Amaranth Strategic RD&E Plan (2021-2026)
Emerging animal and plant industries play an important part in the Australian agricultural landscape.

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AgriFutures Australia
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Executive summary

The Australian Amaranth Strategic RD&E Plan 2021-2026 has been developed in consultation with industry stakeholders and represents a roadmap to support their research, development and extension needs.

Amaranth (Amaranthus spp.) is an ancient pseudo-cereal, defined as any non-grass that is used in much the same way as cereals, that originated in Central America, with cultivation and consumption dating back 8,000 years to Aztec times. Amaranth has traditionally been used as a leafy green vegetable, popular in the Asian market, while communities in the Americas have used the grain for salads, cereals and other applications. The goal of this Strategic RD&E Plan is to support the Australian amaranth industry as it works towards growing its annual gross value of production (GVP) to $10 million by 2030.

Three RD&E investment themes have been identified as central to achieving this target.

The first two themes are designed to equip growers with knowledge of production best practice, variety implementation, consumer preferences and markets. The third theme aims to ensure widespread adoption of research findings by stakeholders and the development of a cohesive, collaborative industry. These themes are accompanied by linked strategies and activities that will guide RD&E investment.
Plan on a page

Table 1: Australian Amaranth Strategic RD&E Plan 2021-2026 snapshot

<table>
<thead>
<tr>
<th>Theme</th>
<th>Strategies</th>
<th>Key performance indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.1 Varietal research – Leverage existing overseas research on varietal development to ensure that research and development funds for trials in Australia are used efficiently and effectively.</td>
<td>• New varieties suitable for Australian conditions, and varieties already being grown overseas, are available for use by Australian growers. • Australian growers have performance and best use knowledge of amaranth varieties. • Guidelines and fact sheets are published that detail best practice management for efficient use of inputs and water for different varieties and uses (seed, leafy green, fodder, ornamental). • Guidelines and fact sheets are published that detail harvest and post-harvest systems for adoption in commercial production settings. • Resources are published that inform on integrated pest and disease management (IPDM) strategies. • There is domestic and international support for networking initiatives to enhance capacity building in the industry. • Industry is participating in conferences and forums run by related industries, such as vegetable, dairy, and nursery. • National and international networks are in place to increase innovation in the industry. • There is improved cross-industry collaboration to increase investment efficiency and leveraging of investment funds.</td>
</tr>
<tr>
<td>1</td>
<td>1.2 Production and best practices – Equip growers with knowledge related to markets, varieties and agronomic practices that support the inclusion of amaranth within existing farming systems.</td>
<td>• New varieties suitable for Australian conditions, and varieties already being grown overseas, are available for use by Australian growers. • Australian growers have performance and best use knowledge of amaranth varieties.</td>
</tr>
<tr>
<td>1</td>
<td>1.3 Collaborative research – Explore national and international research opportunities across research agencies, universities, RDCs and representative bodies of related or potentially benefited industries.</td>
<td>• Amaranth has an increased market share in prioritised markets. • Awareness of amaranth products and their benefits has increased. • Research that links amaranth products with improved human health or animal health has been communicated to foodservice and health professionals and associations for dissemination. • Information on the nutritional value of amaranth has been used to drive consumer demand. • Consumer knowledge of, and preference for, amaranth products has increased. • Information has been shared with key related industries to improve collaboration and drive consumer demand.</td>
</tr>
<tr>
<td>2</td>
<td>2.1 Consumer insights – Identify domestic consumer trends, preferences and appealing attributes of amaranth edible varieties and ornamental varieties.</td>
<td>• An organisation to represent the amaranth industry has been established. • A communication and extension plan has been developed and included in each project funded under the Strategic RD&amp;E Plan. • Participation in industry development programs has increased. • Industry information has been disseminated through workshops, webinars, newsletters or other extension mechanisms. • Growers have adopted R&amp;D findings and implemented changed management practices.</td>
</tr>
<tr>
<td>2</td>
<td>2.2 Market research – Explore and identify new markets for amaranth products.</td>
<td>• Amaranth has an increased market share in prioritised markets. • Awareness of amaranth products and their benefits has increased. • Research that links amaranth products with improved human health or animal health has been communicated to foodservice and health professionals and associations for dissemination. • Information on the nutritional value of amaranth has been used to drive consumer demand. • Consumer knowledge of, and preference for, amaranth products has increased. • Information has been shared with key related industries to improve collaboration and drive consumer demand.</td>
</tr>
<tr>
<td>2</td>
<td>2.3 Stakeholder/consumer education – Collaborate with existing, more established industries, including vegetable, nursery and meat, to support market growth through the introduction of new varieties and information sharing.</td>
<td>• Amaranth has an increased market share in prioritised markets. • Awareness of amaranth products and their benefits has increased. • Research that links amaranth products with improved human health or animal health has been communicated to foodservice and health professionals and associations for dissemination. • Information on the nutritional value of amaranth has been used to drive consumer demand. • Consumer knowledge of, and preference for, amaranth products has increased. • Information has been shared with key related industries to improve collaboration and drive consumer demand.</td>
</tr>
<tr>
<td>3</td>
<td>3.1 Industry formation – Encourage the formation of the amaranth industry through existing industry bodies in each use area.</td>
<td>• An organisation to represent the amaranth industry has been established. • A communication and extension plan has been developed and included in each project funded under the Strategic RD&amp;E Plan. • Participation in industry development programs has increased. • Industry information has been disseminated through workshops, webinars, newsletters or other extension mechanisms. • Growers have adopted R&amp;D findings and implemented changed management practices.</td>
</tr>
<tr>
<td>3</td>
<td>3.2 Industry development and capabilities – Improve amaranth grower capability through making use of extension channels.</td>
<td>• An organisation to represent the amaranth industry has been established. • A communication and extension plan has been developed and included in each project funded under the Strategic RD&amp;E Plan. • Participation in industry development programs has increased. • Industry information has been disseminated through workshops, webinars, newsletters or other extension mechanisms. • Growers have adopted R&amp;D findings and implemented changed management practices.</td>
</tr>
<tr>
<td>3</td>
<td>3.3 Communication and extension – Develop a communication and engagement strategy to support adoption of research outputs. This component needs to be added to every funded project.</td>
<td>• An organisation to represent the amaranth industry has been established. • A communication and extension plan has been developed and included in each project funded under the Strategic RD&amp;E Plan. • Participation in industry development programs has increased. • Industry information has been disseminated through workshops, webinars, newsletters or other extension mechanisms. • Growers have adopted R&amp;D findings and implemented changed management practices.</td>
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</table>
Industry profile

The amaranth industry

Amaranth (Amaranthus spp.) is a fast-growing plant that is widely distributed throughout the world and belongs to the family Amaranthaceae. Amaranth is an ancient pseudo-cereal from Central America that dates back 8,000 years to Aztec times. Pseudo-cereals include plants such as amaranth, quinoa, tartary buckwheat, buckwheat and millet; plants recognised as cereals are monocotyledons, pseudo-cereals, on the other hand, are dicotyledons, also known as dicots. Plants in the Amaranthaceae family are widely acclimatised to different abiotic stresses, such as drought and salinity, and have multiple applications (Sarker and Oba, 2018).

Amaranth has traditionally been used as a leafy green vegetable, the most prominent variety being Amaranthus tricolor, also known as en choy in Asian markets, while communities in the Americas have used the grain for salads, cereals and other applications. It is grown on a relatively small scale in Australia.

Its versatility and potential for dual use makes amaranth a highly promising alternative for vegetable, grain and forage/meat producers. Subject to varietal performance, amaranth has the potential to deliver an attractive growth trajectory if it could grow its share of the fresh leafy Asian vegetables ($77m), fresh leafy salad ($408m), nursery ($2.56b) or cut flower ($293m) markets in Australia (Horticulture Innovation Australia, 2020). This market potential can be added to through uses in fodder ($2.5b), other grain-based amaranth products ($237m) and other value-adding industries, and suggests there is a need for greater local supply (Australian Bureau of Statistics, 2021). Research conducted by Coriolis indicated that there is potential for the Australian amaranth industry to have a $5-10 million annual gross value of production by 2025 (Coriolis, 2017).

<table>
<thead>
<tr>
<th>Property</th>
<th>Presence in amaranth</th>
</tr>
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<tbody>
<tr>
<td>Protein</td>
<td>Amaranth has high protein content (12-15%) and is a carrier of lysine, an amino acid not present or found in negligible amounts in many other grains.</td>
</tr>
<tr>
<td>Oil</td>
<td>Amaranth consists of 6-9% oil, more than most other cereals. Amaranth oil contains approximately 77% unsaturated fatty acids and is high in linoleic acid.</td>
</tr>
<tr>
<td>Fibre</td>
<td>Amaranth is high in dietary fibre.</td>
</tr>
<tr>
<td>Gluten</td>
<td>Amaranth is gluten-free.</td>
</tr>
<tr>
<td>Phytosterols</td>
<td>Amaranth is a rich dietary source of phytosterols and has cholesterol-lowering properties.</td>
</tr>
<tr>
<td>Minerals</td>
<td>Amaranth is high in iron, magnesium, phosphorus and potassium, and has appreciable amounts of calcium.</td>
</tr>
<tr>
<td>Peptides</td>
<td>Amaranth contains a lunasin-like peptide and other bioactive peptides that are thought to have cancer-preventive and anti-hypertensive properties.</td>
</tr>
</tbody>
</table>

The demand for amaranth has recently grown significantly in Europe, North America and Asia, and the global amaranth market had an estimated value of US$5.88 billion in 2017 (Grand View Research, 2019). While no statistics are maintained for volume imported into Australia, it is likely to be substantial as amaranth flour, amaranth seeds and puffed amaranth products are stocked in supermarkets and health food stores. Research conducted by the Grains & Legumes Nutrition Council (GLNC) showed that 34 products across breakfast cereal, crackers, bread, grains and meat alternatives containing amaranth are sold in supermarkets. Over the years, there has been consistent recognition through research of the high nutritional value of amaranth. Table 3 provides a summary of some of its nutritional qualities.

<table>
<thead>
<tr>
<th>Product type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursery1</td>
<td>$2.56b</td>
</tr>
<tr>
<td>Hay</td>
<td>$2.5b</td>
</tr>
<tr>
<td>Fresh leafy salad vegetables2</td>
<td>$408m</td>
</tr>
<tr>
<td>Cut flowers</td>
<td>$293m</td>
</tr>
<tr>
<td>Broadacre crops3</td>
<td>$237m</td>
</tr>
<tr>
<td>Fresh leafy Asian vegetables4</td>
<td>$77m</td>
</tr>
</tbody>
</table>

Table 2: Production value of existing Australian markets


1 Nursery covers live plants grown for a range of uses, including landscaping, re-vegetation and distribution of ornamentals into retail supply chains, plus as starter plants in the commercial production of fruit, vegetables and forestry.
2 Includes exports of 1,345 tonnes of fresh leafy salad vegetables, valued at $9.9m.
3 Combination of ‘Broadacre crops – Cereal crops – All other cereals for grain or seed’ and ‘Broadacre crops – All other crops n.e.c.’.
4 Fresh leafy Asian vegetables covers a range of similar vegetables such as bok choy, pak choy, gai lan and wombok (Chinese cabbage).
The Australian amaranth industry

Within Australia, amaranth has been researched sporadically since the 1980s, with limited commercial adoption and/or expansion. Research within Australia, including Vinning and McMahon (2006), Coriolis (2017) and private research, has predominately focused on the plant for grain production in an attempt to replicate the success of chia and quinoa as high-value superfoods. Some businesses are beginning to investigate the crop for forage, food and use in health/skincare products.

Currently, the leading amaranth production model in Australia is to grow it for use in ornamentals, with infrastructure in place to introduce successful varieties for seed, ornamental (pot) and cut flowers. Nurseries produce plugs from seed to grow further on pots or to plant directly into land. These get to consumers through ornamental plug producers, wholesalers and flower markets/shops; a small proportion of seed is grown for human consumption.

Production figures for amaranth as a vegetable (en choy) in Australia are scarce. A report completed by Coriolis in 2017 suggested the value of the Australian amaranth industry was between $1 million and $2 million (Coriolis, 2017). A collaborative report supported by Horticulture Innovation Australia and AgriFutures Australia from 2003 estimated that en choy made up approximately 1% of Asian vegetables sold by a specialist retailer (Jenny, 2008).

The Australian Horticulture Statistics Handbook (2020) estimated the 2019–20 farmgate value for the leafy Asian vegetables industry was $77.2m (31,897 t), a 17% increase from 2019. Assuming that en choy has grown in popularity over the past 20 years, and now makes up 2–2.5% of the leafy Asian vegetables industry, its farmgate value could have increased to more than $2 million. This data can only be backed by Australian population growth rates as no other formal data is recorded for amaranth.

Separate consumer research funded by Horticulture Innovation Australia identified consumers liked amaranth (red spinach) because of its similar taste, flavour, storage methods and shelf life to regular spinach, and declared the crop as ‘unbalanced’ in terms of amino acid composition as they lack of sufficient amounts of lysine for optimum health. Amaranth protein has nearly twice the lysine content of wheat protein, three times that of maize protein and as much as is found in milk (National Research Council, 1984). Amaranth seeds are used in cereals, confectionary, snack manufacturing, flours (gluten-free), puffed cereals and porridge. New consumer trends looking for alternatives to traditional cereals, gluten-free options and plant-based protein products grown with low environment impact provide amaranth with a comparative advantage over other cereals. Research has also shown that amaranth, when consumed in a mix with other legumes and grains, provides higher levels of phosphorus, potassium, manganese and vitamins E and B, along with niacin.

Amaranth seed harvesting uses similar processes to those used for quinoa, however the seed size is substantially smaller, although some coated options exist. This is an important consideration when planting and harvesting to maximise yield.

Information about the annual value of amaranth production is scarce. However, according to the ABS publication Value of Agricultural Commodities Produced, the production value of broadacre crops excluding major commodities in Australia in 2019–20 was $237 million. This figure combines ‘Cereal crops – All other cereals for grain or seed’ and ‘All other crops not elsewhere classified’.

Amaranth uses

Seed (pseudo-cereal)
A. cruentus L., A. caudatus L. and A. hypochondriacus L. are commonly used varieties for seed/grain production. These are originally from Central America and the Andes regions, where they continue to be widely grown. Researchers have claimed that the importance of the protein present in amaranth seeds doesn’t only lay in its quantity but also in its quality. In 1972, Australian plant physiologist John Downton discovered that amaranth seeds contained protein of unusual quality and that amaranth seeds were high in the amino acid lysine; cereals are considered ‘unbalanced’ in terms of amino acid composition as they lack of sufficient amounts of lysine for optimum health. Amaranth protein has nearly twice the lysine content of wheat protein, three times that of maize protein and as much as is found in milk (National Research Council, 1984). Amaranth seeds are used in cereals, confectionary, snack manufacturing, flours (gluten-free), puffed cereals and porridge. New consumer trends looking for alternatives to traditional cereals, gluten-free options and plant-based protein products grown with low environment impact provide amaranth with a comparative advantage over other cereals.
Industry profile

Biotechnology

A 2014 study led by two Polish universities, the University of Warmia and Mazury and the Warsaw University of Life Sciences, examined the content of select nutrients in the seeds, popped seeds and flakes of amaranth (Amaranthus cruentus), and investigated the lipid content to determine the fatty acid profile and the content of lipid-soluble bioactive substances in amaranth. The study concluded that amaranth seeds are a source of vegetable oil that has high squalene content (Dgradowska et al., 2014).

Squalane is a highly refined botanical lipid used in the composition of dietary supplements, pharmaceutical applications and cosmetic applications. According to skincare manufacturers using this compound, squalane absorbs easily and is often used in products to help replenish the skin barrier.

Amaranth is one of the vegetable sources of squalane (the lipid can also be extracted from animal and biosynthetic sources). The global squalene market is projected to reach US$184 million by 2025, up from US$129 million in 2020 (Markets and Markets, 2020).

Ornamental

Today, the amaranth industry in Australia is mainly concentrated on the production of ornamental varieties for both pot and cut flowers (fresh or dried). Existing commercial varieties include Celosia argentea plumosa (Dragon's Breath), Celosia argentea 'Intenz', Celosia argentea var. spicata, Amaranthus hypochondriacus (Pygmy Torch) and 'Green Thumb'. These varieties have been sourced internationally and are commercialised privately by nurseries. They are attractive to consumers given their brightness, variety of colours and variety of shapes.

According to the Australian Horticulture Statistics Handbook, the nursery value of production in Australia in 2019-20 was $2.56 billion. This represented 5% and 4% increases, respectively, from the previous year (Horticulture Innovation Australia, 2020).

Leafy greens

There are about 70 consumed species of Amaranthus in the world, 17 of which are cultivated for edible leaves, and three cultivated as food grains (Jenssen, 1978).

Research shows that amaranth leaves and stems are good sources of carotenoids, proteins, including the essential amino acids methionine and lysine, dietary fibre and minerals, such as magnesium, calcium, potassium, copper, phosphorus, zinc, iron, and manganese. Amaranth is also abundant in several pigments and naturally abundant antioxidants, such as flavonoids, phenolics, carotenoids, and vitamin C (Sarker et al., 2014; Repo-Carrasco-Valencia et al., 2010).

Amaranth leafy greens are widely consumed in the Americas, Asia, Africa and some parts of Europe. Its nutritional value, taste and attractive leaf colour make it very popular. Amaranth plants are annuals and grow from seed; the time from seeding to harvest is about three to six weeks. Amaranth leaves can be grown in greenhouses, under hydroponic systems, or directly in the ground. A two-stage greenhouse production process – seed to seedling, seedling to ground – is also commonly used.

Several studies underway in the above-mentioned regions are investigating ways to make vegetables with higher nutritional value more available, with the ultimate aim being to improve population health.

Amaranthus tricolor L. is one of the most commonly cultivated and used varieties in South and Southeast Asia, and is also known as edible amaranth, hon-toi-moi, tampala, Chinese spinach, choy and bireum in the Republic of Korea, India, Bangladesh and China. In local cuisines, it is consumed in stir-fry dishes, soups and salads. The leaves are sold in bunches or as loose leaves. At harvesting, young green leaves are used in salads, while older green leaves are cooked like spinach.

According to the Australian Horticulture Statistics Handbook, the fresh leafy Asian vegetables value of production in Australia in 2019-20 was $77 million, and the fresh leafy salad value of production was $408 million. This represented 17% and 3% increases, respectively, from the previous year (Horticulture Innovation Australia, 2020).

Fodder

The fodder industry is an important industry in Australia. According to the ABS publication Value of Agricultural Commodities Produced, the production value of hay in Australia in 2019-20 was $2.5 billion; formal silage data is not publicly available. Over the same period, the production value of Australian livestock products to which fodder is a substantial input, including milk, wool, eggs and meat, was $32.4 billion.

The fodder industry faces similar challenges to other agriculture sectors in that climate conditions and production challenges make innovation a key factor in its success, and the success of those industries that rely on its production. Examining, developing and producing potential fodder alternatives capable of adapting to climate change and environmental sustainability demands, e.g. those that require few inputs and limited water but produce a commodity with high nutritional value, has never been more important.

While much of the prior research on amaranth has focused on seed production, amaranth has significantly broader applications. These include using it within farming systems as a rotational crop that has a rapid growth rate, requires modest inputs and can deliver high levels of nutrition for both animal and human consumption. A Food and Agriculture Organisation (FAO) report published in 2013, Identification of Amaranthus plant as a forage resource, concluded that amaranth has appropriate forage quality at the seeding stage of development, and that the silage made from amaranth forage is good quality, however the addition of molasses improved the silage quality. Further research is required to explore the nutritional effects in animal digestibility and the nutritional value of amaranth hay and silage.

The dual-purpose capability of amaranth can also provide the fodder industry with an alternative income stream, e.g. if a wet spring season prevents a harvest for biomass, producers can still obtain a grain yield and therefore a suitable return.
<table>
<thead>
<tr>
<th>Application</th>
<th>Product category</th>
<th>Uses and products</th>
<th>Benefits</th>
<th>Opportunities</th>
<th>Potential participants / collaborators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human consumption and uses</td>
<td>Grains and seed (pseudo-cereal)</td>
<td>• Flours • Cereals/cereal bars • Confectionary • Food stabilisers, e.g. yogurts • Seeds • As an ingredient (supplements)</td>
<td>• Gluten-free or low-gluten alternative • Produced locally • Potential dual-purpose varieties (green leaves/seeds)</td>
<td>• Expand the superfood range for consumers/manufacturers</td>
<td>• Food processors and manufacturers • Grain/flour/cereal/pasta manufacturers • Grain/ pseudo-cereal growers • Grains Research and Development Corporation • Seed producers</td>
</tr>
<tr>
<td></td>
<td>Green leaves and leafy greens</td>
<td>• Salad mixes (leafy green) • Frozen vegetable • Juices • Dried leaves (supplements) • Fermented foods</td>
<td>• High nutritional value similar to spinach • Can leverage consumer familiarity with spinach • Imported products have barriers to entry • Potential dual-purpose varieties (green leaves/seeds) • Potential dual-purpose varieties (green leaves/inflorescence)</td>
<td>• Additional alternative to current vegetable/green leaf products</td>
<td>• Vegetable/horticulture growers • Ausveg • Horticulture Innovation Australia • Fresh salad or frozen greens manufacturers</td>
</tr>
<tr>
<td></td>
<td>Inflorescence</td>
<td>• Tea</td>
<td>• Potential dual purpose varieties (green leaves/inflorescence) • High-biomass green manure application</td>
<td>• Asian market demand • Tea producers</td>
<td>• Biotech/pharmaceutical companies</td>
</tr>
<tr>
<td></td>
<td>Biototechnology</td>
<td>• Squalene (skincare and haircare products) • Whiting agents • Antioxidants (pharmaceutical, vitamin and supplement markets)</td>
<td>• Highly sought-after compounds in the beauty market, specifically in Asia • High-biomass green manure application</td>
<td>• Alternative and locally produced source of compounds for manufacturers of beauty products</td>
<td>• Biotech/pharmaceutical companies</td>
</tr>
<tr>
<td></td>
<td>Ornamental</td>
<td>• Expansion of the existing ornamentals range</td>
<td>• Short cycle, adaptable to various conditions • Already marketed in Australia and used at iconic locations as a pot flower and cut flower</td>
<td>• Access to ornamental market • Develop a low-maintenance inflorescence alternative</td>
<td>• Nursery growers • Ornamental and cut flower producers</td>
</tr>
<tr>
<td>Animal consumption and uses</td>
<td>Fodder</td>
<td>• High nutritional value • Alternative/rotational crop in farming systems • High-yielding varieties • High-biomass green manure application</td>
<td>• Source of silage and hay – opportunity exists for Western Australia to develop a new fodder crop for export to meet demand from the Chinese pork industry • Alternative to lucerne in dryland applications • Alternative to lucerne in irrigated applications – particularly due to its ability to grow when irrigated with high-salinity irrigation water • In-row production for horticulture producers</td>
<td>• Livestock industries and relevant research and development corporations • Fodder industry participants • Agronomy groups</td>
<td></td>
</tr>
</tbody>
</table>
## Strengths, weaknesses, opportunities, threats

### Strengths
- High protein levels in various off-takes from modest inputs
- C4 plant is more efficient in arid conditions than C3 plants (climate change)
- Short production cycle
- Higher productivity when considering its ratio of biomass to water and land used (dependant on variety)
- Ability to be used in gluten-free products
- Ability for seed and related products to be produced locally
- Versatile plant that offers multiple options to growers
- Internationally recognised crop characteristics
- Internationally researched crop – new and enhanced varieties for different end uses
- Preliminary research conducted in some parts of Australia
- International relationships with key, long-term researchers of amaranth varieties

### Weaknesses
- Limited consumer knowledge of benefits of amaranth in Australia
- Limited end use evaluations conducted for the different end uses of amaranth
- Lack of the infrastructure required for oil extraction process and squalene
- Considerable production required for low-extraction volumes
- Variability of squalene yield due to extraction conditions and genotype

### Opportunities
- Overall expansion of amaranth nationally given various end uses and currently available varieties
- Manufacturing/processing for human consumption
- New domestic and export market channels
- Viable alternative to traditional fodder sources
- Linkages with readily available international innovation sources
- Greater collaboration with domestic and international industry participants
- Access to a wider spectrum of the amaranth value chain – adding to ornamentals
- Greater knowledge of markets, varieties and agronomic practices
- Potential to embed amaranth within crop rotation in farming systems
- Locally produced seed and related products can ease reliance on imports
- Expansion of traditional cereal grains and legume crops (e.g. lucerne) industries – can become an alternative for existing producers
- Potential to benefit from shark fishing regulations limiting the ability to use this animal source of squalene (shark liver oil is the richest natural source of squalene)
- Increasing global demand for superfood, high-protein and gluten-free products

### Threats
- Access to cheaper imported materials
- Potential restrictions on certain varieties being grown in some states
- Reduction in funding sources to develop the industry
- Lack of interest from local growers
- Pests and diseases
Industry consultation

Amaranth is an emerging industry without a representative body. The initial step in the consultation process for the Australian Amaranth Strategic RD&E Plan 2021-2026 was the identification of key audiences.

In the first instance, these were identified as a mix of existing industry participants, including cereal, seed, vegetable, ornamental and forage crop producers. The aim of consulting with this group was to strengthen knowledge of amaranth markets, consumer applications, farming benefits and production management practices, and the ability to introduce a commercial crop alternative in farming systems.

Another key audience was supply chain participants, such as manufacturers, distributors and food processing agents. These stakeholders were engaged to understand how they might leverage key initiatives within the Strategic RD&E Plan to establish new markets, develop new value-added products and guarantee volume and continuity of supply locally.

Government, research agencies and universities were also contacted during the consultation process to understand the potential growth opportunities for amaranth and to inform them about the development of a cohesive plan for the industry that would enable targeted sponsorship and technical support for RD&E initiatives.

Potential investors and international stakeholders were consulted to provide transparency about the primary objectives, enabling initiatives and risk profile of the industry, opening the door for them to commit funds and expertise to industry development.

The consultation process incorporated a combination of communication initiatives, interviews and a survey. The survey was used to develop initial RD&E priorities based on potential interest among stakeholders in the opportunities that the amaranth industry can offer.
The themes, strategies and activities for the Australian amaranth industry set out below have been identified as part of the consultation process for this Strategic RD&E Plan. As a truly emerging industry, existing stakeholders are limited to nursery/ornamental industry participants. The prioritisation of activities within this plan was based on extensive research and consultation with these participants and potential future participants in the leafy greens, seed, meat and dairy industries. However, the list of indicative activities is not exhaustive.

This Plan aims to guide RD&E investment to maximise the benefits for the industry. The amaranth industry should leverage other research undertaken by various research organisations to maximise return on investment.

The small size and infant nature of the industry made it difficult to prioritise these activities, however considerable work has been done in this regard. Activities written in blue are seen to be delivering the most immediate, commercial benefit to the industry. These were prioritised based on the level of industry support, the indicative economic value that could be generated and the likelihood of the benefit being realised using current or novel industry capability.

Key performance indicators (KPIs) are allocated against each theme. Each project funded under this Plan will address a macro KPI and individual project KPIs.
Australian Amaranth Strategic RD&E Plan 2021-2026

Theme – Production and productivity

Strategies

1.1 Varietal research – Leverage existing overseas research on varietal development to ensure that research and development funds for trials in Australia are used efficiently and effectively.

Timing Years 1-5 and beyond

1.2 Production and best practices – Equip growers with knowledge related to markets, varieties and agronomic practices that support the inclusion of amaranth within existing farming systems.

Timing Years 1-3

1.3 Collaborative research – Explore national and international research opportunities across research agencies, universities, RDCs and representative bodies of related or potentially benefited industries.

Timing Years 1-5 and beyond

Indicative activities

1.1 Undertake testing to select varieties for:

- Appropriate seed size and sowing/planting practices
- Consumer demand and production system challenges
- Yield potential, efficiency and quality when grown under Australian conditions
- Seed dropping, shattering and lodging considerations
- Processibility
- Mineral content and human and animal nutritional performance

1.2 Undertake research on, and develop best practice management manuals covering, the following amaranth industry considerations:

- Biosecurity and the impact of varieties in the Australian ecosystem
- Supply chains associated with various uses, including the roles of nurseries and protected cropping
- Production systems and labour requirements
- Environmental impact, water requirements, drought tolerance and the role of amaranth in carbon sequestration
- Growth cycle and nutrition
- Integrated pest and disease management (IPDM) strategies, with a focus on productivity
- Self-pollination and cross-pollination
- The role of amaranth as a sacrificial crop
- Viability in tropical farming systems
- Harvest and post-harvest management
- Product quality, integrity and food safety
- Potential collaboration opportunities with the pyrethrum industry for ornamental amaranth and other industries
- Grower profitability and business models

1.3 Undertake collaborative research projects exploring:

- The role of amaranth in crop rotation for both seed and animal feed purposes, and to maintain soil health.
- The effect of amaranth as feed for ruminants – dietary benefits, methane and nitrate production, and nutritional value at different stages of growth.
- The nutritional value of amaranth in silage for animal feed, and how amaranth compares with other fodder/silage options.
- The role of amaranth as a value-added alternative for cattle producers
- Processing and manufacturing, and product application innovation.

Key performance indicators

- New varieties suitable for Australian conditions, and varieties already being grown overseas, are available for use by Australian growers.
- Australian growers have performance and best use knowledge of amaranth varieties.
- Guidelines and fact sheets are published that detail best practice management for efficient use of inputs and water for different varieties and uses (seed, leafy green, fodder, ornamental).
- Guidelines and fact sheets are published that detail harvest and post-harvest systems for adoption in commercial production settings.
- Resources are published that inform on integrated pest and disease management (IPDM) strategies.
- There is domestic and international support for networking initiatives to enhance capacity building in the industry.
- Industry is participating in conferences and forums run by related industries, such as vegetable, dairy, and nursery.
- National and international networks are in place to increase investment efficiency and leveraging of investment funds.
Strategies

2.1 Consumer insights – Identify domestic consumer trends, preferences and appealing attributes of amaranth edible varieties and ornamental varieties.

Timing: Years 1-2

2.2 Market research – Explore and identify new markets for amaranth products.

Timing: Year 1

2.3 Stakeholder/consumer education – Collaborate with existing, more established industries, including vegetable, nursery and meat, to support market growth through the introduction of new varieties and information sharing.

Timing: Years 1-3

Indicative activities

2.1 Undertake a consumer awareness campaign in collaboration with retailers to create awareness of the leafy greens market.

2.2 Research and collaborate with other pseudo-grain organisations and the vegetable industry to identify consumer trends, including products and packaging.

2.3 Research current uses of amaranth in food product manufacturing, its retail presence, and where amaranth products fit in the supply chain.

2.4 Research and test consumer behaviours regarding what amaranth is best consumed with (specifically concerning seeds and leafy green salads) and what it is competing against in the shopping basket.

2.5 Explore potential markets for amaranth and amaranth products, and the consumer trends within those markets.

2.6 Research packaging and labelling requirements, and the impact of packaging and product sourcing on demand.

2.7 Research the potential for amaranth to capitalise on new consumer trends, such as plant protein (direct and indirect), gluten-free and low climate impact.

2.8 Support consumer demand through the development of a facts-driven story for amaranth, highlighting that it is gluten-free, has a low environmental impact, has high nutritional and protein value and high product integrity.

2.9 Investigate the nutritional value of amaranth, including its alignment with national dietary guidelines and specific health benefits – both whole grains and when combined with other foods. Research should consider amaranth for human consumption and animal feed purposes.

2.10 Explore value-adding opportunities for amaranth, such as advanced manufacturing (extractive industries), nutraceuticals, pharmaceuticals and beauty products, packaging, and ready-to-eat meals.

2.11 Research consumer trends for ornamental varieties, and explore opportunities to collaborate with other cut flower industries and the nursery industry.

2.12 Explore ‘feed gap’ markets and demand for forage products.

2.13 Develop partnerships with existing industries, industry bodies and community and advocacy groups to increase consumer knowledge of amaranth varieties.

Key performance indicators

- Amaranth has an increased market share in prioritised markets.
- Awareness of amaranth products and their benefits has increased.
- Research that links amaranth products with improved human health or animal health has been communicated to foodservice and health professionals and associations for dissemination.
- Information on the nutritional value of amaranth has been used to drive consumer demand.
- Consumer knowledge of, and preference for, amaranth products has increased.
- Information has been shared with key related industries to improve collaboration and drive consumer demand.
Theme – Extension and adoption

Strategies

3.1 Industry formation – Encourage the formation of the amaranth industry through existing industry bodies in each use area.

Timing Year 1

3.2 Industry development and capabilities – Improve amaranth grower capability through making use of extension channels.

Timing Years 1-3

3.3 Communication and extension – Develop a communication and engagement strategy to support adoption of research outputs. This component needs to be added to every funded project.

Timing Years 1-5 and beyond

Indicative activities

3.1 Initiate discussions with existing peak industry bodies about industry formation. Discussions should cover representation, engagement and communication.

3.2 Develop collaboration opportunities with other amaranth industry stakeholders, both domestic and international, to prevent industry fragmentation.

3.3 Promote skills development along the supply chain.

3.4 Use communication and extension channels, such as online videos, training sessions and webinars, to deliver capability training to growers.

3.5 Develop a communication and engagement plan that:

- Identifies ambassadors/champions for the industry to participate in project trials and extension activities
- Showcases the Australian amaranth industry at existing sector conferences and forums, at both local and international levels
- Extends research outcomes to all existing and potential stakeholders
- Communicates the importance of innovation and adaptability in management practices
- Continuously identifies stakeholders and partnerships to extend industry knowledge and the communication of program outputs
- Identifies growers or grower groups to trial varieties, to achieve increased adoption
- Continuously engages and provides innovators/early adopters with a forum to share experiences of early-stage amaranth production
- Encourages continuous collaboration with research bodies, such as universities
- Explores the potential to convene a global amaranth conference in Australia
- Encourages collaboration to ensure consolidation of supply through preservation of genetic lines

Key performance indicators

- An organisation to represent the amaranth industry has been established.
- A communication and extension plan has been developed and included in each project funded under the Strategic RD&E Plan.
- Participation in industry development programs has increased.
- Industry information has been disseminated through workshops, webinars, newsletters or other extension mechanisms.
- Growers have adopted R&D findings and implemented changed management practices.
The communication and extension plan encompasses a series of activities that build awareness of the Australian Amaranth Strategic RD&E Plan 2021-2026, with the ultimate objective being to generate adoption of outputs. Its development is listed as an activity under Theme 3 of this Strategic RD&E Plan. Objectives and KPIs linked to the communication and extension plan are also contained within Theme 3.

In addition, each project funded under the Plan will have its own communication plan to maximise reach to audiences. The key audiences that need to be targeted include:

- Growers and producers of vegetables/leafy greens, cut flowers, seed/grain, livestock, dairy and fodder
- Government and government agencies
- Industry representative bodies
- Delivery partners, including researchers and/or co-investors
- Industry investment and/or co-contribution
- Co-investment partnerships and investment from industry
- Direct co-investment by interested parties, including research agencies, universities, private businesses and producers

Examples of communication material to be delivered to key audiences include manuals, guidelines, newsletters, fact sheets, online videos, webinars and progress reports.

Collaborations with existing industry representative bodies will be key to the early delivery of RD&E outputs, given the emerging status of the industry and the need to maximise limited funding.

The implementation of this Strategic RD&E Plan will considerably depend on industry capacity to invest in its activities or new investors/co-investors to participate in this emerging industry. Encouraging collaborative research with existing industries that have larger funding capacity will help leverage limited funds. It is recommended that any project funded under this Plan has independent experts as part of project reference group. These experts will be able to assist by applying their specific knowledge, e.g., on genetic varietal improvements, ornamental market knowledge, seed production or stakeholder engagement, to enable successful delivery of project outputs.

### Financial resources

As an emerging industry, the amaranth industry R&D program isn’t supported by a statutory levy. The industry will rely on alternative investment models to achieve implementation of this Strategic RD&E Plan. These may include:

- Co-investment partnerships and investment from funding bodies
- Industry investment and/or co-contribution
- Direct co-investment by interested parties, including research agencies, universities, private businesses and producers

### Risk management

This Strategic RD&E Plan is qualified by potential risks that are specific to its delivery. The risks outlined in this section are not intended to represent an exhaustive list of the risks facing the industry.

Risks that could prevent projects funded under this Plan not being delivered will be assessed on a case-by-case basis during the investment assessment process.

Risks that could prevent on-farm adoption of RD&E outputs, such as competing priorities for government agencies and the limitation of available funding, may constrain the delivery of aspects of the Plan. Initiative prioritisation and early engagement with custodians of funding will be key to rapidly activating the strategy.

### References


