Australian Industrial Hemp
Strategic RD&E Plan
(2022–2027)

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Emerging animal and plant industries play an important part in the Australian agricultural landscape. They contribute to the national economy and are key to meeting changing global food and fibre demands.

Industrial hemp, i.e. low tetrahydrocannabinol (THC) hemp, has a wide range of applications, including textiles, paper, rope, fuel, oil and stockfeed, as well as building materials, cosmetics and pet food. In Australia, the industrial hemp industry is in its infancy, trailing Canada, China and the European Union in terms of scale and value of production.

The development of a Strategic Research, Development and Extension (RD&E) Plan is a crucial step in growing the Australian industrial hemp industry. The industry requires an increase in the scale of production, access to regionally suitable varieties, better understanding of the agronomy, more efficient mechanisation for harvesting and processing, and established long-term markets before hemp starts to become a valuable crop in Australia.

This Strategic RD&E Plan is the result of extensive research and stakeholder consultation across the Australian industrial hemp industry, and pulls together specific recommendations for future investment to support the long-term growth of the industry.

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Executive summary

Industrial hemp, or ‘hemp’, refers to the plant Cannabis sativa L. and its application in multiple uses. For the purposes of this Strategic RD&E Plan, these uses do not include medicinal and nutraceutical/pharmaceutical applications.

Hemp is a dioecious (i.e. plants are either male or female and can change sex or become hermaphrodite mid-life cycle), dicotyledonous annual herbaceous plant that originates from Asia and is considered one of the oldest domesticated crops known to humans.

Hemp grows in temperate, subtropical and tropical climates, and is a short-day plant, i.e. the plant requires a set number of successive short days for flower initiation. It also has a high light requirement during its growing period. In temperate regions such as southern Australia, industrial hemp can only be grown in the summer months, but regions further north can produce two crops per year.

Almost all of the hemp plant has some potential use, however the three main industrial use parts of the hemp plant are the inner fibres (hurd), the outer fibres (bast) and the flowering part (seed).

For thousands of years, hemp fibres have been used for clothing, shoes, cordages, carpets, tarps, ropes, sails, nets, paper, matting and insulation. Hemp clothing is hard-wearing and has natural antiseptic properties. The hurd is used for animal bedding and biofuels, and more recently for building materials (hempcrete and particle board), fibre-composites (e.g. car parts), bio-plastics and alternatives to fibreglass.

The seeds are a nutritious food (25-30% protein), and oils in the seed (25-35%) are used for a wide range of purposes, from cooking to cosmetics (Crini et al, 2020). Since 2017, it has been legal to consume hemp foods in Australia, and food has become the major end use of hemp grown in Australia.

Hemp is used to produce environmentally sustainable alternatives to many existing products. Hemp has also been used in the environmental regeneration of land, phytoremediation, and carbon sequestration, and in the manufacture of biodegradable and non-toxic plastics (bio-plastics), such as groundcover matting in horticulture and other intensive crop production.

globally, regulation covering the recreational use of high tetrahydrocannabinol (THC) hemp varieties has severely constrained the growth of the industrial hemp industry. Recent regulatory changes, however, are starting to open the door, enabling many more of the economic and environmental benefits of hemp production to be realised.

The Australian industrial hemp industry is in its infancy but is rapidly growing, and the timing is perfect to review the current situation and plan a pathway for future growth. AgriFutures Australia has led the development of this Australian Industrial Hemp Strategic RD&E Plan for 2022-27. An industry engagement process was adopted to develop this Plan, and the industry has agreed to a vision – that research, development and extension enables the gross value of Australian industrial hemp production to greatly exceed $10 million per annum by 2026; as of 2019-20, the industry’s GVP was an estimated $6 million.

The Australian Industrial Hemp Strategic RD&E Plan has five major objectives covering seed and varieties; variety trial results in a timely and professional manner.

The Plan includes several strategies and specific prioritised activities that if implemented would greatly assist the industry in achieving its agreed objectives and in turn its vision.

The 10 highest-priority activities are listed below, and focus on environmental factors, varieties and regulatory barriers.

1. Document the opportunities and value proposition for carbon sequestration throughout the hemp value chain.
2. Establish a nationally coordinated industrial hemp variety trial system that covers the current and future (see strategies 1.1 and 3.1) major production environments.
3. Identify and develop a mechanism to collect industry data to enable and facilitate better and/or more focussed policy, industry strategy, communications and RD&E.
4. Establish an effective process for communication of variety trial results in a timely and professional manner.
5. Identify the regulatory barriers and develop a plan to reduce the regulatory burden by addressing the barriers.
6. Establish a regulated and certified seed system that is consistent with other crop types/plant species in terms of additional requirements (e.g. heavy metals and terpenes).
7. Determine and communicate the potential options for monetisation of carbon sequestration.
8. Establish a clear understanding of the variety information needs of Australian industrial hemp growers.
9. Develop and implement a communication strategy that considers extension and adoption of hemp research outcomes.
10. Undertake a comprehensive greenhouse gas emissions life cycle assessment for industrial hemp that includes scope 1 and scope 2 emissions, but determine the relative value proposition of including scope 3 emissions before proceeding with this component.

Vision

That research, development and extension enables the gross value of Australian industrial hemp production to greatly exceed $10 million per annum by 2026.
Industry situation analysis

The hemp plant and growing conditions

Hemp is a dioecious (i.e. plants are either male or female and can even change sex or become hermaphrodite mid-life cycle), dioecious sexual annual herbaceous plant that originates from Asia and is considered one of the oldest domesticated crops known to humans. Hemp can grow up to 5 m in height, has a stem diameter of up to 4 cm, and has a deep tap root.

Industrial hemp can be grown on a wide variety of soil types in Australia, but has been observed to perform well on fertile, neutral to slightly alkaline, well-drained, clay loam or silt loam soils. Good moisture and nutrient-holding capacity are important because of the quick growth rate of the plant. Hemp is very sensitive to wet, waterlogged and flooded soil. Hemp is also extremely sensitive to soil compaction.

Hemp grows in temperate, subtropical and tropical climates. It generally prefers a mild climate (optimum temperatures for growth are 15–27 °C), a moderately humid atmosphere and rainfall of at least 600–700 mm per year.

Industrial hemp is a short-day plant, i.e., the plant requires a set number of successive short days for flower initiation. It also has a high light requirement during its growing period. In temperate regions such as southern Australia, industrial hemp can only be grown in the summer months, however regions in Europe and therefore not adapted to Australian conditions.

Hemp is a genetically diverse species, with varieties adapted to a wide range of latitudes and climatic zones across the world. Hemp is very sensitive to wet, waterlogged and flooded soil. Industrial hemp can be grown on a wide variety of soil types in Australia, but has been observed to perform well on fertile, neutral to slightly alkaline, well-drained, clay loam or silt loam soils. Good moisture and nutrient-holding capacity are important because of the quick growth rate of the plant. Hemp is very sensitive to wet, waterlogged and flooded soil. Hemp is also extremely sensitive to soil compaction.

Historically, all developed fibre varieties of hemp were bred in Europe and therefore not adapted to Australian conditions.

Maximising plant production is important for hemp grown for fibre, and therefore the crop is generally sown as early as possible. By contrast, hemp grown for seed is generally sown later to minimise stalk height.

Adequate moisture during the first six to eight weeks of crop establishment is important to ensure maximum growth rates and early canopy closure for the effective suppression of weeds. Without rainfall, the crop will require an estimated 2–6 ML of irrigation water per hectare, however this will depend on the desired end products, the price of water and potential return. Trials with flood irrigation in various areas of Australia have shown reduced yields compared with overhead irrigation. Production has been successful on raised beds in furrow-irrigated systems.

While there have been a number of pests recorded in hemp crops across Australia, only a few have ever warranted control. In fibre crops, Heliothis armigera and Heliothis punctigera, redshouldered leaf beetles (Monolepta australis), green vegetable bug (Nezara viridula), jassid (Eurygema fenestrale), lucerne flea (Sminthurus viridus) and Rutherford (Nysius vinitor) have been recorded, and cutworm (Agrotis ipsilon) infestations have been experienced in Tasmania.

Fungal attack has caused limited occurrences of plant death in field trials in Queensland and New South Wales, and this has been identified as white mould, Sclerotium rolfsii. The infection has been more prevalent in clay soils or where frequent watering occurs, creating a wet-dry cycle that encourages the disease. In cooler, moist conditions in southern Australia, Botrytis cinerea in hemp grain crops may be a problem.

Varieties

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Weeds, pests and diseases

Hemp is considered an efficient weed suppressor if densely planted and, as a result, herbicides are not widely used or used sparingly. This is a significant advantage for hemp products sold into markets that require very low or zero chemical residue, or none (organics). There are very few registered chemicals for weed control in hemp in Australia.

Another significant advantage of hemp, particularly when grown for fibre, is it only has a limited number of pest and disease problems compared with most other crops, and many cause only minimal damage or crop loss. Browsing wildlife, grasshoppers and locusts can be pests, as can birds. Birds will strip the flowers of seed.

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Root knot nematodes have been identified in the root systems of hemp in cropping soils where nematodes are known to be a problem, for example in every sugar cane growing region in NSW and Queensland (Sugar Research Australia, 2022).

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Root knot nematodes have been identified in the root systems of hemp in cropping soils where nematodes are known to be a problem, for example in every sugar cane growing region in NSW and Queensland (Sugar Research Australia, 2022).

Uses of hemp

Almost the entire hemp plant has potential use, however the three main usable parts (for industrial application) of the hemp plant are the inner fibres (hurd), the outer fibres (bast) and the flowering part (seed).

The separation of the bast and hurd was traditionally done in the field through natural decomposition in a process called retting. More recently, the processing is done through mechanical decortication at harvest.

For thousands of years, hemp fibres have been used for clothing, shoes, cordages, carpets, tarps, ropes, sails, nets, paper, matting and insulation. Hemp clothing is hard-wearing and has natural antiseptic properties. The hurd is traditionally crushed into pieces of various sizes with different applications. The hurd is used for animal bedding and biofuels, and more recently for building materials (hempcrete and particle board), fibre-composites (e.g. car parts), bio-plastics and alternatives to fibreglass.

The seeds are a nutritious food (25–30% protein), and oils in the seed (25–35%) are used for a wide range of purposes, from cooking to cosmetics (Crim et al, 2020). Since 2017, it has been legal to consume hemp foods in Australia, and food has become the major end use of hemp grown in Australia. Hemp is not only high in protein and oil, but it also contains Omega 3 and 6, which are important to human nutrition and are present in hemp at the ideal rate for human health.

Different varieties are grown for either fibre or seed, although there are varieties that are dual purpose. Production systems for hemp are largely geared to producing either fibre or seed, but generally not both.
Tetrahydrocannabinol (THC) and regulation

The hemp plant contains tetrahydrocannabinol (THC), which at high concentrations is a psycho-active or mind-altering ingredient. In approximately 90% of hemp varieties, the concentration of THC in leaves and flowering heads is low and is generally deemed harmless. It is important to note that THC levels in industrial hemp are very low, usually much less than 1%. However, since 1937, all forms of hemp production and use have been demonised and largely, until very recently, prohibited. This was fuelled largely by concern about drug use and was possibly due to its significant threat to the synthetic fibres industries.

Prospective hemp growers in Australia need a licence from the relevant state government for cultivation. The cultivation of plants with a THC level of greater than 0.35% in Victoria, and greater than 1% in New South Wales, Queensland, Western Australia, South Australia, Tasmania and the Northern Territory, is an offence under relevant Australian state drug laws. Crops cannot be planted with seed that has tested higher than 0.5% THC content.

Sustainability of hemp

Hemp is used to produce environmentally sustainable product alternatives to many existing products. Hemp has also been used in the environmental regeneration of land, phytoremediation, and carbon sequestration.

Industrial hemp could be an opportunity for carbon sequestration during plant growth, and carbon storage in the form of durable products. Studies have reported hemp carbon sequestration several fold greater than many crops, including canola, sugar beet and even forestry (Ciri et al., 2020). Hemp matures in 90-120 days compared with 20-30 years for forestry. This is important in combating climate change. Further, there is empirical data demonstrating that hemp uses less water than cotton (Cherritt et al., 2005).

Studies of hemp building materials have confirmed that hempcrete could be ‘carbon negative’, that is carbon sequestration by hemp could exceed the total CO2 emissions accrued during cultivation and processing for building construction (Ciri et al., 2020). From a building perspective, hemp and other natural fibres are lightweight, have a high insulating potential, have a high strength-to-weight ratio, and are more recyclable than conventional materials. Hemp fibre is also termite- and fire-proof. Hemp has been used in the construction of cars where the fibres are incorporated into bio-composites that are lighter than steel and much stronger. A further application is the use of hemp in the manufacture of biodegradable and non-toxic plastics (bio-plastics), including groundcover matting in horticulture and other intensive crop production.

The Australian Institute of Marine Science has shown that the water and fish of the Great Barrier Reef are contaminated with micro-debris. The worst pollutants were not tiny particles of plastic, but microfibres of nylon and polyester, most likely from clothes and furniture. Hemp offers a natural bio-degradable alternative to nylon and polyester, and can limit such environmental impacts.

Reportedly, hemp could be a good rotational crop for phytoremediation. Phytoremediation is the use of plants to clean up heavy metal-polluted soils, by adsorbing these contaminants.

Production and value

The Australian industrial hemp industry is in its infancy, notably trailing Canada, China and the European Union in terms of scale and value of production. The infancy of the Australian industry is influenced by the lack of reliable information on the current production and use of hemp in Australia, and it is therefore challenging to assign value. However, there are some estimates available. Industrial hemp from Tasmania (primarily seed for food) was estimated to be worth $6 million (farm gate value) in 2018-19 (Australian Hemp Council, 2022). The Australian Industrial Hemp Alliance recently studied the annual reports of Australian listed hemp food companies. They estimated that the Australian hemp food market had a retail value of $15 million.

A summary of the change in estimated area planted to industrial hemp in Australia by state is shown in Figure 1. Total area peaked in 2019-20 at an estimated 4,200 hectares. As a result of a massive increase in production in the 2019-20 season, there had been an oversupply of product for a slowly emerging local market. The impact of this was a significant reduction in plantings in 2020-21. It is estimated that only 3% of the area planted is used for fibre, with the majority of crops harvested for food.

Figure 1: Area (ha) of industrial hemp planted in Australia by state (2013-14 to 2020-21). Source: Australian Hemp Council, based on data sourced by CSIRO.

References
A consultant (Jefferies Ag Solutions) was commissioned to assist in the development of the Australian Industrial Hemp Strategic RD&E Plan (2022-2027). Jefferies Ag Solutions conducted several interviews with key industry stakeholders, including the chairs of the Australian Hemp Council and the Australian Industrial Hemp Alliance, however the primary consultation process was through a broader industry workshop.

That workshop was held via video conference on 24 November 2021 and involved 26 key Australian industrial hemp industry stakeholders. The participants were provided with a draft Strategic RD&E Plan for them to review and discuss at the workshop. The draft Plan included a vision statement and high-level objectives and strategies, but not activities or specific actions. The intent of the workshop was to agree to and refine the vision, objectives and strategies, and identify potential activities of value. The workshop was very successful in achieving these aims.

The outcomes of the workshop, together with further feedback and written responses from workshop participants, were consolidated into a second phase strategic document that included the agreed vision statement, objectives, strategies and activities (35). Workshop participants were then requested (via e-mail) to prioritise the activities from 1 to 4, where 1 was ‘very high priority’ and 4 was ‘very low priority’. Eighteen of the 26 workshop participants prioritised the activities, which were consolidated into high, medium and low priorities.
Australian Industrial Hemp
Strategic RD&E Plan
(2022-2027)
Australian Industrial Hemp Strategic RD&E Plan (2022-2027)

1 Industrial hemp seed and varieties

Goal
Growers have access to hemp varieties suitable for profitable fibre and seed/oil production, and that have the traits/characteristics required for adaptation to the potential production environment.

Strategies

1.1 Determine the most important range of industrial hemp end products (or combination of products) and their most likely suitable production environments. Following this, define the plant type, product profile and farming system required to enable optimal profitable hemp production.

1.2 Ensure an effective pathway for the delivery of new varieties for fibre and seed/oil production to growers.

1.3 Provide growers with information to guide their decision about which varieties to plant.

Activities

1.1.1 Undertake a review of the range of possible industrial hemp products (and combinations of products) in Australia, and their current and future potential value.

1.1.2 Determine the range and scope (e.g. what regions and the size of those regions) of possible production environments for each of the higher-value end products or product combinations, and the major constraints likely to be encountered in those environments (including northern Australia).

1.1.3 Identify which high-priority end products are best suited for each production environment, and determine the plant morphology and quality/functionality characteristics required for each.

1.2.1 Based on the outcomes of strategies 1.1 and 3.1, determine the high-priority pre-breeding targets (functional traits, X) that will greatly contribute to enhancing the growth and value of the Australian industrial hemp industry.

1.2.2 Determine what breeding tools (e.g. DNA marker technology) would greatly enhance rates of genetic gain in hemp breeding.

1.2.3 Determine the processes and actions required to introduce an industrial hemp levy to support greater investment in hemp R&D.

1.3.1 Establish a nationally coordinated industrial hemp variety trial system that covers the current and future (see 1.1 and 3.1) major production environments.

1.3.2 Establish a clear understanding of the variety information needs of Australian industrial hemp growers.

1.3.3 Establish an effective process for communication of variety trial results in a timely and professional manner.
Goal
Growers have access to the information and tools required to overcome major agronomy, crop protection and harvesting constraints, and have the systems and processes in place to mitigate against biosecurity threats.

Strategies
2.1 Ensure growers have access to information and tools to optimise agronomic management of industrial hemp for specific end uses.
2.2 Ensure growers have access to information and tools to mitigate and overcome prioritised crop protection-related production constraints in their environment.
2.3 Ensure growers have knowledge of and access to the equipment and practices necessary for effective and efficient industrial hemp harvest, as well as on-farm cleaning and storage for fibre and seed/oil production.
2.4 Ensure the Australian industrial hemp industry has a robust and effective biosecurity system.
2.5 Ensure the Australian industrial hemp industry has awareness of and access to research outcomes as they arise.

Activities
2.1 Improve understanding of the nutritional needs (macro and micro nutrients but particularly nitrogen) and constraints (e.g. aluminium toxicity, salinity, sodicity) for hemp grown for specified end products in different environments (see 1.1 and 3.1).

Priority Medium

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Priority Medium

2.1.2 Determine optimum sowing rates for specified end products and growing environments (see 1.1 and 3.1).

Priority Medium

2.1.3 Improve understanding of the optimum soil moisture levels required for early establishment, growth and productivity for different end products and growing environments (see 1.1 and 3.1).

Priority Medium

2.1.4 Improve understanding of the optimum timing and frequency of irrigation to maximise production and quality of hemp for specified end products in different environments (see 1.1 and 3.1).

Priority Low

2.2 Determine the high-priority current and likely future weed control issues in hemp crops and develop a pathway for the delivery of registered (or permit) herbicides for the control of the high-priority weeds.

Priority Medium

2.2.1 Determine the high-priority current and likely future weed control issues in hemp crops and develop a pathway for the delivery of registered (or permit) herbicides for the control of the high-priority weeds.

Priority Medium

2.2.2 Identify and deliver non-chemical weed control options for hemp production.

Priority Low

2.3 Determine the high-priority current and likely future diseases in hemp production, and develop a pathway for the delivery of control options (genetic, chemical, other non-chemical) for the high-priority diseases.

Priority Medium

2.3.1 Determine the high-priority current and likely future diseases in hemp production, and develop a pathway for the delivery of control options (genetic, chemical, other non-chemical) for the high-priority diseases.

Priority Medium

2.4 Determine the high-priority current and likely future pests in hemp production, and develop a pathway for the delivery of control options (genetic, chemical, other non-chemical) for the high-priority pests.

Priority Medium

2.4.1 Determine the high-priority current and likely future pests in hemp production, and develop a pathway for the delivery of control options (genetic, chemical, other non-chemical) for the high-priority pests.

Priority Medium

2.5 Develop and implement a communication strategy that considers extension and adoption of hemp research outcomes.

Priority High

2.5.1 Develop and implement a communication strategy that considers extension and adoption of hemp research outcomes.

Priority High
Industrial hemp products

Goal
The industry has a good understanding of, and the means to address, the constraints, opportunities and market competitiveness of a prioritised list of industrial hemp products.

Strategies
3.1 Ensure industry participants have a good understanding of prioritised hemp product qualities with regards to functionality and sources of variation (genetic, environmental, management, processing).

3.2 Undertake benchmarking of the attributes/characteristics (functionality, cost, safety, other benefits) of prioritised industrial hemp products against their market alternatives.

3.3 Ensure the industry understands the post-farm gate hemp processing constraints and opportunities, and develops ways to address those constraints and capture opportunities.

Activities
3.1.1 Improve understanding of the quality requirements and constraints of the high-priority (see 3.1) products (and combinations of products), including identifying and managing sources of variation (genetic, environmental, management, processing).

Priority Low

3.2.1 Undertake benchmarking of the attributes/characteristics (functionality, cost, safety, other benefits) of prioritised industrial hemp products against their market alternatives.

Priority Medium

3.3.1 Determine the high-priority post-farm gate processing constraints for different end products in different environments (see 1.1 and 3.1), and develop a pathway for overcoming the major constraints.

Priority Low
4 Industrial hemp industry sustainability

Goal
The industry has the information and tools to effectively monetise the sustainability credentials and other environmental benefits of industrial hemp.

Strategies
4.1 Undertake a comprehensive greenhouse gas emissions life cycle assessment for industrial hemp.
4.2 Ensure the industry understands the opportunities and value propositions for carbon sequestration, and has a mechanism to develop/access the tools necessary for monetisation of carbon sequestration.
4.3 Ensure the industry understands and has quantified the value of other environmental impact credentials.

Activities
4.1.1 Undertake a comprehensive greenhouse gas emissions life cycle assessment for industrial hemp that includes scope 1 and scope 2 emissions, but determine the relative value proposition of including scope 3 emissions before proceeding with this component.4
Priority High
4.1.2 Identify (from similar systems) and/or establish a standard approach for benchmarking sustainability criteria for different industrial hemp production systems/environments.
Priority Medium
4.2.1 Document the opportunities and value proposition for carbon sequestration throughout the hemp value chain.
Priority High
4.2.2 Determine and communicate the potential options for monetisation of carbon sequestration.
Priority High
4.3.1 Improve understanding of the rotational benefits of hemp, including its ability to assist with the control of pests, weeds and diseases in farming systems.
Priority Medium
4.3.2 Improve understanding of the benefits of hemp production for soil and remediation.
Priority Medium
4.3.3 Improve understanding of the additional environmental benefits (beyond the immediate obvious applications) of hemp products, including insulation, energy efficiencies, fire proofing and health.
Priority Medium

5 The industrial hemp regulatory environment

Goal
The industry has the community support, regulatory freedom and information required to deliver on the industry’s potential.

Strategies
5.1 Develop and implement a communications and engagement plan to alleviate community concerns relating to tetrahydrocannabinol (THC) and recreational use of cannabis, and reduce the regulatory burden, particularly for registering and approving new products.
5.2 Ensure the industry has the necessary knowledge and information on the risks of community access to high THC, or high THC entering the food system.

Activities
5.1.1 Identify and develop a mechanism to collect industry data to enable and facilitate better and/or more focused policy, industry strategy, communications and RD&E.
Priority High
5.1.2 Identify the key influencers for engagement and the key issues each influencer or influencer group are concerned about, and develop an engagement and communications strategy tailored for each influencer or influencer group that addresses their issues of concern, ensuring clear and consistent terminology.4
Priority Medium

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4Scope 1 emissions – emissions released into the atmosphere as a direct result of a set of activities, at the business/entity level; Scope 2 emissions – indirect emissions from the generation of energy purchased from a utility provider. In other words, all GHS emissions released into the atmosphere from the consumption of purchased electricity, steam, heat and cooling; Scope 3 emissions – indirect emissions not included in scope 2 that occur in the value chain of the reporting business/entity, including both upstream and downstream emissions.

4The industry workshop that shaped this Australian Industrial Hemp Strategic RD&E Plan (2022-2027) identified that the major issue for industrial hemp was the public perception of its association with recreational cannabis.
