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GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

# CHICKPEA

## SECTION A

## INTRODUCTION

CROP OVERVIEW | 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.
- In Western Australia (WA), chickpeas are mainly grown in the northern and eastern parts of the cropping region.
- Pulse crops, including chickpeas, tend to be grown in areas of medium to low rainfall (350–250 millimetres (mm)).
- 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 in WA.

## A.1 Crop overview

Chickpea (*Cicer arietinum*) is the second most important cool-season food legume worldwide. It is also the largest pulse crop in Australia (after lupin) in terms of planting area and production. On average, chickpeas are sown on 411,000 ha annually to produce 448,000 t, with an average yield of 1.15 t/ha (ABARE 2012). [1]

Chickpeas are an annual leguminous crop, and the grain is 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. In Western Australia, chickpeas are mainly grown in the northern and eastern parts of the cropping region (although a small industry also exists for a specialty large-seeded kabuli chickpea, grown under irrigation in the Ord River irrigation area). [2]

1 DAFWA. Desi Chickpea Essentials. https://www.agric.wa.gov.au/chickpeas/desi-chickpea-essentials

2 https://www.agric.wa.gov.au/pulses/western-australian-pulse-industry

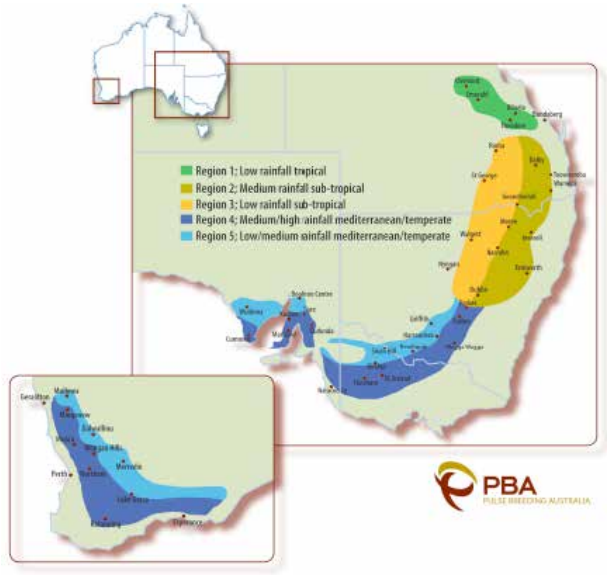


**Figure 1:** *Main growing areas for chickpeas in Australia. Pulse Breeding Australia (PBA) categorises chickpea production areas into five regions, based on rainfall and geographic location.*

Source: http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/northern-guide

## Desi

Desi types of chickpea 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 (Figure 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(b)) fitting this use. Desi chickpeas have traditionally made up about 90–95% of Australian production. [3]

**Figure 2:** *Desi Chickpeas are split to make dhal, a very important dish in India.*

3 http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/southern-guide

### Kabuli

Kabuli have larger, rounder seeds, weighing about 400 mg. 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 over $100 per tonne (t) over desi types, and sizes >8 mm considerably more.

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 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 suited to well-drained, non-acidic soils of a medium-to-heavy texture. [4]

Chickpeas are prepared and eaten in a variety of ways (Figure 3). 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, and the rest is exported.

**Figure 3:** *Chickpeas are exported for human consumption.*

Photo: Flickr

## 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. [5] Pulses do not include green beans and peas; these are considered vegetable crops. Crops grown mainly for oil extraction (such as peanuts and soybeans) are also excluded. Pulses are a minor part of the cropping system in WA, accounting for about 1% of the total

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

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

value of all broadacre grain production. The major pulses grown in WA are field pea, faba bean and chickpea, with smaller amounts of lentils also grown in some seasons. Pulse crops tend to be grown in the medium-to-low rainfall environments (350–250 mm). They are generally sown in winter and harvested in late spring or summer; chickpeas are sown at the start of the growing season in May. [6]

Chickpeas are grown in Western Australia, South Australia, Victoria, 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. [7]

## A.1.2 Quality attributes

Australian chickpeas are exported to more than 40 countries. The industry is committed to supplying chickpeas with quality attributes tailored to these markets (Figure 4). 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 chickpeas [8]

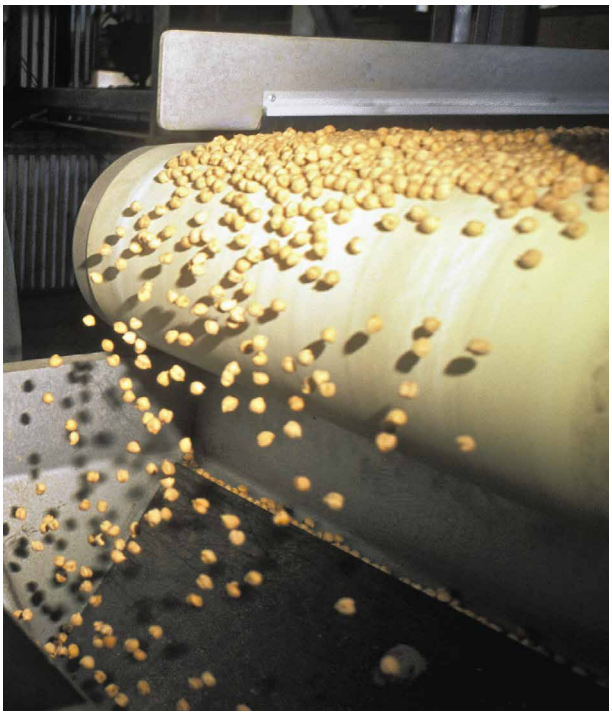

**Figure 4:** *Chickpea being graded. Because chickpea is traded for human consumption, samples must be of high quality.*

Photo: B Collis, Source: GRDC

6 https://www.agric.wa.gov.au/pulses/western-australian-pulse-industry

7 P Chudleigh (2012) An economic analysis of GRDC investment in the National Chickpea Breeding Program. GRDC Impact Assessment Report Series, December 2012. https://www.grdc.com.au/Research-and-Development/~/media/2FE8D5C5C0FE42B8BC7985647002FD70.pdf

8 Pulse Australia (2010) A snapshot of Australian pulses. Poster reprint from CICILS/IPTIC Convention

## 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. Pulses are the major source of protein in vegetarian diets, with a protein percentage of 20–25%; wheat has only half this amount, and rice only has a third of the protein of pulses. [9] Starch, which is the principal carbohydrate component, varies in content from 41–50%, and is lower in desi varieties than 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.1.4 Agronomy at a glance

- Measure stored soil moisture depth
- 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
- Sow in an up-and-back row formation
- 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 [10]

9 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

10 Pulse Australia, Checklist for Northern Growers http://www.pulseaus.com.au/storage/app/media/crops/2010_NPB-Chickpea-checklist-north.pdf

## A.2 Brief history

The first grain legumes to be introduced into Australia were most likely field pea and chickpea in the late 19th century. Field pea has been grown ever since, albeit on a limited scale until its resurgence in the 1980s, but chickpea remained ignored for almost 80 years. Market demand was low, with 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 4). [11]

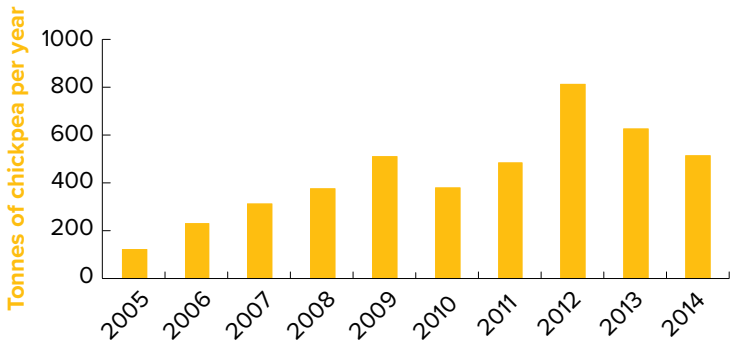


**Figure 5:** *Australia chickpea production (desi and kabuli), tonnes of chickpeas per year.*

Source: ABARES and Pulse Australia

Chickpeas were first grown in Australia as a commercial crop in Goondiwindi, Queensland, during the early 1970s. In the mid-1990s, chickpea was the most rapidly expanding pulse industry in south-western Australia. WA's chickpea industry rose to be a significant 70,000 hectare grain legume crop until the arrival of the fungal disease Ascochyta blight in 1999 devastated the industry. Currently production is less than 10,000 tonnes (see Tables 2 and 3). New higher yielding varieties with improved resistance to Ascochyta blight have now been developed and should help to stimulate chickpea plantings in WA. [12]

**Table 2:** *Production (tonnes) of chickpea crops in Western Australia, 2011–2015.*

| 2011 | 2012 | 2013 | 2014 | 2015 | 5-year average |
|---|---|---|---|---|---|
| 6,000 | 4,000 | 6,000 | 4,000 | 3,000 | 4600 |

Source: DAFWA

**Table 3:** *Adjusted trial yields in t/ha and expressed as percentage of site mean.*

| Region/Nearest town | Agzone 2 Wongan Hills | | Agzone 4 Mullewa | | NVT long-term yield potential |
|---|---|---|---|---|---|
| Variety name | Average yield (t/ha) | % Site mean | Average yield (t/ha) | % Site mean | 2009–2013 |
| Ambar(l) | 0.53 | 99 | .71 | 111 | 1.207 |
| Genesis™ 079 | 0.63 | 116 | .59 | 92 | 1.189 |
| Genesis™ 090 | 0.38 | 70 | .37 | 58 | 1.089 |
| Genesis™ 836 | 0.53 | 97 | .74 | 116 | 1.155 |

11 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.

12 https://www.agric.wa.gov.au/pulses/western-australian-pulse-industry

| | | | | | |
|---|---|---|---|---|---|
| Neelam() | 0.64 | 119 | .62 | 98 | 1.247 |
| PBA Maiden() | 0.59 | 110 | .68 | 106 | 1.169 |
| PBA Slasher() | 0.54 | 99 | .73 | 114 | 1.195 |
| PBA Striker() | 0.56 | 104 | .78 | 122 | 1.257 |
| Site mean (t/ha) | 0.54 | | .64 | | |
| LSD (t/ha) | 0.11 | | .08 | | |
| CV% | 13.92 | | 8.32 | | |
| Sowing date | 15 May 2014 | | 12 May 2014 | | |

Source: Ian Pritchard, DAFWA and NVT

## A.3 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, or 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 faster delivery of varieties to Australian growers than current methodologies. [13]

The principal outputs of GRDC chickpea breeding investments have been improved varieties. 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.


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

GRDC's investment in three projects (DAN00065, DAN00094, DAN00151) 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

13 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.

value of $80 million, a benefit-cost ratio of just under 3:1 (over 30 years, using a 5% discount rate), and an internal rate of return of over 15%. [14]

Pulse Breeding Australia (PBA) is a world-class Australian breeding program for chickpeas, field peas, faba beans, lentils and lupins. PBA has operated since 2006, with a vision to see pulses expand to more than 15% of the cropping area, thereby underpinning 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)

## A.4 Keywords

Chickpeas, desi, kabuli, pulse, nitrogen fixation, rotation, breeding, farming systems, Western Australia.

14 P Chudleigh (2012) An economic analysis of GRDC investment in the National Chickpea Breeding Program. GRDC Impact Assessment Report Series, December 2012. https://www.grdc.com.au/Research-and-Development/~/media/2FE8D5C5C0FE42B8BC7985647002FD70.pdf