Durum wheat production

John Kneipp (Technical Specialist, Farming Systems)
NSW Department of Primary Industries,
Tamworth Agricultural Institute, Calala




NSW DEPARTMENT OF PRIMARY INDUSTRIES

GRDC
Grains Research & Development Corporation

For updates to this publication, check http://www.dpi.nsw.gov.au
Published by NSW Department of Primary Industries
First Published November 2008

ISBN 978 0 7347 1950 8

Acknowledgements

The author Mr John Kneipp (Technical Specialist, Farming Systems) has extracted information from numerous sources for this document. Contributions were made by:
Ms Loretta Serafin, District Agronomist, DPI Tamworth.
Dr Stephen Simpfendorfer, Plant Pathologist, DPI Tamworth.
Mr Frank McRae, Technical Specialist (Cereals), DPI Orange.
Dr Mike Sissons, Cereal Chemist, DPI Tamworth.

In each state where durum wheat is produced there are cereal growing guides and also specific durum production publications.

As well there are publications that set out specific weed control and disease control guidelines. These publications are available from state Departments of Agriculture and Primary Industries.

Finally I pay tribute to Dr Ray Hare who has assisted with information for this document but more specifically for his enormous contribution to the Australian and international durum wheat and pasta industries.

Disclaimer

The information contained in this publication is based on knowledge and understanding at the time of writing (June 2008). However, because of advances in knowledge, users are reminded of the need to ensure that information on which they rely is up to date and to check the currency of the information with the appropriate officer of New South Wales Department of Primary Industries or the user's independent advisor.

Job No 9092

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1. HISTORY AND DEVELOPMENT

Durum wheat (*Triticum turgidum*) or pasta wheat compared with common bread wheat (*Triticum aestivum*) is known for its hardness, protein, intense yellow colour, nutty flavour and excellent cooking qualities.

Durum wheat was first produced in Australia in the early 1930s. A small plant breeding program was established at the NSW Agriculture Glen Innes Experiment Farm but was interrupted by the outbreak of WWII. It was restarted in 1948 and in the early 1960s was relocated to the Tamworth Agricultural Research Station where it remains today as the lead agency of the National Program. The program was led by Dr Ray Hare until his retirement in 2008.

A secondary breeding and evaluation program was commenced at the Waite Institute of Agricultural Research at Adelaide in South Australia in 1991 under Dr Tony Rathgen. The two programs have now been combined (ADWIP) to concentrate all efforts on a national perspective.

The two programs are supported by a cereal chemistry laboratory located at Tamworth Agricultural Institute and led by Dr Mike Sissons.

Although now more widely grown, the industry was founded on the fertile vertosols of Northern NSW and Southern Queensland that were capable of producing high quality Prime Hard bread wheats.

Prior to 1979 the varieties Dural (1956) and Duramba (1970) were the industry standard varieties and produced an annual crop of around 10,000 tonnes. The release in 1977 of the cultivar Durati with both increased yield and pasta quality saw a rise in production to 40,000 tonnes in 1979. This increased production of high quality durum wheat led to considerable interest from both the domestic and international milling industries.

Since that time the Tamworth and South Australian programs have released the following varieties.

Kamilaroi (1982)	Jandaroi (2007)
Yallaroi (1987)	Kalka (2003)
Wollaroi (1993)	Caparoi (2008)
Tamaroi (1998)	Hyperno (2008)
Gundaroi (1999)	Saintly (2008)
EGA Bellaroi (2003)	

Due to a combination of strong international prices, very high quality grain and improved export marketing facilities, Australian durum wheat production has made impressive growth from around 8,000 tonnes produced in northern NSW and SA in the late 1970s to current domestic production of around 500,000 tonnes.

The Australian durum wheat industry is highly competitive with the leading overseas producers (i.e. Canada, USA, EU, Turkey and Syria). Australian durum quality is now

regarded by Italian millers/producers as the best in the world, especially grain shipped from the port of Newcastle.

Italy is the main and most discerning export market for Australian durum (50% of exports). Australia has displaced Canada in this high quality, high value market. When the single desk was in place the AWB actively pursued sales in a range of diverse markets (e.g. North Africa, South Africa, South America, Middle East and East Asia) to reduce Australian reliance on the Italian market. This has continued since the deregulation of the market in Australia.

Historical durum wheat production in Australia

Season	Qld	NSW	Vic	*SA*	*WA*	*Total production (tonnes)*
1994–95	2000	2000	0	33,000	0	37,000
1995–96	6000	55,000	0	65,000	1000	127,000
1996–97	5997	210,000	0	51,000	0	266,997
1997–98	4971	200,600	0	82,601	0	288,172
1998–99	10,737	303,730	0	84,429	984	399,880
1999–00	51,382	527,358	0	142,423	5120	726,283
2000–01	6334	138,696	0	269,524	4009	418,830
2001–02	6033	380,696	0	405,565	4142	796,283
2002–03	8100	55,000	0	162,000	3000	228,100
2003–04	47,700	337,000	2000	217,900	6895	611,495
2004–05	50,000	375,000	2000	220,000	7000	654,000
2005–06	16,230	297,135	6500	117,086	5200	442,151
2006–07	10,000	125,000	10,000	50,000	5000	200,000
5 Year Av.	26,406	237,827	5125	153,397	5419	427,149

Source: AWB Ltd.

2. PRODUCTION IN AUSTRALIA

Since 2001–02 production has declined due to a number of factors including unfavourable seasons, disease, and lower prices. In 2005–06 production was around 500,000 tonnes.

Recent record prices for Australian durum (A$600+ per tonne delivered Liverpool Plains, NNSW in 2007) have increased interest in durum with an increase in sowings in 2008.

NSW accounts for around 56% and South Australia 41% of current production. The balance is produced in Qld, Vic and WA.

Domestic requirement is for around 300,000 tonnes of durum. Industry rationalisation has reduced the number of domestic pasta manufacturers. San Remo, in Adelaide, is the largest user at approximately 100,000 tonnes annually. This is forecast to rise to 125,000 tonnes in 5 years and to 200,000 tonnes in 15 years. The other major manufacturer is Rinaldi in Melbourne. Bellata Gold (Tamworth NSW) is a small but growing private miller and pasta manufacturer. Weston Milling (Brisbane), Goodman Fielder (Sydney), Defiance and Manildra (Gunnedah) produce semolina for Australian and overseas customers.

Currently about 75,000 tonnes of the northern NSW crop is used domestically for pasta manufacture.

A considerable amount of durum can be used for stock feed depending on price, locality and supply of alternate grains.

The Australian Durum Industry Association is advocating a production increase to provide for a reliable supply of 1 million tonnes for export in the next five years. A considerable expansion in production would be required to achieve this outcome.

There is potential for expansion of production in the traditional areas of NSW, Qld, SA and WA as well as other areas such as southern NSW and Victoria.

In the past, overseas customers have been critical of the reliability of supply from Australia. Production risk needs to be spread across a range of environments and an expanded area to guarantee a reliable supply of quality grain.

Northern NSW regularly supplies 400,000 tonnes. In recent drought years this has been down to around 300,000 tonnes . The disease crown rot has been perceived as the major limitation to production in northern NSW but appropriate rotations have been shown to overcome this disease.

Competition with feed grains is also a factor, particularly sorghum.

The increasing adoption of no-till in northern cropping systems and significant developments in sorghum breeding has seen major yield increase in the sorghum crop. (dryland yields as high as 9 tonnes/ha on the Liverpool Plains). The northern durum crop is exported through the port of Newcastle.

South Australia has reached a peak production of 400,000 tonnes but in the past three years has declined to around 150,000 tonne. Continuous cereal cropping in a winter rainfall environment is unhelpful for control of crown rot. Varietal adaptation, seed purity and black crease have all been problems. Genetic control of crown rot has so far been limited.

Export is through the ports of Adelaide and Giles.

Central Queensland has potential to produce 50,000 tonnes for export through the port of Gladstone.

Southern Queensland could produce 100,000 tonnes of durum with major competition from Prime Hard wheat, malt and feed barley and sorghum.

Export facilities exist at Brisbane.

Western Australian production is limited by the inability to produce grain that consistently meets protein requirements. However, better adapted cultivars and improved cropping systems may see this change.

The release of Jandaroi with better adaptation yield and quality will be watched with interest.

There is potential to increase the amount of durum grown under irrigation, particularly in southern NSW. There is currently a small percentage of the northern NSW crop produced under irrigation. In recent years the irrigation industry has taken a battering due to drought and the lack of irrigation water supplies. This will be an ongoing challenge.

There is also some potential for durum production in the Victorian mallee region depending on future varietal adaptation. Pasture and cropping rotations in this region suggest that protein levels would be satisfactory.

In summary, it is likely that 500,000 tonnes could be regularly produced in northern NSW, 250,000 tonnes in SA, 100,000 tonnes under irrigation in southern NSW and 150,000 tonnes in other regions (total 1m tonnes) .

3. VARIETIES AND BREEDING PROGRAMS

NSW DPI has been involved in durum breeding for more than 60 years. The early releases, Dural (1956), Duramba (1970) and Durati (1977) have been greatly improved in both yield and quality to facilitate the growth in the durum industry.

Eight durum wheat cultivars released by NSW DPI continue to dominate the industry Australia wide (95% market share in 2004).

Kamilaroi, 1982: The first significant breakthrough in improved quality and yield. Kamilaroi set the benchmark for what was to follow, possessing good dough properties, high protein and good tolerances to all of the then current rust strains.

Yallaroi, 1987: Released to complement Kamilaroi and should be sown slightly earlier. Consistently out-yields Kamilaroi but may produce grain of lower protein content. Has excellent colour, dough strength and resistance to black point. Slightly less tolerant of weather damage than Kamilaroi but still satisfactory by current standards.

Wollaroi, 1993: Medium height. Strong straw with good lodging resistance. Grain protein content is about 0.5% higher than Yallaroi. Pasta made from Wollaroi has a superior bright, clean yellow appearance and has been popular with manufacturers.

Tamaroi, 1998: Released as being a better adapted cultivar in the South Australian environment. Yields around 15% higher than Yallaroi and is marginally quicker in maturity. This variety has also produced higher protein levels than Wollaroi and Yallaroi.

A crop of Wollaroi in the North Star region of Northern NSW. Photo: Dr R. Hare.

Gundaroi, 1999: Another cultivar having more specific adaption to South Australia. Slightly better yielding than Yallaroi in SA but similar to Tamaroi, Wollaroi and Yallaroi in NSW. Gundaroi offers the South Australian durum wheat industry a cultivar with specific superior site adaptation, while maintaining the pasta quality and disease resistance characteristics of Yallaroi and Tamaroi.

Bellaroi, 2003: Grain yield similar to or better than Yallaroi and Wollaroi in NNSW. Grain protein is consistently higher than other current commercial varieties. Bellaroi has exceptional pasta making quality . Resistant to moderately resistant to stem and leaf rust. Resistant to yellow leaf spot and common root rot. Current major market shareholder.

Jandaroi, 2007: expected to replace Yallaroi and Wollaroi in NSW and Queensland and also to suit central Queensland, SA and possibly WA.

Kalka, 2003: developed by the University of Adelaide and released by Australian Grain Technologies, Kalka is derived from Yallaroi with improved tolerance to high soil boron. During 2000 and 2001, seasons generally free of boron toxicity, its yields were on average 2–3% above Tamaroi but in recent seasons this margin has narrowed. The grain of Kalka is slightly lighter but has less screenings than Tamaroi and features improved semolina colour and hence better marketability.

Most recent releases for 2009 plantings:

Caparoi, 2008: high yielding (similar to Jandaroi), mid-season semi-dwarf variety which is suitable for production across Australia, with high yield performance noted in southern Queensland. Grain quality is similar to EGA Jandaroi and superior to Wollaroi.

Hyperno, 2008: high yield potential, mid-season variety with excellent potential in northern NSW, Queensland and SA. Hyperno has APDR classification in NSW.

Saintly, 2008: Derived from an awnless Kalka sister line crossed twice to Tamori. Saintly is an early maturing line suited to both short and medium season production environments. Saintly is well suited to production zones that are at risk of experiencing a sharp finish to the growing season. Saintly has an APDR classification in South Australia. Saintly produces high quality semolina with higher yellow pigment colour than the current dominant SA varieties Tamaroi and Kalka.Saintly offers an excellent disease package, with high levels of resistance to stem, stripe and leaf rust.

This breeding team has been led by Dr Ray Hare (NSW DPI, retired) in collaboration with colleagues at SARDI, DAFWA and QDPI.

Australian Grain Technologies in conjunction with the University of Adelaide has had an active breeding program for more than 10 years.

The durum breeding program has recently restructured to create one national program between GRDC, NSW DPI and the University of Adelaide. The recent retirement of Dr Hare (July 2008) has been a significant loss to the industry.

Crop of Bellaroi durum wheat grown at Duri, NNSW in 2008. Photo: Mr J. Kneipp.

4. PRODUCTS MANUFACTURED FROM DURUM WHEAT

Photo: Mr J. Kneipp.

Take a walk through any regional supermarket in Australia and be amazed at the variety of durum semolina products on display. The major manufacturing companies both in Australia and overseas describe their pasta products in a standardised order.

Long pasta products

These are the traditional spaghetti type products that are available in a range of thicknesses, such as angel hair (very fine) compared with standard number 5 spaghetti In more recent times some of these long products such as fettucine have been produced in a range of flavours and colours.

Short pasta products

Traditionally this was a standard macaroni shell-like product. However there are now in the order of 40 to 50 shapes and colours of these products. Products like Penne, bow ties, short spirals have become popular additions to salads, some with vegetable flavouring and accompanied with creamy sauces rather than the more traditional tomato sauces.

Lasagna and cannelloni

These products are the typical sheet pastas, either kept as a sheet or rolled into a cylinder to then subsequently be filled with combinations of meat, vegetable and cheese.

Fresh pasta and handmade pasta

There is an increasing demand for fresh pasta products that have a refrigerated shelf life but in combination with a sauce provide a ready made, quick and nutritious meal. These products are often filled with combinations of meat and/or vegetables. There is also demand in the restaurant industry for high quality durum semolina to produce, fresh pasta. There is also an increasing range of ready to cook frozen meals.

Canned pasta and pre-packaged ready-made meals

The demand for these products remains constant and shelf space in supermarkets would indicate this.

These products, particularly the canned pasta, require good strong dough and protein qualities so that when reconstituted in such devices as microwave ovens they retain their structure and are not destroyed by reheating.

5. DOMESTIC AND INTERNATIONAL MARKETING

The market for durum wheat is predominately an export dominant market. AWB Ltd predicts that the export market could reach 700–1000 kt . The domestic market consumes 250,000 to 300,000 tonnes and is steadily rising as the demand for pasta products increases.

There are world markets for both high and lower quality durum wheat.

Mature crop of Wollaroi in northern NSW. Photo: Dr R. Hare

Australian durum (ADR1) has very good physical grain qualities including low grain moisture, low screenings and a high test weight.

Depending on seasonal conditions grain has low levels of black point, high vitreous kernels and very high yellow pigment levels (bright yellow pasta products).

Australian durum is also known for its high semolina yield when it is milled, forming a product with low semolina ash and low residual flour yield. It also yields high levels of quality gluten which is associated with high stable grain protein. Australian wheat is also well known for its cleanliness and freedom from foreign contaminants (weed seeds, etc.).

These quality attributes of Australian durum wheat attest to a very high standing in world markets and this is acknowledged by Italian millers and pasta manufacturers.

Durum wheat has traditionally been marketed to AWB Ltd export pools or under a licensed contract to the domestic semolina milling industry. In more recent years AWB has issued private grain accumulators with a licence to trade durum on the international market.

In the middle of 2008 with a change in Federal Government the single desk export monopoly held by the AWB was revoked. This effectively means that all grain accumulators in Australia can now compete on both the domestic and export markets with AWB Ltd.

The marketing of grain takes particular skills but time spent on tracking markets and using the financial mechanisms available, such as forward selling and hedging contracts, can make a substantial difference to farm profits.

Durum growers are probably more experienced at selling their commodity, but in order to best protect their sales they should look to organisations such as National Agricultural Commodities Marketing Association Ltd (NACMA). NACMA was formed in 1991 with the aim to standardise grain standards and trade rules/contracts across the Australian grain industry. Over 95% of the Australian grain crop is stored in facilities operated by NACMA members, with 90% of the grain contracts executed in Australia each year referring to NACMA grain standards and/or trade rules. NACMA has over 300 member organisations, from grain producers to domestic end users and grain exporters.

Durum wheat production

CLIMATE AND AGRONOMY

As described in the earlier part of this document, durum production is mainly confined to the states of New South Wales, South Australia, Queensland and to a lesser extent Western Australia.

In NSW the major production is in northern NSW. In Queensland it is the Darling Downs and Central Queensland, and in South Australia the south-east. Northern NSW and southern Queensland share similar summer dominant rainfall conditions while South Australia and Western Australia are typical Mediterranean winter dominant rainfall environments.

Typical climate statistics for major zones of durum production

	Dalby, Qld	Gunnedah, NSW	Clare, SA	Merredin, WA
Annual rainfall (millimetres)	612.1	615.7	590.3	326.8
Mean maximum temperature (°C)	26.8	26.0	21.4	24.9
Mean minimum temperature (°C)	12.0	10.9	8.0	11.3

Source: Bureau of Meteorology

The vertosol soils of both the Darling Downs and the Liverpool Plains are typically deep friable black clays capable of storing plant available water to the depth of a metre plus. Most fallows are no-tilled to maximise the storage of summer rainfall.

In contrast the winter growing areas of South Australia and Western Australia rely on growing season rainfall and limited stored plant available water. Apart from the limited summer rains, the lighter textured and shallower soils do not have the same ability as the vertosols to store water.

Durum wheat is also grown successfully under irrigated conditions in most of the production areas using both surface and overhead irrigation systems. Both water and nitrogen management are crucial if high yielding crops of high quality grain are to be achieved. In northern NSW irrigated crops have yielded 8–10 tonnes per hectare using approximately 3.5 mL of water per hectare. Irrigated durum wheat must not follow maize in the rotation as significant outbreaks of Fusarium head blight can occur causing both yield and quality losses. In severe outbreaks of Fusarium head blight toxic fungi or mycotoxins may contaminate the grain making it unfit for human or livestock consumption.

Typical vertosols of the Liverpool Plains in Northern NSW where high quality durum wheat is grown. Photo: Mr J. Kneipp.

Essential durum wheat agronomy considerations

- Select paddocks that are fertile, store good levels of stored water or receive reliable in-crop rainfall or have access to supplementary irrigation. Durum wheat must only be grown where a reliable harvest of high protein (13%+), plump hard vitreous grain can be produced. The highest grade of durum (ADR1) must have a minimum protein level of 13% and ADR2 greater than 11.5%. Careful management of soil nitrogen is essential to achieve this.
- Paddocks that carry high levels of the crown rot fungus (*Fusarium pseudograminearum*) must be avoided at all cost. The crown rot fungus enters the plant through the roots disrupting plant water supply and hence grain yield. Moisture stress will exacerbate these conditions, resulting in the appearance of 'white heads' in the crop that produce small shrivelled grain. It is therefore not recommended that durum crops be grown following a previous wheat crop or maize which is also a carrier of the fusarium head blight fungus (*Fusarium graminearum*).
- Crop rotations using pulses, canola, sorghum, sunflower and pasture legumes are essential to control disease but also to provide opportunities for weed control. A robust crop rotation must be planned over a number of seasons if successful crops of durum wheat are to be produced.
- Quality seed for planting is essential. Only use seed that has a high germination, is large and plump, is both genetically pure, and is free of all contaminants such as weed seeds and impurities of other winter cereals, in particular bread wheat and barley. Seed must be treated with an appropriate fungicide to avoid head disease (smuts and bunts) and leaf diseases (stripe rust).

- Plant seed into a cultivated or chemically prepared seed bed at around 4–6 cm depth and preferably use minimum disturbance equipment with a press wheel adjusted to soil and moisture conditions.
- Seeding rates and sowing times will vary from state to state therefore consult local information. Commonly used seeding rates are 45–50 kg/ha (NNSW) and May through June are the standard planting times. Most current durum wheat cultivars are mid-maturing compared with bread wheats and planting should be adjusted to suit the local seasonal conditions to avoid frost damage to the heads and stems at head emergence and during flowering.
- Crop nutrition is critical to the durum crop if you are to achieve a high quality product. To achieve high protein levels (13% +) soil nitrogen management requires careful planning. Ideally plant durum into a rotation following a grain or pasture legume phase. Alternatively use cropping history in conjunction with soil tests to calculate a nitrogen budget. It is important to soil test for nitrogen to the effective rooting depth of the crop. Nitrogen fertiliser is now an expensive input in our farming systems and it pays dividends to get the critical levels correct. Depending on location other nutrients such as phosphorus, sulfur and on highly alkaline soils, zinc requirements should be met. The variety Kalka in South Australia shows some tolerance to boron toxic soils.
- Weeds compete for both moisture and nutrients so timely and correctly applied herbicides are essential. Seek local advice from advisors/agronomists and follow label directions.

Ellison Bread wheat (Triticum aestivum) *Photo: Mr J. Kneipp.*

Bellaroi durum wheat (Triticum turgidum*) Photo: Mr J.Kneipp.*

- The major diseases of durum wheat are controlled by genetics that have been crossed into current varieties. These include tolerance to the major diseases such as stem, leaf and stripe rust. The changing pattern of behaviour of leaf and stem diseases of all cereal crops requires careful monitoring. It is most important to report any irregularities in the behaviour of these diseases to an advisor/agronomist or plant breeder. Yellow leaf spot, another significant disease of winter crops, is largely avoided by not planting cereal crops into previous cereal crop residues, hence crop rotation is again important.
- Attention to detail at harvest is required for durum wheat. Premiums are only paid when grain is large and undamaged, not mottled or bleached and most importantly not contaminated by other grains, and meets all other delivery specifications. Therefore issues of grain harvester machine settings, careful segregation and clean insect-free grain storage must receive attention. Damaged, contaminated or insect-infested grain will be downgraded. Durum wheat is a high quality product trading into a high quality food market and detail at harvest is critical.

Future expansion of the durum wheat industry

The future expansion of the durum wheat industry is dependant on the following issues being resolved.

1. CROWN ROT

Resistance must continue to be a major breeding objective if the industry is to expand. Currently in northern NSW, southern and central Queensland durum wheat can be grown successfully where good crop rotation practices are followed. In these areas the option of a summer crop make these rotations more flexible as compared with southern winter cropping dominant farming systems. Crown rot has increased in South Australia since the introduction of durum wheat.

Currently, there appears to be very little genetic tolerance to crown rot within the tetraploid population. This means that durable resistance will most likely come from the hexaploid population, a more difficult population to transfer resistance from.

However, for the industry to expand this has to be a very high priority.

2. SOUTHERN IRRIGATION AREA IN NSW

Has some capacity to expand but is limited to around 100,000 tonnes due to a lack of irrigation water supply and the likely constriction in the rotation due to crown rot. Durum wheat following rice appears to be a reasonable rotation but water is the limiting factor. There has been some debate about quality but given appropriate nitrogen management systems this can be overcome. There is also a significant maize industry in this area which competes for area, further limiting the role of durum wheat in the rotation.

3. BREEDING PROGRAM

A well structured and well funded breeding program needs to be maintained. The industry requires secure supplies of high quality grain for the export and domestic markets, which are both growing. A benchmark for quality has been set and for the industry to survive and thrive it must be serviced by a breeding program that continues to release new improved varieties that maintain grain quality disease resistance and high yield.