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& DEVELOPMENT
CORPORATION

CHICKPEA

SECTION A

INTRODUCTION

CROP OVERVIEW | AGRONOMY AT A GLANCE | KEYS TO SUCCESSFUL
CHICKPEA PRODUCTION | BRIEF HISTORY | GRDC CHICKPEA BREEDING
INVESTMENT | KEYWORDS

Introduction

Key messages

- Chickpeas are an annual leguminous crop, used for human and animal consumption.
- There are two groups of chickpeas grown in Australia: Desi and Kabuli.
- Pulse crops, including chickpeas, tend to be grown in the medium to low rainfall (300-500 millimetres (mm)).
- Chickpeas prefer warmer growing conditions; average temperatures below 15°C will reduce pollen viability and can cause flower drop, and average temperatures over 35°C will lower the potential yield and cause possible flower abortion. Therefore, timing of sowing is very important for high yield harvests.
- Chickpeas are a very good source of carbohydrates and proteins, which together constitute about 80% of the total dry seed weight.
- New higher yielding varieties with improved resistance to *Ascochyta* blight have now been developed and should help to stimulate chickpea plantings.¹

A.1 Crop overview

Chickpea (*Cicer arietinum*) is the second most important cool-season food legume worldwide, and is the largest pulse crop in Australia after lupin in terms of planting area and production (Figure 1). On average, chickpeas are sown on 41,1 000 ha annually to produce 448,000 t, with an average yield of 1.15 t/ha.² Chickpeas prices surged in early 2016.³

1 Agriculture Victoria. Growing Chickpea. <http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-chickpea>

2 Reen, R. A., Thompson, J. P., Clewett, T. G., Sheedy, J. G., & Bell, K. L. (2014). Yield response in chickpea cultivars and wheat following crop rotations affecting population densities of *Pratylenchus thornei* and arbuscular mycorrhizal fungi. *Crop and Pasture Science*, 65(5), 428-441.

3 A Felton-Taylor. ABC Rural. Chickpea price surges while disease risk is highlighted. <http://www.abc.net.au/news/2016-04-06/chickpeas-set-to-surge-in-queensland/7303452>

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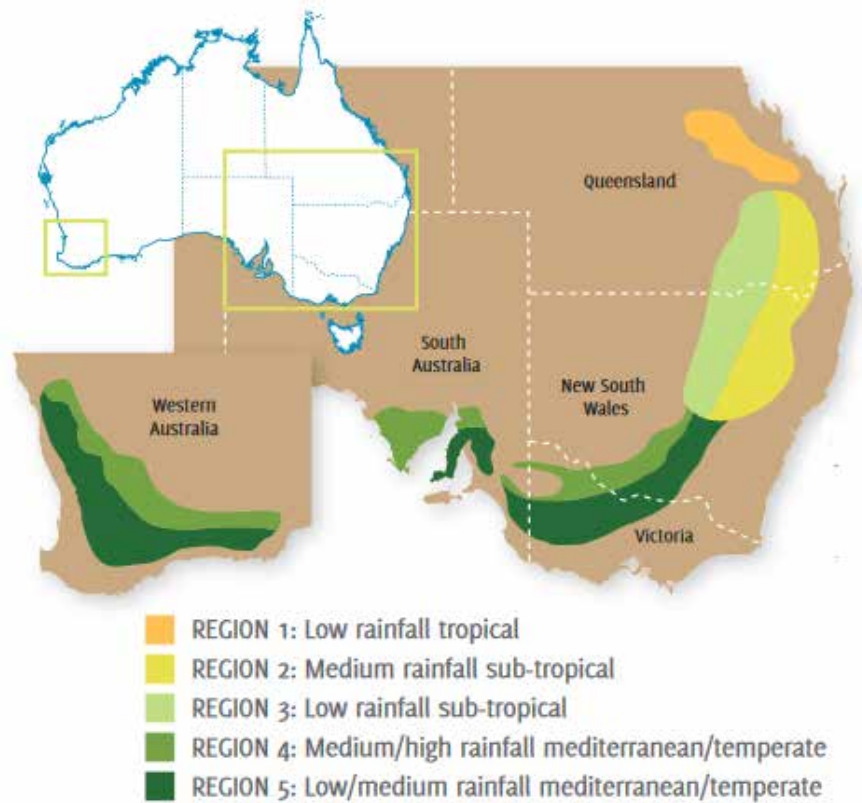


Figure 1: Main growing areas for chickpeas in Australia. Pulse Breeding Australia (PBA) categorises chickpea production areas into five regions based on rainfall and geographic location.

Source: [Pulse Australia](#).

Chickpeas are an annual leguminous crop, with its grain used for human and animal consumption. There are two groups of chickpeas grown in Australia, Desi and Kabuli, mainly distinguished by seed size, shape, and colour. They also have different growth requirements, markets and end-users (Photo 1).



Photo 1: Sales samples of pulses including split lentils, whole polished lentils, desi chickpeas and split field peas (being pointed to) at the Mumbai pulse markets, India.

Source: [GRDC](#).

Desi

Desi types have small angular seeds weighing about 120 mg, are wrinkled at the beak and range in colour from brown to light brown and fawn. They are normally dehulled and split to obtain dhal (Photo 2) and are favoured in the Asian sub-continent. Desi types are generally earlier maturing and higher yielding than the Kabuli types, particularly the larger seeded Kabulis. There is an increasing use of large, whole seeded desi types in a range of food preparations in Bangladesh. A small premium has been paid for Desi types (e.g. Kyabra) fitting this use. Desi chickpeas have traditionally made up about 90% to 95% of Australian production.⁴



Photo 2: *Desi Chickpeas (left) are split (right) to make dhal.*

Photos: [DAFWA](#) and [MaGlobal](#).

Kabuli

Kabuli have larger, rounder seeds, weighing about 400 mg (Photo 3). They are white–cream in colour and are almost exclusively used whole. They are preferred through the Mediterranean region. They are sold whole, so seed size and appearance are critically important. Yields are generally lower and more variable than Desi varieties, although premiums for larger chickpeas can offset the yield disadvantage. Advances through plant breeding are giving more consistent results from Kabuli varieties. Kabuli seed sizes of 7–8 mm can command price premiums of >\$100 per tonne (t) over Desi types, and sizes >8 mm considerably more. Most of Australia’s Kabuli production occurs in the southern grain growing region.⁵



Photo 3: *Kabuli chickpeas produce larger seeds than desi.*

Source: Australian Agricultural Crop Technologies.

The plant is erect and freestanding, ranging in height from 40–60 cm, although well-grown plants may reach 80 cm. They have a fibrous taproot system, a number of woody stems forming from the base, upper secondary branches, and fine, frond-like

⁴ Pulse Australia. Chickpea Production: Southern and Western Regions. <http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/southern-guide>

⁵ Pulse Australia. Chickpea Production: Southern and Western Regions. <http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/southern-guide>

leaves. Each leaflet has a thick covering of glandular hairs that secrete a strong acid (malic), particularly during pod-set, and this provides some protection from insects. The plant can derive >70% of its nitrogen from symbiotic nitrogen fixation. Yields are best in areas with reliable seasonal rainfall and mild spring conditions during seed filling. Chickpeas are well suited to well-drained, non-acidic soils of a medium to heavy texture. ⁶

Chickpeas are prepared and eaten in a variety of ways (Photo 4). Chickpeas are a staple food in the Middle East and the Indian subcontinent. The consumption of pulses in the western world is increasing as diets are becoming more diverse and people are recognising pulses' nutritional value. However, this is still a very small percentage of global consumption. Only 1% of Australian chickpeas is consumed locally, with the remaining percentage exported.



Photo 4: Chickpeas are exported for human consumption.

Source: Pulse.org.

A.1.1 Pulses

Chickpeas are pulses, which are annual legume crops that fix nitrogen from the atmosphere and produce high-protein grain for human consumption. ⁷ Pulses do not include green beans and peas; these are considered vegetable crops. Crops grown mainly for oil extraction (e.g. peanuts and soybean) are also excluded. Pulse crops tend to be grown in the medium to low rainfall (300-500 mm) environments with chickpea sown at the start of the growing season in May.

⁶ Pulse Australia. Chickpea, (*Cicer arietinum*). <http://www.pulseaus.com.au/growing-pulses/bmp/chickpea>

⁷ E Armstrong (2013) The role of pulses and their management in southern NSW. GRDC Update Papers 31 July 2013, <http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/The-role-of-pulses-and-their-management-in-southern-NSW>

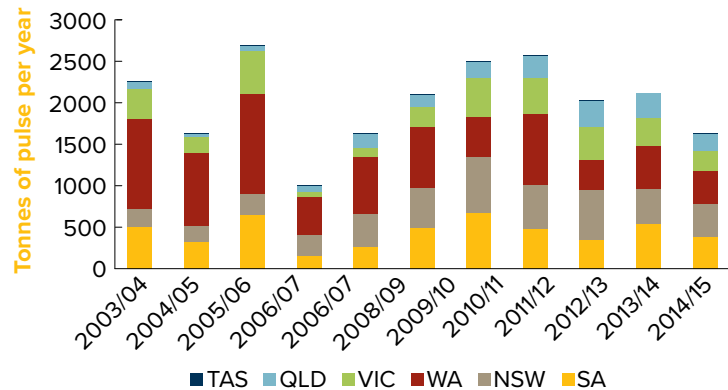


Figure 2: Australian pulse production (tonnes of pulse per year).

Source: ABARES and Pulse Australia.

Australian pulse production has increased rapidly over the last 30 years as a result of the appreciation by farmers of the financial returns from growing these crops and the role of pulses in sustainable cropping rotations. The area sown to pulses has increased from almost nothing in 1965 to over two million hectares in 2012, or about 10% of the area cropped (Figure 2). As part of crop rotation, chickpea has helped alleviate problems caused by continuous cereal cropping such as fungal root diseases, the depletion of soil organic matter and nitrogen levels, degradation of soil structure, and herbicide resistance in weeds.⁸

Pulse crops are generally sown in winter and harvested in late spring or summer. Chickpeas are grown in South Australia, Victoria, Western Australia, New South Wales, and Queensland. The majority of Australian-produced chickpeas are exported, with India, Pakistan and Bangladesh taking nearly 80% of all exported chickpeas. Chickpeas are suitable for both ruminant and non-ruminant feeds but are not commonly used for these purposes because of the higher prices obtained from human consumption markets.⁹

A.1.2 Quality attributes

Australian chickpeas are exported to more than 40 countries. The industry is committed to supplying chickpea with quality attributes tailored to these markets. Important quality traits targeted by chickpea breeders include:

- large and uniform seed size
- lighter coloured seed coat
- splitting quality of Desi chickpea
- hydration and cooking characteristics of Desi and Kabuli chickpeas¹⁰

A.1.3 Nutritional information

Chickpeas are a very good source of carbohydrates and proteins, which together constitute about 80% of the total dry seed weight (Table 1). Pulses are the major source of protein in vegetarian diets. Pulses have a protein percentage of 20–25%, compared with wheat, which has only half this amount and rice, only one-third this

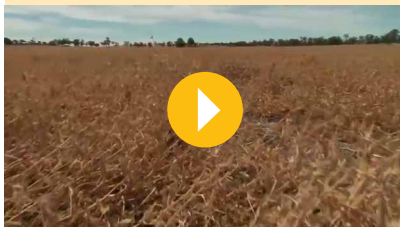
⁸ Siddique, K. H. M., Brinsmead, R. B., Knight, R., Knights, E. J., Paul, J. G., & Rose, I. A. (2000). Adaptation of chickpea (*Cicer arietinum* L.) and faba bean (*Vicia faba* L.) to Australia. In *Linking research and marketing opportunities for pulses in the 21st century* (pp. 289-303). Springer Netherlands.

⁹ P Chudleigh (2012) An economic analysis of GRDC investment in the National Chickpea Breeding Program. GRDC Impact Assessment Report Series, December 2012. <https://grdc.com.au/about/our-investment-process/impact-assessment>

¹⁰ Pulse Australia (2010) A snapshot of Australian pulses. Poster reprint from CICALS/IPIC Convention, http://www.pulseaus.com.au/storage/app/media/crops/2010_Australian-pulses.pdf

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1. GCTV9: [Southern Pulse.](#)



amount.¹¹ Starch, which is the principal carbohydrate component, varies in content from 41–50% and is lower in Desi varieties than in Kabuli varieties. Total seed carbohydrates vary from 52–71%. The crude protein content of chickpea varieties ranges from 16–24%. Crude fibre, an important constituent of chickpeas, is mostly located within the seed coat. Based on amino acid composition, the proteins of chickpea seed were found, on average, to be of higher nutritive value than those of other grain legumes. Chickpeas meet adult human requirements for all essential amino acids except methionine and cysteine, and have a low level of tryptophan. Chickpeas have a high protein digestibility and are richer in phosphorus and calcium than other pulses.

Table 1: Nutritional information for pulses per 100 g raw. These values should be taken as guidelines only; values can vary with variety, conditions of growth and age of pulse.

	Chickpea	Field pea	Lupin	Lentil (red)	Lentil (green)	Faba bean	Mungbean
Energy (kJ)	986	886	1840	968	1550	1680	1800
Protein (g)	13	18	32	14	27	25	26
Fat (g)	3.8	0.8	5	0.4	2.5	1.3	2
Carbohydrate	41	40	26	44	58	57	72
Fibre (g)	17	19	15	7	10	8	12

Source: [Pulse Australia](#).

A.2 Agronomy at a glance

- Avoid saline or sodic soils.
- Assess the Phytophthora risk.
- Avoid waterlogged areas.
- Control broadleaf weeds.
- Ensure there are no damaging levels of herbicide residue.
- Avoid planting near old chickpea stubble.
- Research variety choice and specific variety management packages.
- Ensure seed quality and seed fungicide dressing is adequate.
- Ensure inoculation procedures are adequate.
- Ensure fertiliser requirements are met.
- Assess crop establishment conditions.
- Monitor crops at critical stages.
- Respond to crop management needs in timely way.
- Set up boom spray for fungicides.
- Consider desiccation as harvest aide.
- Prepare storage infrastructure for grain at 14–16% moisture.¹²

A.3 Keys to successful chickpea production

- Make chickpeas part of an integrated cropping system involving wheat, canola, or barley. By taking a systems perspective and assessing financial performance over several seasons, you can estimate the true benefits of chickpeas in a rotation.
- Choose the right variety based on long term yield data for your region, maturity, disease resistance and the market opportunities for human consumption.

¹¹ DAFF (2012) Chickpea—overview. Department of Agriculture Fisheries and Forestry Queensland, <http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/chickpeas/overview>

¹² Pulse Australia, Checklist for Northern Growers http://www.pulseaus.com.au/storage/app/media/crops/2011_NPB-Chickpea-quality-seed.pdf

- Use good quality seed with high germination (80%+) and vigour that is free from seed-borne *Ascochyta* and *Botrytis* infection.
- Select and manage paddocks well in advance to control weeds and retain crop residues. Select paddocks with free draining soil of more neutral pH and low sodicity, salinity, and boron toxicity. Herbicide residues need to be considered, as well as likely weed pressure and the ability to effectively control weeds before seeding and in-crop.
- Establish sufficient plants as recommended for the variety, situation and sowing time. Ideally ground cover should coincide with the time pod filling begins. Plant populations can range from 30–50 plants/m² for rain-fed crops or higher if sown late.
- Sow on time. Sowing time is critical and regional recommendations should be followed. Late sowing reduces yield potential by lowering crop biomass, shortening the pod-filling period and increasing risks from moisture stress and high temperatures. Early sowing can lead to bulky crops, poor early pod set, and greater disease risks.
- Ensure good nutrition. Nitrogen (N) fertiliser is unnecessary as the crop's N requirement will be met through symbiotic fixing of atmospheric nitrogen, provided the seed is inoculated at sowing with the correct commercially available rhizobia inoculant. On phosphorus (P) deficient country, apply fertiliser at rates similar to or slightly less than those for wheat. On alkaline clay soils, fertilising with zinc may be warranted. On acid soils, molybdenum may be deficient and should be applied at or before sowing.
- Know the disease threats to chickpea and how to manage them for your district. No varieties are resistant to all fungal and virus diseases. The major risks are *Ascochyta* blight, *Botrytis* grey mould, and plant viruses. The impact of fungal diseases on yield can be diminished through the strategic selection and use of fungicides and crop management. Maintain an isolation distance of more than 500 m from the previous year's chickpea stubble, and eradicate volunteer plants over summer and autumn as these plants are a source of aphids (potential plant virus vectors) and disease inoculum.
- Control insect pests such as aphids and *Helicoverpa*. Controlling the 'green bridge' of weeds and volunteer crop plants over summer can reduce aphid populations and reduce the numbers that can infest the crop in the early growth stages. Monitoring for *Helicoverpa* (native budworm) caterpillars is essential during podding. Caterpillar feeding during podding will affect yield and potentially render the seed unsuitable for human consumption markets.
- Harvest on time, with a properly set-up header. Start harvesting when the seeds in the majority of pods 'rattle'. Stems may not be completely dry at this stage. Pods will thresh easily to yield clean, whole seeds with a minimum of splits and cracks provided the header settings are correct.
- Have a marketing plan that includes plans for on-farm storage or delivery options off-header. Investigate forward contracting if storage, pools, or warehousing is not an option.
- Optimise irrigation set-up and timing. Chickpeas respond well to irrigation in dry areas. Furrow irrigation is preferred over over-head irrigation. If necessary, pre-water then sow. To maximise yield potential, irrigate crops to produce maximum biomass while avoiding over-watering, as chickpea crops will not tolerate waterlogging. Do not allow the plants to stress during flowering and pod-fill.¹³

A.4 Brief history

The first grain legumes to be introduced into Australia were most likely field pea (*Pisum sativum* L.) and chickpeas (*Cicer arietinum* L.) in the late 19th century. Field pea has been grown ever since, albeit on a limited scale until its resurgence in the 1980s, but chickpeas remained ignored for almost 80 years. Market demand was low, with

¹³ Pulse Australia. Chickpea Production: Southern and Western Regions. <http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/southern-guide>

limited consumption of grain legumes as food in Australia at that time and a restricted knowledge of trade opportunities. With a humble beginning of <0.08 million ha in 1971, winter grain legumes reached >2.3 million ha in the 2012 season (Figure 3).¹⁴

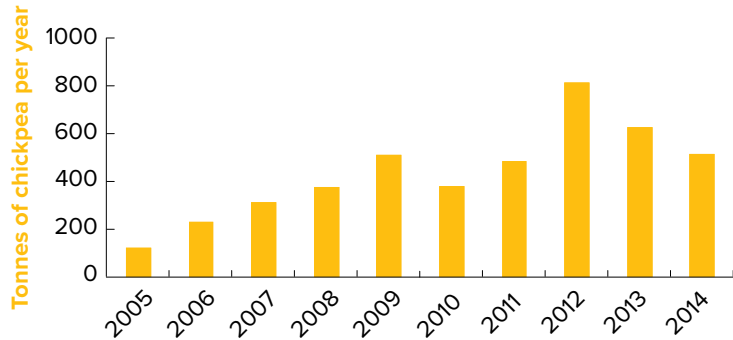


Figure 3: Australia Chickpea production (Desi and Kabuli), tonnes of chickpea per year.

Source: [ABARES and Pulse Australia](#).

Chickpeas were first grown in Australia as a commercial crop in Goondiwindi, Queensland, during the early 1970s. The mixed cropping zone of dryland agriculture of south-eastern Australia traditionally raised cereal crops for 2–5 years followed by a matching or greater period of grazed, legume-based pastures. Chickpeas were first grown in the southern region during the 1980s with the sown area peaking in the mid-1990s before *Ascochyta* blight almost wiped the industry out. New varieties of chickpeas that are *Ascochyta*-resistant are now available and the industry is growing once again.¹⁵

The amount of chickpeas grown in the southern growing region has varied over the last five years (Figures 4-7).

¹⁴ Siddique, K. H. M., Erskine, W., Hobson, K., Knights, E. J., Leonforte, A., Khan, T. N., ... & Materne, M. (2013). Cool-season grain legume improvement in Australia—use of genetic resources. *Crop and Pasture Science*, 64(4), 347-360.

¹⁵ Pulse Australia. Chickpea Production: Southern and Western Region. <http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/southern-guide>

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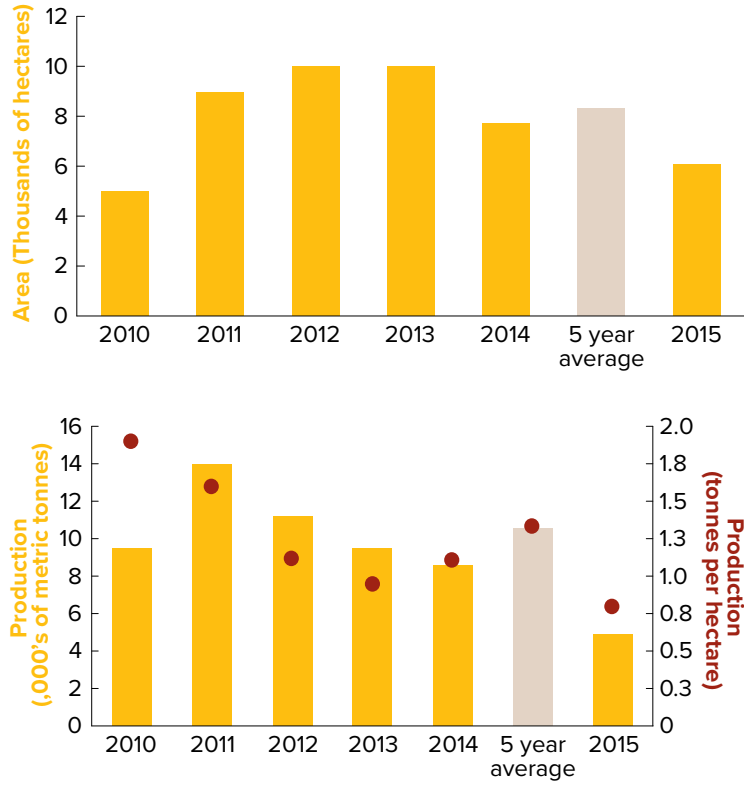


Figure 4: Area sown to Desi chickpeas (top) and production in metric tonnes (bottom) in Victoria.

Source: [Pulse Australia](#).

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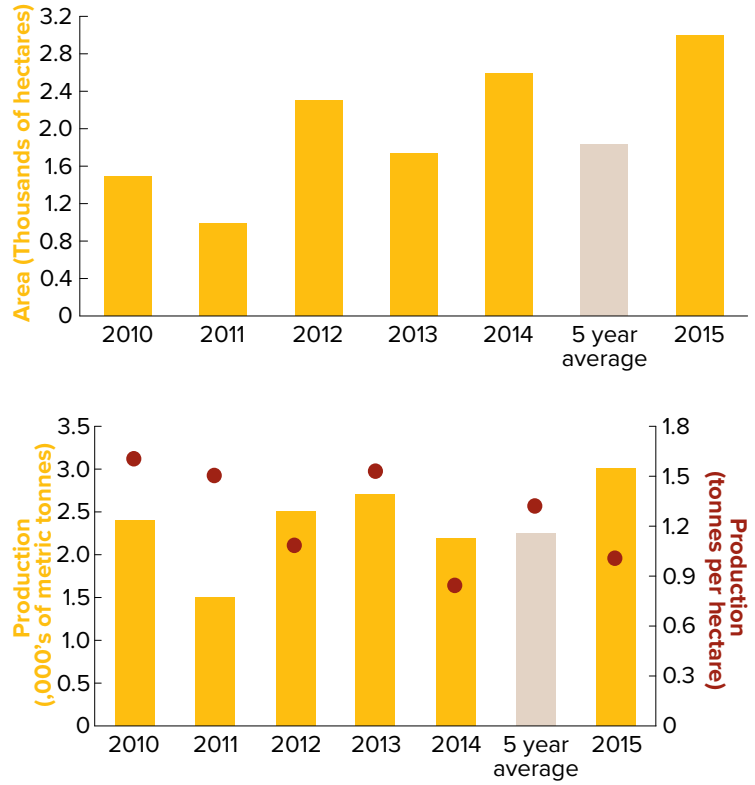


Figure 5: Area sown to *Desi* chickpeas (top) and production in metric tonnes (bottom) in South Australia.

Source: [Pulse Australia](#).

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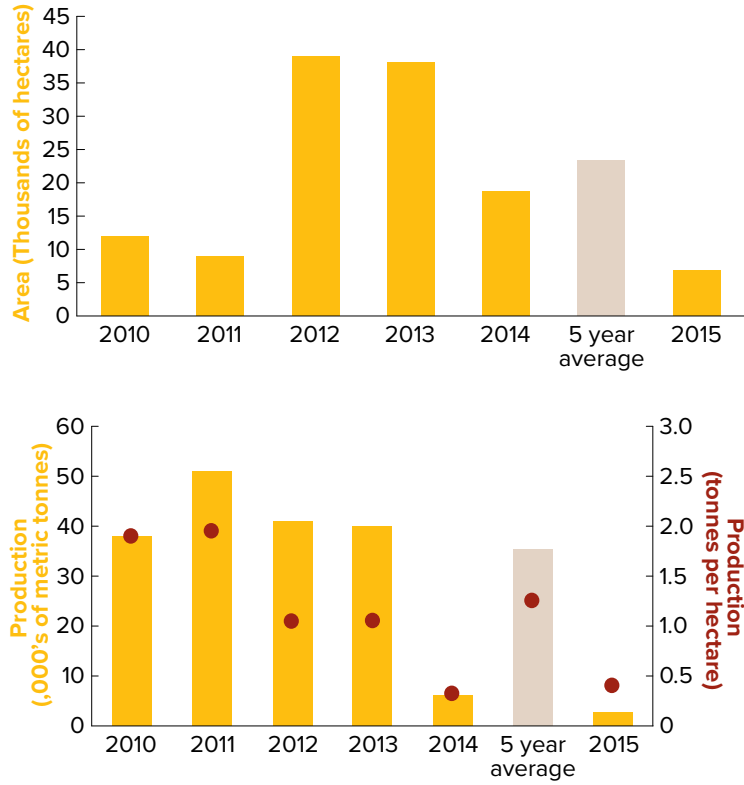


Figure 6: Area sown to Kabuli chickpeas (top) and production in metric tonnes (bottom) in Victoria.

Source: [Pulse Australia](#).

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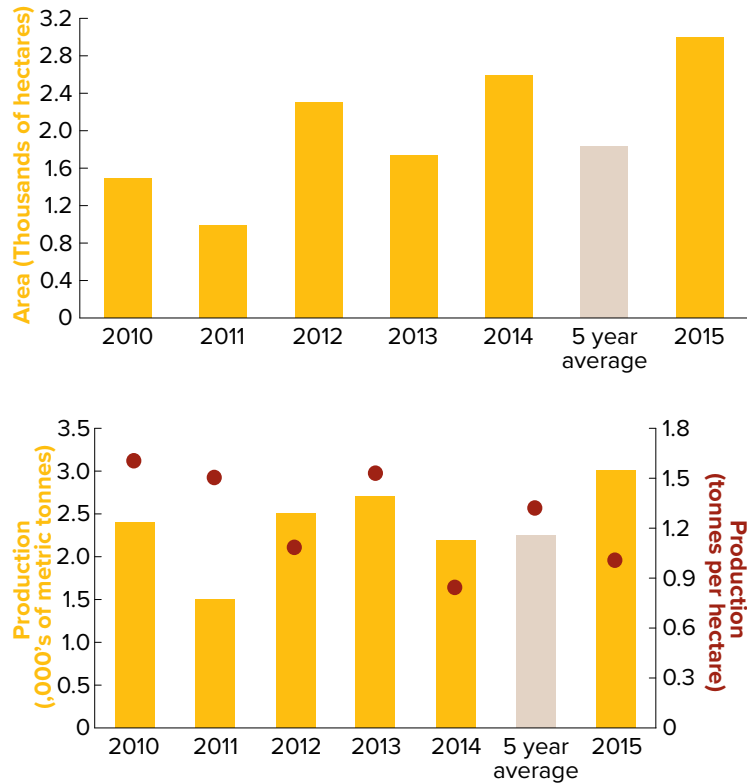


Figure 7: Area sown to Kabuli chickpeas (top) and production in metric tonnes (bottom) in South Australia.

Source: [Pulse Australia](#).

Table 2: Chickpea crop production Ha and Tonne for 2015-2016 in South Australia.

	Lower Eye Peninsula	Eastern Eye Peninsula	Yorke Peninsula	Upper North	Mid North	Lower North	Central hills and Fleurieu	Lower Murray	Nth Murray Mallee	Sth Murray Mallee	Upper south east	Lower south east	State total
Ha	400	200	6500	3200	5000	1000	200	200	1400	1000	200	200	19500
t	500	100	8500	3500	5500	1300	250	200	1000	900	300	250	22300

Source: [PIR SA](#).

2016 saw South Australia's first line of cooked, ready-to-serve chickpeas, as an alternative to imported canned products. The chickpeas are sourced from a collection of growers from the mid-north of South Australia to the York Peninsula (Photo 5).¹⁶

¹⁶ In Daily, Adelaide. Ready-to-eat chickpeas a first for SA. <http://indaily.com.au/eat-drink-explore/2016/02/09/ready-to-eat-chickpeas-a-first-for-sa/>



Photo 5: The first line of chickpeas grown and packaged in Southern Australia.

Source: [In Daily](#).

A.5 GRDC Chickpea breeding investment

The chickpea breeding program has so far relied on conventional breeding techniques. However, the amount of genetic and genomic resources is increasing, and in the near future, marker-assisted breeding methods will be deployed for traits such as pyramiding minor genes for *Ascochyta* blight resistance and combining these with high levels of PRR resistance. It is anticipated that the use of such technologies will be more economical and allow quicker delivery of varieties to Australian growers than current methodologies.¹⁷

The principal outputs of GRDC chickpea-breeding investments have been improved varieties (Photo 6). Important traits from these improved varieties have been disease and pest resistance and traits that influence yield. Improvements in these traits were delivered in the new varieties released between 2005 and 2012. Higher yields and increased disease resistance can translate into higher profits from the chickpea crop, in turn potentially increasing the attractiveness of chickpeas in a cereal rotation and benefiting the next cereal crop.

¹⁷ Siddique, K. H. M., Erskine, W., Hobson, K., Knights, E. J., Leonforte, A., Khan, T. N., ... & Materne, M. (2013). Cool-season grain legume improvement in Australia—use of genetic resources. *Crop and Pasture Science*, 64(4), 347-360.



Photo 6: The GRDC-funded chickpea-breeding program has resulted in improved varieties with better disease and pest resistance.

Source: [NSW DPI](#).

GRDC’s investment in three projects (including the Australian Chickpea breeding program (DAN00094), PBA Chickpea – National breeding program (DAN00151) and DAN00065) is expected to produce a number of benefits. The total investment of \$43 million has been estimated to produce total gross benefits of \$123 million, providing a net present value of \$80 million, a benefit–cost ratio of just under 3 to 1 (over 30 years, using a 5% discount rate), and an internal rate of return of >15%.¹⁸

Pulse Breeding Australian (PBA) is a world-class Australian breeding program for chickpeas, field peas, faba beans, lentils, and lupins. PBA has operated since 2006 and its vision is to see pulses expand to >15% of the cropping area so as to underpin the productivity, profitability, and sustainability of Australian grain farming systems. PBA is developing a pipeline of improved varieties for Australian growers that achieve higher yields, have resistance to major diseases and stresses, and have grain qualities that enhance market competitiveness.

PBA is an unincorporated joint venture between:

[Department of Primary Industries, Victoria \(DPI Vic\)](#)

[South Australian Research and Development Institute \(SARDI\)](#)

[Department of Agriculture, Fisheries and Forestry, Queensland \(DAFF Qld\)](#)

[New South Wales Department of Primary Industries \(NSW DPI\)](#)

[Department of Agriculture and Food Western Australia \(DAFWA\)](#)

[University of Adelaide](#)

[University of Sydney](#)

[Pulse Australia](#)

[Grains Research and Development Corporation \(GRDC\)](#)

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2. [GCTV4: Pulse Breeding Australia Retrospective](#)



A.6 Keywords

Chickpeas, Desi, Kabuli, pulse, nitrogen fixation, rotation, breeding.

¹⁸ P Chudleigh (2012) An economic analysis of GRDC investment in the National Chickpea Breeding Program. GRDC Impact Assessment Report Series, December 2012. <https://grdc.com.au/about/our-investment-process/impact-assessment>