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SOYBEAN

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Introduction

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[GRDC 2010 Raising the bar with better Soybean Agronomy](#)

A.1 Crop overview

Soybean or soya bean is a species of legume (*Glycine max*) native to eastern Asia. It is classified as an oilseed rather than a pulse due to its high oil content and its more popular use as a source of vegetable oil and industrial applications such as biodiesel. It has been grown in China for over 5,000 years.

It has a raft of applications including a source of vegetable oil for human food and industrial uses, as a valued protein source in livestock production, for use in preparing a range of human foods such as traditional foods like tofu and soy milk as well as novel uses as a protein isolate and for textured protein. Soybean also has an almost endless application in industrial products such lubricants, plastics, waxes and a range of intermediate chemicals including fatty acids. And in more recent times, soybean has been recognised for its health and well being properties and is now used in a range of nutrition bars, cereals, pasta and baked goods.



Figure 1: Soybean kibble is used in food including multigrain bread. (Photo: Rebecca Thyer)

Soybeans typically contain about 40% protein, 20% oil and 35% carbohydrates. Soy oil is the major food product used worldwide and after extraction the protein is used as a valued meal for livestock. However the protein is also used in soy foods requiring high temperature processing such as tofu, soy milk and textured vegetable proteins.¹

¹ Soy Australia, soybean fact sheets: http://www.australianoilseeds.com/soy_australia/soybean_fact_sheets

Soybean is not only the most important grain legume crop grown in the world because of its dual purpose oil and protein production, it also has important properties that make it a very flexible crop in cropping systems.²

The largest soybean production area in Australia is the New South Wales north coast. Other important regions include inland northern NSW, the southern Queensland coast, the Riverina, and the north-west of Western Australia and Northern Territory. With a wide latitude range (12° to 36° south) and different daylight-length and district differences in temperatures, disease and environments, developing Australian varieties has been a sizeable challenge.

Australian soybean areas are different to other soybean-growing regions such as in the US. Desirable traits for Australian growing conditions, such as disease resistance, high quality and agronomic aspects, are not readily available in overseas varieties.³

The soybean industry is represented by Soy Australia which was formed with the support of the following organisations:

- Australian Oilseeds Federation (AOF)
- Northern Australian Soybean Industry Association (NASIA)
- North Coast Oilseed Growers Association (NCOGA)
- Riverina Soybean Growers Association (RSGA)⁴

Table 1: Australian soybean oilseed production

Market Year	Production	Unit of Measure	Growth Rate
1964	1	(1000 MT)	NA
1965	1	(1000 MT)	0.00 %
1966	1	(1000 MT)	0.00 %
1967	2	(1000 MT)	100.00 %
1968	2	(1000 MT)	0.00 %
1969	5	(1000 MT)	150.00 %
1970	9	(1000 MT)	80.00 %
1971	28	(1000 MT)	211.11 %
1972	38	(1000 MT)	35.71 %
1973	63	(1000 MT)	65.79 %
1974	74	(1000 MT)	17.46 %
1975	45	(1000 MT)	-39.19 %
1976	55	(1000 MT)	22.22 %
1977	77	(1000 MT)	40.00 %
1978	99	(1000 MT)	28.57 %
1979	82	(1000 MT)	-17.17 %
1980	73	(1000 MT)	-10.98 %
1981	77	(1000 MT)	5.48 %
1982	53	(1000 MT)	-31.17 %
1983	89	(1000 MT)	67.92 %
1984	110	(1000 MT)	23.60 %
1985	105	(1000 MT)	-4.55 %
1986	115	(1000 MT)	9.52 %
1987	68	(1000 MT)	-40.87 %

² Australian Oilseeds Federation (2013), Better Soybeans manual http://www.australianoilseeds.com/soy_australia/Soybean_Production

³ GRDC (2014) Australian Soybeans come of age <http://www.grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-113-NovDec-2014/Australian-soybeans-come-of-age#sthash.2qG1Lio.dpuf>

⁴ Soy Australia: http://www.australianoilseeds.com/soy_australia

Market Year	Production	Unit of Measure	Growth Rate
1988	129	(1000 MT)	89.71 %
1989	77	(1000 MT)	-40.31 %
1990	62	(1000 MT)	-19.48 %
1991	63	(1000 MT)	1.61 %
1992	51	(1000 MT)	-19.05 %
1993	81	(1000 MT)	58.82 %
1994	28	(1000 MT)	-65.43 %
1995	44	(1000 MT)	57.14 %
1996	74	(1000 MT)	68.18 %
1997	54	(1000 MT)	-27.03 %
1998	109	(1000 MT)	101.85 %
1999	105	(1000 MT)	-3.67 %
2000	49	(1000 MT)	-53.33 %
2001	63	(1000 MT)	28.57 %
2002	18	(1000 MT)	-71.43 %
2003	74	(1000 MT)	311.11 %
2004	54	(1000 MT)	-27.03 %
2005	56	(1000 MT)	3.70 %
2006	32	(1000 MT)	-42.86 %
2007	35	(1000 MT)	9.38 %
2008	80	(1000 MT)	128.57 %
2009	60	(1000 MT)	-25.00 %
2010	30	(1000 MT)	-50.00 %
2011	86	(1000 MT)	186.67 %
2012	92	(1000 MT)	6.98 %
2013	32	(1000 MT)	-65.22 %
2014	46	(1000 MT)	43.75 %
2015	60	(1000 MT)	30.43 %

(Source: Index Mundi)⁵

A.1.1 Grain soybean

The vast majority of soybean grown in Australia is harvested for grain. Grain soybean will deliver all the agronomic benefits of a legume in the crop rotation sequence with, for example, maize, wheat or sugarcane. However, an important additional benefit is the cash income that can be generated by taking the crop through to grain harvest.

There are three main markets for grain soybean in Australia. The underlying backbone of the industry is the oilseed crushing sector. Crushing soybean is processed into vegetable oils for further processing into table oils and margarine spreads and also for animal feed. This market is heavily influenced by the import parity price of soybean meal from North and South America. Soybean varieties with a dark coloured hilum can only be sold for oil and crushing as hilum colour is not critical for this market.

The oil from grain soybean can also be used for industrial applications such as biodiesel.

⁵ Index Mundi, Australia Soybean Oilseed Production by Year: <http://www.indexmundi.com/agriculture/?country=au&commodity=soybean-oilseed&graph=production>



Figure 2: Twin crop trials of soybean and sunflower. (Photo: GRDC)

Grain soybean can also target the human food sector. Edible grade soybean of superior quality can be sold into the high end culinary market to be processed into a variety of foodstuffs such as milk, tofu and a variety of baking additives such as kibble and flour. This market prefers high protein beans of a large size and only clear or pale coloured hilum varieties are accepted. Soybean that does not satisfy the superior quality required for milk and tofu but still meet all the other quality specifications for colour, protein and size can be sold into the edible flour market.⁶

A.1.2 Fallow/green manure soybean

Soybean has gained popularity as a fallow/green manure option in the sugar industry on Queensland's wet tropical coast. In this region it is not practical to consider soybean as a grain crop as consistent seasonal rains will cause harvesting difficulties in the majority of years. However, as soybean grows very well under high rainfall conditions it is considered highly desirable as a break or fallow crop in the sugarcane cropping system where it is largely managed as a green manure crop. In effect soybean is replacing more traditional green manure crops such as cowpea and lablab because it produces more dry matter (Table 2) with a higher nitrogen concentration (3.0-3.5% N compared with 2.0-2.5% for cowpeas).

Table 2: Example of fallow legume alternatives

Legume species	Dry matter (kg/ha)	N returned (kg/ha)
Broadcast cowpeas	3,313	50
Planted cowpeas	4,689	140
Planted soybean	7,429	310

Soybean N returned is for incorporation of the whole crop. If harvested for grain 66% is removed with the grain.

As a green manure, soybean can be sown anytime from late October to December. This usually fits in well with the sugarcane cropping system where the last ratoon is often cut at the end of the season and ploughed out. Cane is then re-planted in the following autumn/winter following a 6-9 month legume break period.

The varieties Leichhardt and Stuart are well adapted to the tropics, with Leichhardt, in particular, being ideally suited as a green manure crop. The inclusion of soybean in the

⁶ Australian Oilseeds Federation (2013), Better Soybeans manual http://www.australianoilseeds.com/soy-australia/Soybean_Production

sugarcane cropping system in the wet tropics provides a range of benefits, even though the grain is not harvested. These include:

- Good biomass production being well adapted to wet conditions.
- Better tolerance of waterlogging than other legumes such as lablab and Meringa cowpeas.
- Capacity to produce more dry matter and fix more nitrogen per hectare than alternatives.
- More potential soil health benefits by reducing soil borne diseases and lesion nematode numbers.
- A weed control option that will benefit the following plant cane crop.
- Good groundcover for erosion control over the heavy summer rainfall period.

In tropical areas, south of the wet tropics (Burdekin and Mackay) both Leichhardt and Stuart are suitable for grain production.

Traditionally green manure legumes in the sugar industry have been broadcast and disced into the soil. Recent research has shown that their growth and beneficial contribution can be greatly enhanced by establishing them with a planter, using raised beds or ridges and applying a pre-emergent herbicide. Good weed control in the legume will carry through to the next cane crop.⁷

A.1.3 Forage soybean

Although not widely used for the purpose, soybean crops are suitable for both green-chop and hay and silage production, particularly in the sheep, beef and dairy production systems of northern NSW. The best forage yields can be expected from early-planted, long-season varieties, cut around the mid-podfill stage. The preferred varieties for southern Queensland districts appear to be Warrigal, Jabiru and Oakey while Leichardt is the most suitable for the tropics. In northern NSW the varieties Warrigal and A6785 ('Asgrow') are most commonly used for this purpose. In dry years where grain crops fall short on rainfall to finish many producers will cut soybeans for high quality hay. The high protein content of the hay is perfect to be used in supplementary feeding rations, or feed to livestock as a source of high quality fibre and protein.

Silage yields (at around 35% dry matter, cut at the milky-dough/pod fill stage) can be expected to be around 25 t/ha. This equates to around 8 t/ha dry matter yield.⁸

A.2 Executive summary

- Choose a variety that is recommended for your region and plant it at the optimum time to maximise yield potential and grain quality.
- Wherever possible, plant soybean into a full profile of soil moisture unless irrigation is available. Irrigated soybean fields should preferably be pre-irrigated and have an irrigation budget of 6-8 ML/ha. Avoid moisture stress from flowering to physiological maturity.
- Check seed germination and purity—insist on a current germination test certificate. Ensure seed coat has not been damaged prior to planting.
- Always inoculate seed correctly using the soybean-specific strain of Group H inoculant (strain CB 1809).
- Plan weed control measures carefully selecting appropriate herbicides (pre-emergent and/or post-emergent) and/or use inter-row cultivation. Always try to control weeds before you plant.

⁷ Australian Oilseeds Federation (2013), Better Soybeans manual http://www.australianoilseeds.com/soy_australia/Soybean_Production

⁸ Australian Oilseeds Federation (2013), Better Soybeans manual http://www.australianoilseeds.com/soy_australia/Soybean_Production

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- Seed size varies widely between varieties and seasons. Check the bag for seed size and use a formula to calculate sowing rates based on seed size and target plant population (not on bags of seed/ha).
- Establish and maintain a uniform plant stand at the recommended plant population for your climatic and soil conditions.
- Take a soil test prior to planting. Correct any nutritional deficiencies of phosphorus, sulphur, potassium and trace elements (in particular zinc on heavy clay soils). Potassium is commonly deficient in the sugarcane system on many soil types.
- Inspect crops for insect pests and beneficials at least once a week in the vegetative stage and then twice a week from flowering to maturity.
- Reduce the risk of phytophthora root and stem rot by using resistant varieties and selecting paddocks with good drainage and a disease-free history.
- Harvest soybeans as soon as possible to maximise grain quality by reducing the risk of weather damage or harvest losses from over-dry grain.⁹

⁹ Australian Oilseeds Federation (2013), Better Soybeans manual http://www.australianoilseeds.com/soy_australia/Soybean_Production