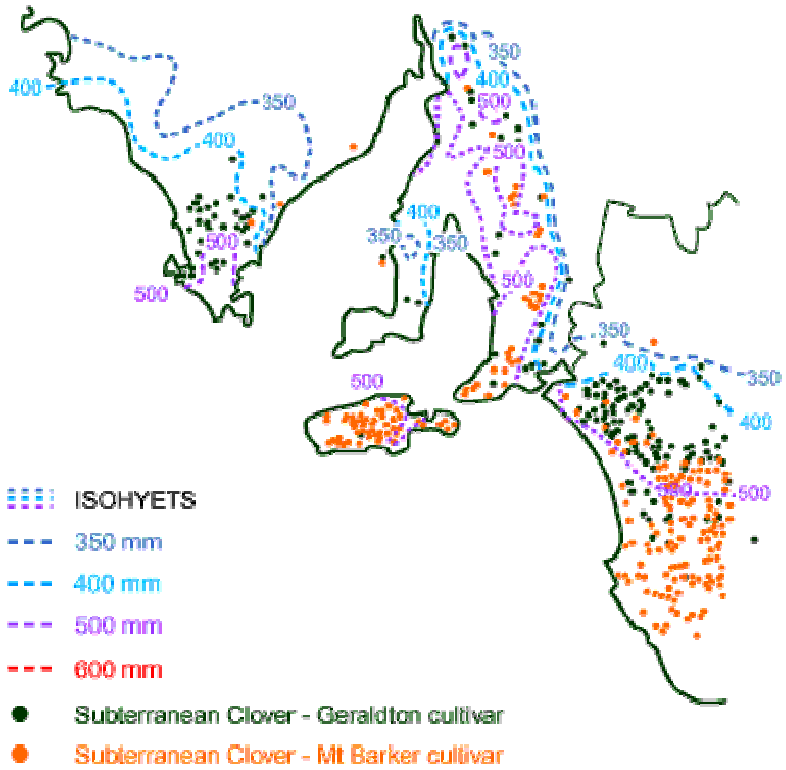
A typical field trial comparing growth of a range of species and different breeding lines within species in small plots. Breeders will select the most promising material for further genetic improvement.

Increasing plant adaptive range: subterranean clover

Subterranean clover provides another excellent example of using variation within species. Over 30 cultivars of sub clover have been bred and released in Australia since the early 1900's. These differ in a number of adaptive features, including disease resistance, time of maturity (flowering and seed set), tolerance of different soil conditions, and morphology.

The first cultivar produced was Mt. Barker, in 1908. Mt. Barker is classified as a mid-season cultivar, suited to areas with rainfall in the range approximately 500- 600 mm per year. It was not until 1958 that Geraldton, an early season cultivar suited to areas with rainfall in the range 350 - 500 mm per year, was released. Thus, for 50 years, there was no productive legume base available for pastures in large areas of South Australia used for wool production. Consequently, soils in these areas were nitrogen deficient and pastures were generally dominated by unproductive annual grasses and weed species.

Note in the map how the distribution of Mt. Barker falls roughly between the 500 and 600 mm isohyets in South Australia, whereas the same map for Geraldton shows this cultivar hugging the band between 350 and 500 mm rainfall.



The release of Geraldton dramatically increased the land area of South Australia where sub clover could be used successfully.

This development led to major advancements in agricultural production, and was based on the principles of plant adaptation to environment that we have covered in this module. Further advances have been achieved since then in several species, and in most regions of Australia. These advances have been underpinned by scientific knowledge of plant ecology, physiology and genetics, and applied through the use of plant breeding and pasture management technologies.

Subterranean clover, the cornerstone of pasture production in the medium - low rainfall zones of southern Australia, has undergone intensive breeding to increase its adaptive range and productivity.

The impact of sub-clover breeding programs on extending the adaptive range, and use, of this important legume can be seen in the Table below. In 1960, there were few sub-clover cultivars available and these were estimated to be suited to 34 million hectares of agricultural land in Australia. A surge in plant breeding between 1960 and 1990, and the release of several more cultivars, saw the area across which sub-clover could potentially be used rise to 71 million hectares, and actual usage rise to 29 million hectares. These improvements have had a major positive effect on agricultural productivity in southern Australia.

	Potential	Actual
1960	34	19
1990	71	29

Area of Australia (million ha) where sub-clover could potentially be grown, and was actually grown, in 1960 and 1990. Source: Ayres, J.F. *et al*.