Summary

At the start of this project, the soybean industry in Australia was relatively depressed and production had been falling for several years. The entry of CSIRO into soybean breeding was underscored by the premise that either the profitability or the flexibility of soybean cropping needed to be improved in order for the industry to expand. CSIRO considered that profitability could be enhanced either through increasing irrigated yield potential such that soybeans became more competitive with cotton or through higher value grain. Higher value grain could be achieved through breeding of specialty varieties with grain quality matching the requirements of high value culinary markets, principally for off-season supply to Japan. Managing and marketing culinary quality grain would also be attractive for the involvement of the private sector, offsetting the decline in public sector advice.

The flexibility of soybean cropping could be enhanced through reducing the photo-sensitivity of soybeans such that both the width of the planting window could be broadened and the north-south range of adaptation of a given variety expanded. Flexibility would also be enhanced through the inclusion of physiological drought tolerance into adapted germplasm. Broader adaptation would also make provision of seed a more attractive and efficient enterprise for the seed industry.
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Conclusions
Photoperiod sensitivity. It is possible to breed varieties possessing near photoperiod insensitivity for sub-tropical environments. These varieties then possess a dramatically increased north-south range of adaptation and broader adaptation to sowing date.

Drought tolerance. This project documented physiological drought tolerance in a soybean genotype derived from an Indonesian landrace. This type of drought tolerance if transferred to agronomically desirable genotypes could result in greater reliability of soybean production in rainfed or infrequently irrigated cropping on the Darling Downs and Central Queensland (QLD), potentially providing an alternative pulse to mungbeans in these environments.

Culinary quality. The project has developed a critical understanding of grain quality attributes necessary to access higher value culinary markets. A key component of this work has been the development of a rapid small scale tofu quality test. It is apparent that some of the tests used in Australia to measure the tofu potential of grain are inadequate for this purpose.

Weathering tolerance. New sources of tolerance to pre-harvest grain weathering which are unrelated to current coastal varieties have been found and are being incorporated into the breeding program to test if even greater levels of tolerance can be achieved.

Recommendations
Culinary quality. It is recommended that the new project focuses on development of the highest culinary quality realistic for the cropping environment and that a critical understanding of the effect of environments on culinary qualities be developed and this be used to advantage in targeting regions for particular culinary types. For inland areas with irrigation, focus on high tofu quality appears desirable, whereas for dryland and less reliable irrigation areas, the focus should be on natto quality. For coastal environments, the focus should be on maximising yield potential and weathering tolerance with a progressive move to light hilum as opportunity permits. Weathering tolerance and adequate resistance to phytophthora and other diseases need to be progressively enhanced in new material.

Drought tolerance. These traits should be progressively moved into culinary types with suitability for dryland areas.
Outcomes

Benefits

Varieties released to industry

Improved profitability of soybean cropping through provision of soybean varieties with higher yields and development of germplasm with greatly enhanced culinary potential, pyramided phytophthora resistance, broad adaptation and an ongoing ability to deliver these benefits to industry as they become available.

Achievements/Benefits

The variety Melrose with substantially enhanced yield potential and broader adaptation to sowing date has been released. Grower experience with this variety has shown that exceptional yields are easily achieved at a wide range of sowing dates, however in instances where control of sucking insects has been non-existent or poor, Melrose suffers a greater yield penalty than other varieties. Over the next few years, varieties with grain quality matching the requirements of high value tofu and natto, varieties with coastal adaptation and light hilum suited to either the crushing or flour markets, and varieties with dryland adaptation will be released, particularly for QLD, southern New South Wales (NSW) and Victoria (VIC). A strategy to progressively include reduced photosensitivity into all future varieties is in place and should result in varieties with far broader adaptation to both sowing date and latitude than current varieties. All varieties will possess the necessary phytophthora resistance genes. Private sector involvement in the soybean industry has flourished. This is particularly the case in QLD with Phil Brodie Grains and Seed and Grain IAMA, at least partially as a result of the CSIRO engagement strategy.

CSIRO released the soybean variety Melrose which resulted from the semi-dwarf conversion program. In small plots, Melrose had a yield potential of 7t/ha compared with the best variety available at that time Manark of 5t/ha. Melrose also had broader adaptation to sowing date than all other Australian varieties. High yields are able to be achieved with Melrose with sowing anytime from October though to early February. High yields have been confirmed in grower test strips on the Darling Downs with Melrose yielding more than 6t/ha and the next best variety Jabiru at 4.45t/ha. In 2000, the irrigated crops competition was won with a crop of Melrose yielding 6.3t/ha. Melrose was targeted to compete with irrigated cotton on the Darling Downs, something it does successfully. It has been found to also have high yield potential on the coast from Grafton north to the Burdekin, the Atherton Tablelands and in the Douglas Daly, but as it lacks tolerance to weathering, it could not be recommended for coastal areas. In Central QLD, Melrose consistently yields more than 20% higher than the next highest variety. Melrose also has levels of phytoestrogen two to three-fold higher than other light hilum varieties. This has been communicated to the public through the press with a great deal of interest generated. Last summer was the second year of commercial production of Melrose on the Darling Downs and it occupied approx. 20% of the soybean area.

Release of Melrose and confirmation of its exceptionally broad adaptation are proof of concept for the long juvenile conversion and predicted performance. The usefulness of research on photo-periodism, and the value of underpinning the breeding program with strategic research rather than ad-hoc inter-mating of adapted material have been clearly validated.

Several lines are nearing release: CLS1112 is a long juvenile semi-dwarf line with weathering tolerance derived from the Brazilian variety Tropical. CLS1112 will be released in late 2001 for the humid coast from Bundaberg north and is adapted to both wet and dry season planting. It has excellent yields in the Burdekin, on the Atherton Tablelands, in Central QLD and yields similarly to other varieties on the Darling Downs. However, as a black hilum variety, it is not likely to find much favour on the Darling Downs except as a seed crop to supply planting seed to the coast.

Line CM60 will be released in late 2001 for the wet tropical coast and tablelands of north QLD where soybean rust has emerged as a severe problem in green manure crops in this region. CM60 is a line introduced from Thailand, it has high tolerance to rust combined with the Rpp1 gene for resistance, good grain and dry matter production in the tropics during both the wet and the dry seasons.

Tofu quality lines 96127-2-1-2 and 96149-1-11-1-1 have been seed increased on the Darling Downs in anticipation of larger scale tofu and milk quality evaluation. Both lines have large seed, white hilum and high yields. 96127-2-1-2 arose from a cross between the Japanese tofu-quality variety Yomeyutaka and the CSIRO bred long juvenile semi-dwarf line X88. It has been proven to possess excellent tofu quality, and has dispelled the myth that very high culinary quality could not be produced outside the temperate zone. However, although 96127 possesses excellent culinary quality matching that of its Japanese
parent, and disease resistance and yield potential of the other parent, it is not likely to be released because it has low levels of seed shattering at maturity which makes it unsuitable for release.

96149 possesses good tofu quality and is acceptable for all other traits. It will be progressively released for commercial use in late 2001 with full commercial testing both domestically and internationally to occur as grain supplies become available.

CNW0225 is in preliminary seed increase and purification. It has a clear hilum with high yield, Phytophthora resistance and weathering tolerance equal to Zeus. This line has demonstrated that it is possible to combine clear hilum with high levels of weathering tolerance.

Lines have been advanced to the F8 generation in the Riverina possessing large seed size, clear hilum, high yield, pyramided Phytophthora resistance and maturity earlier than existing varieties. These lines principally contain the Rps 1c and Rps 3 genes which in combination confer resistance to all known races in Australia. Work is continuing to combine field tolerance, Rps 2, Rps 4 and Rps 6 into tofu quality background with Riverina adaptation.

The current project has expanded from the previously narrow focus on conversion of semi-dwarf varieties to sub-tropical adaptation through the long juvenile conversion approach. The project has now developed a wide range of advanced breeding material of light hilum or culinary quality with adaptation from northern VIC to the tropics. Specific sub-sets of germplasm contain culinary quality suited to the high value markets for tofu, physiological drought tolerance, exceptional yield potential, true photo-insensitivity or weathering tolerance 50% greater than current best varieties. Work on photo-insensitivity and physiological drought tolerance are highly significant achievements and world-firsts.

**Intellectual property summary**

Varieties are licensed to single merchants so that they have a commercial interest in maintaining supplies of high quality planting seed to industry.

**Additional information**

**Publications**


