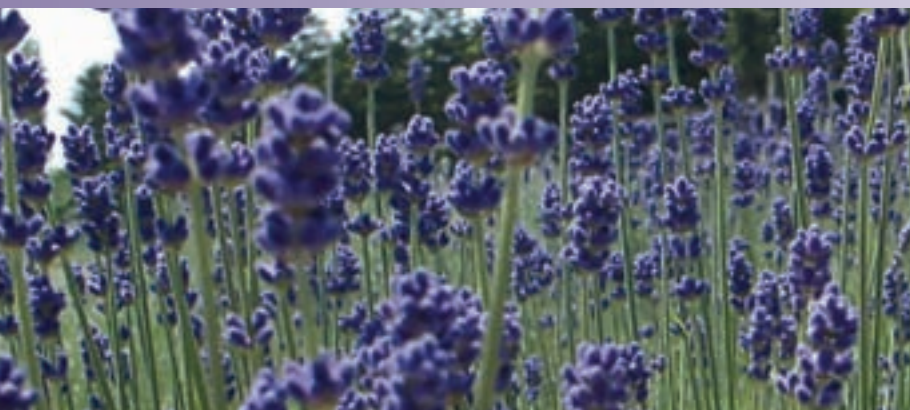




Australian Government
Rural Industries Research and
Development Corporation

Essential Oils and Plant Extracts Five-Year R&D Plan 2008 – 2013



RIRDC Shaping the future





Australian Government

**Rural Industries Research and
Development Corporation**

Essential Oils and Plant Extracts Five-Year R&D Plan 2008 to 2013

May 2008

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Foreword

The Essential Oils and Plant Extracts Program is managed by the Rural Industries Research and Development Corporation (RIRDC) in consultation with an advisory stakeholder committee made up of industry and research representatives.

The Program funds R&D that supports the development of the essential oil and plant extract industries in Australia. The 2006–07 Program had a budget of \$327,325, with industry and research organisations making contributions to individual project funding.

RIRDC has been funding research projects under this Program since early 1990 and this is its third Five-Year R&D Plan and will cover the period from 2008 to 2013.

RIRDC is committed to the development of Five-Year Plans for each of its Research and Development Programs in keeping with the Corporation's Five-Year Strategic Business Plan, and the National and Rural Research Priorities.

The Australian Government provided funds to produce this Plan.

This R&D Plan is an addition to RIRDC's diverse library of over 1800 publications and forms part of the Essential Oils and Plant Extracts Program that aims to provide the knowledge and skills base for industry to provide high, consistent and known qualities in their essential oils and plant extracts products that respond to market opportunities and enhance profitability.

Peter O'Brien
Managing Director
RIRDC

Snapshot of the Five-Year Plan

Vision

A profitable and sustainable industry producing essential oils and plant extracts of the quality and content that meet their customers' evolving demands.

Goal of the Five-Year R&D Plan

To provide the knowledge and skills base for industry to provide consistently high quality essential oils and plant extracts that respond to market opportunities and enhance profitability.

Objectives

The objectives, with indicative budget allocation are as follows.

1. Improve production systems to raise productivity and control over product qualities (50%)
2. Support the demonstration of safety and effectiveness of Australian products and facilitate the satisfaction of regulatory requirements to enhance market access (20%)
3. Support new ideas that provide potential for growing the market for Australian product (15%)
4. Improve the industry and research capacity (15%)

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1. Introduction

This is the third Five-Year Research and Development (R&D) Plan for Australia's essential oils and plant extract industries. The first Five-Year R&D Plan was developed in 1995 and the second R&D Plan, developed in 2001, covered 2002–2006¹. This plan builds on the previous plans with a focus on the areas of R&D that are of greatest potential value to Australia's essential oils and plant extract industries and where there are capabilities to provide high quality R&D.

Preparation of the Plan

The R&D Plan was developed in a workshop with industry representatives in Sydney on June 26 2007. The workshop discussed the:

- achievements of the R&D investment to date and lessons to improve the relevance, uptake and impact of R&D
- main factors limiting the growth and success of the industry and the opportunities emerging for the industry
- the role that R&D could play in addressing constraints and engaging with opportunities
- priorities for R&D where there is common interest across industry members
- strategies for raising the quality and quantity of R&D to support industry development.

A survey of the outputs and outcomes of the Essential Oils and Plant Extracts Program was conducted in March 2007 as part of the development of the business case. A Review Paper was prepared as background for the planning workshop. A draft of the Five-Year R&D Plan was distributed to the Essential Oils and Plant Extract Program's key stakeholders, workshop participants and interested parties before being finalised.

Overview of the R&D Plan

Vision

A profitable and sustainable industry producing essential oils and plant extracts of the quality and content that meet their customers' evolving demands.

Goal of the Five-Year R&D Plan

To provide the knowledge and skills base for industry to provide high, consistent and known qualities in their essential oils and plant extracts products that respond to market opportunities and enhance profitability.

¹ RIRDC 2001, *R&D Plan for Essential Oils and Plant Extracts*, Publication No. 01/062, Canberra.

Objectives

The objectives, with indicative budget allocation, are as follows:

1. Improve production systems to raise productivity and control over product qualities (50%)
2. Support the demonstration of safety and effectiveness of Australian products and facilitate the satisfaction of regulatory requirements to enhance market access (20%)
3. Support new ideas that provide potential for growing the market for Australian product (15%)
4. Improve the industry and research capacity (15%)

Alignment with Government and RIRDC priorities

The plan aligns well with the Australian Government's National Research Priorities and Rural Research Priorities and with RIRDC's corporate objectives.²

Contribution to RIRDC outcome areas

RIRDC has an overarching goal of facilitating a more profitable, dynamic and sustainable rural sector by maximising the return across the triple bottom line of its investments. The Corporation's enabling legislation is the *Primary Industries and Energy Research and Development Act 1989* (the PIERD Act) and the RIRDC Board is accountable to the Parliament of Australia through the Minister for Agriculture Fisheries and Forestry. The RIRDC Corporate Plan 2007–2012 sets out the goals that RIRDC will work to achieve. The Essential Oil and Plant Extracts Program is in RIRDC's New Rural Industries Portfolio, of which the objective is:

To provide the knowledge for diversification in Australia's rural industries.

National Research Priorities

The Australian Government National Research Priorities are set out below.

- An environmentally sustainable Australia
- Promoting and maintaining good health
- Frontier technologies for building and transforming Australian industries
- Safeguarding Australia.

The R&D Plan makes contributions across all of these priorities. The essential oils and plant extract industries are a mix of long established but small industries and new industries. They generally complement other rural production and can offer a high return land and water use. In many cases they utilise Australian native species. They also provide excellent opportunities for value adding in tailoring products to customer needs and in the more traditional sense of value adding through processing, packaging and marketing. This R&D Plan focuses on enhancing the capacity of the industry to meet their customer's evolving needs, which is very much about frontier technologies for building and transforming Australian industries.

² See RIRDC, Corporate Plan 2007-20012, on the web at <http://www.rirdc.gov.au/corporateplan/index.html>

Rural Research Priorities

The four objectives of the Plan, and associated research, will meet on an individual basis either one or more of the Rural Research Priorities set out below.

Productivity and adding value

Improve the productivity and profitability of existing industries and support the development of viable new industries. The Plan has a focus on value adding through developing the technologies and knowledge to deliver products of known and consistent qualities tailored to customer needs. However, it includes strategies to improve the general level of productivity across the industry, harnessing and promoting knowledge of best management practices. It also includes trouble shooting R&D to address threats to production.

Supply chain and markets

Better understand and respond to domestic and international market and consumer requirements and improve the flow of such information through the whole supply chain, including to consumers. The focus of the plan is on providing producers with the knowledge base to be able to meet customer needs. Identifying what these needs are, is a responsibility of the industry and such information can be highly commercial in nature so is not addressed in the Plan. At a more general level the Plan provides support to the industry in its efforts to demonstrate the safety and effectiveness of products. This can also be important for registration of essential oils and plant extracts, and the Plan also promotes understanding of the required processes that are a critical step in market access.

Natural resource management

Support effective management of Australia's natural resources to ensure primary industries are both economically and environmentally sustainable. The essential oils and plant extract industry includes native plants, both cultivated and wild harvest, and offers opportunities to encourage the protection and expansion of native flora. Commercial uses of native flora provide incentives to collect, identify and preserve the genetic diversity of Australian native plants. The industry tends to be efficient users of land and water. It also offers improved commercial returns from trees planted for land care purposes, most notably the production of cineole from eucalyptus trees.

Climate variability and climate change

Build resilience to climate variability and adapt to and mitigate the effects of climate change. New industries, like essential oils, provide much needed alternatives and opportunities where climate change drives land use change. Building understanding of the interactions of plant physiology, growing conditions and production systems provides research skills as well as knowledge that will contribute to understanding the implications of climate change on a range of agricultural activities across Australia.

Biosecurity

Protect Australia's community, primary industries and environment from biosecurity threats. The R&D Plan does not have a biosecurity focus. That said, it aims to build up diagnostic and other analytical capacities that would stand the industry in good stead should any threats emerge.

Supporting the rural research and development priorities

Improve the skills to undertake research and apply its findings and promote the development of new and existing technologies. The R&D Plan takes research skill development very seriously as declining skills has been identified as a major issue for the industry. The strategies directly address the need to involve producers in the R&D to ensure adoption and to undertake R&D in the most efficient way possible.

2. Overview of the Essential Oils and Plant Extracts Industry

The Essential Oils and Plant Extracts Program represents a number of different industries, and a wide variety of end uses. The common feature is that all involve growing plants to harvest active ingredients. Users include the pharmaceutical, industrial and food industries. This chapter briefly describes the industries in Australia, the global context and industry representation.

Essential oils

Essential oils are used for therapeutic properties, perfumery, food additives, and as industrial chemicals (solvents, etc). Dominant products in Australia are eucalyptus, lavender, peppermint, fennel, sandalwood and tea tree. Tea tree is not included in the Essential Oil Program as it has its own RIRDC Program. Citrus oil R&D is supported by Horticulture Australia Limited. Other essential oils produced in Australia that have been supported by the Program include exotic species such as peppermint, celery and dill and native species such as *Agonis fragrans*, and boronia.

Global context

Internationally, the essential oils industry produces around \$500 million of oils each year. Orange oil makes up around 17 per cent of the market, with eucalyptus oils around 10 per cent (based on 1990 data (Lawrence 1993)). Production of high value oils is concentrated in Europe and the United States, suggesting that quality dominates costs of production in the market for high quality extracts for cosmetics, food additives and therapeutic goods. Quality is characterised by the satisfaction of the purchaser set standards which may change relatively quickly. On the bulk product, lower price end, China's production of essential oils has grown over the last decade, with the major expansion in the production of eucalyptus oils of particular interest to Australia. As quality assurance systems improve in China, the advantage for developed country producers will increasingly be in the ability to tailor product to meet purchaser requirements.

Markets for essential oils vary with use, with stringent regulatory regimes for food and therapeutic uses in most developed country markets. Prices for the higher quality products also tend to be volatile, with consumer trends, and supply response catch-up driving a cycle of boom and bust. Marketing and market responsiveness are important for maintaining profitability in what is a rapidly evolving market.

Production in Australia

Australia exported \$26.8 million of essential oils in 2003-04 and imported \$22.7 million (ABS 2005). Citrus oils made up 21 per cent of the value of exports, and eucalyptus 11 per cent. Essential oils grown in Australia and included in the RIRDC Program for which data is available are listed in table 2.1 according to the main states where they are produced.

Table 2.1 **Australian essential oils production (2003-04)**

Essential oil	Production	Exports	Value	Main areas of production
	kg	kg	\$/kg	
Eucalyptus	125,000	163,700	18.57	Victoria (Bendigo) NSW (West Wyalong) WA
Lavender	2,300	5,600 ^a	65.91	Tasmania
Sandalwood	12,000	12,000	177	WA (wild harvest, Ord River plantation) SA (plantation)
Pyrethrum	5,000,000 ^p	65,800	220.86	Tasmania
Fennel ^b	10-15,000	na	22	Tasmania
Peppermint ^b	7,000	na	48	Tasmania

^a Includes re-exports, b. dried flowers, exports is saps and extracts, ^b Tasmania only 2006

Source: Foster, Jahan and Smith (2005), Read personal communication, February 2007.

Supply chain in Australia

There is very limited information available on production levels and marketing of essential oils. There are three main types of supply chain:

- large scale commercial producers selling to large processors, often under contract growing arrangements – eucalyptus, fennel, peppermint, sandalwood, boronia, and lavender
- vertical integration of growing and processing, where processors also grow the product – eucalyptus, lavender
- small scale cottage industry production for multiple uses. Local cooperatives have developed for some essential oils that process and market local products

Major processors and marketers of essential oils in Australia include Essential Oils of Tasmania Pty Ltd (EOT) (purchased by Bronson and Jacobs, in turn acquired by Orica), Thursday Plantations (now TP Health), Felton Grimwade and Bickford, Australian Botanical Products and GR Davis. The Natural Plant Extracts Cooperative Society Ltd in Tasmania is a consortium of 30 producers that liaises with EOT. There is a trend in Tasmania to larger areas cropped by fewer farming enterprises and EOT provides the infrastructure including cropping programs for the industry in the state. The industry in Tasmania is estimated to be worth approximately \$2 million per annum (DPIW Tasmania 2004).

Industry organisations

The industry peak body is the Essential Oil Producers Association of Australia (EOPAA). Some specific products, regions and states have their own industry associations:

- lavender is represented by The Australian Lavender Grower's Association (TALGA), and Australian Lavender Industries. The latter organisation includes processors as well as growers and is a commercial arrangement. TALGA has around 200 members, while the estimated number of producers is around 600 (Peterson 2002)
- eucalyptus oils are represented in Western Australia by The Oil Mallee Association
- Natural Plant Extracts (NPE) is a grower cooperative representing all Tasmanian producers. It was established in 1985, and is the only organisation in the industry that collects a research levy
- boronia is represented by the Tasmanian Boronia Growers Association, which is funded as a commodity group under the NPE banner

Research capacity

There is some capacity on agricultural production issues in the state departments of agriculture and universities in Victoria, New South Wales, Tasmania, and Western Australia, the major producing states. Some capacity for research in oil chemistry and microbiology exists in UTAS, Southern Cross University, and University of Western Australia. There appears to have been a decline in the number of chemists who specialise in essential oil chemistry, e.g. Wollongbar Agricultural Institute.

Medicinal herbs

Medicinal herbs are produced for complementary medicines and for extraction of active compounds for pharmaceutical medicines.

Global context

The global market for medicinal herbs has been growing steadily over the past decade. Yap (2006) reports sales of natural medicines in the United States growing at between 3 to 4 per cent a year over 1998 to 2002. The place of alternative medicines is also being recognised by the medical community. This has created good market opportunities, but also is increasing the demand for regulation of the industry.

China, India and Eastern Europe are major suppliers of medicinal herbs, due largely to their lower cost base. Eastern Europe is also a major source of wild harvest herbs, although there is pressure to reduce such activities on environmental grounds. As with essential oils, the higher value crops are largely from North America and Western Europe. The industry is mature in these countries and appears able to weather price fluctuations.

The industry, as with essential oils, is subject to fads resulting in volatile prices for some products.

Australian production

The main medicinal herbs produced in Australia are Echinacea species, liquorice, skullcap, dandelion, golden seal and valerian. There are three large herb growers in Australia — Australian Organic Herbs, Busch Herb and Botanical Resources Australia.

There are a small number of medium sized growers, usually specialising in a particular herb, and an estimated 50-60 small –scale growers that are the main sources of medicinal herbs (Yap 2006). These farmers grow around 1 to 2 hectares producing around 20 to 50 kg of dried plant material, and total supply and consistency of supply is uncertain as many growers rotate between horticultural crops depending on the expected returns (Yap 2006).

The value of the medicinal herb market is not known but is estimated to be around \$1 million a year for medicinal uses and at least this for herbal teas (R. Lehmann personal communication 6 November 2006).

- Ginseng has been grown commercially since around 1991. In 2001 it was estimated that around 150 hectares were under production (Wills and Stuart 2001). High quality Australian root sells for around \$1000/kg (op cit.).
- Echinacea production is reported to have risen from around 1 tonne in 1993 to over 40 tonnes in 2003 (Stuart, Wills and Dickeson 2004). The wholesale price in Australia in 1998 is reported as \$90/kg for *E. angustifolia* root and \$35/kg for *E. purpurea* root (op cit.).
- Skullcap (*Scutellaria lateriflora*) is reported grown in Australia (Wills and Stuart 2004). Yap (2006) reports that Australian producers' costs were around \$22/kg when supplying the domestic market 3 to 4 years ago, and import prices from the US were \$16/kg. Australian producers dropped out of the market and prices have since risen to \$42/kg.
- Valerian is reported to be grown in most Australian states (Wills and Shohet 2003).

Supply chain

The processing of medicinal herbs in Australia draws largely on imported material. MediHerb is the largest purchaser of medicinal herbs in Australia with around 50 to 70 per cent of demand (R. Lehmann personal communication 6 November 2006). Other processors and distributors include Botanical Resources Australia, Sphere Laboratories and Blackmores. There are several manufacturers of herbal teas such as Austral Herbs and Southern Light Herbs.

There is considerable scope for import replacement, however, both processing and growing costs are relatively high, which tends to restrict competition to the high value high quality end of the market.

Industry organisations

There is no industry association for medicinal herbs. The Australian Herb and Spice Industry Association is a peak body for herb growers, but most members are fresh culinary herb growers. There is an Australian Ginseng Grower's Association (AGGA) with 124 members as at 2001 (Wills and Stuart 2001).

Research capacity

Research into complementary medicines is conducted in several universities, including the University of Queensland Centre for Complementary Medicine (ACCMER), Southern Cross University and the Centre for Phytochemistry and Pharmacology, RMIT

(Chinese Herbal Medicine), and the University of Sydney Herbal Medicine Research and Education Centre (HMREC). A recent initiative from the federal government and NSW state government has established a National Institute for Complementary Medicines with its headquarters at the University of Western Sydney.

The University of Newcastle Centre for the Advancement of Food Technology and Nutrition has expertise in the analysis of properties of medicinal herbs and the impact of varieties, growing and processing on those properties.

The Tasmanian Institute of Agricultural Research has conducted research into the agronomic aspects of medicinal herbs.

Other plant extracts and phytochemicals

The main plant extracts produced in Australia are pyrethrum (see table 2.1) and hops. Drugs derived from botanical sources, phytochemicals, are of increasing interest to major pharmaceutical companies. Tasmania has produced poppies for many years. Recently milkweed is being explored as a source of active compounds identified by an Australian biotechnology company.

- Pyrethrum is grown mainly in Tasmania, with around 170 farmers growing under contract to Botanical Resources Australia Pty Ltd (BRA). BRA processes and markets most of the product (Foster, Jahan and Smith 2005 p. 86).
- Mountain pepper (*Tasmania lanceolata*) has a solvent extract with a principal pungent agent called polygodial. A native of Tasmania, it has been produced and exported to Japan since 1994. The major use is as a food additive (confectionary flavouring), but there is interest in use as an anti-fouling agent. In Australia there is a small trade in preparations of whole, dried and fresh plant parts (Menary et al 2003), and in the last 18 months there has been increasing activity in Europe and North America (C. Read personal communication 12 February 2007).

Regulatory arrangements

Australian regulations

The regulatory arrangements in Australia depend on the use of the product.

- National Industrial Chemicals Notification and Assessment Scheme (NICNAS) regulate essential oils used in aromatherapy, environmental fragrance and for household cleaning purposes. NICAS does not require the notification of naturally occurring substances as these are taken to be on the Australian Inventory of Chemical Substances (AICS)
- The Therapeutics Goods Administration (TGA) regulates use for therapeutic purposes (pharmaceutical use)
- Australian Pesticides and Veterinary Medicines Authority (APVMA) regulates use in agricultural and animal use, primarily uses for insect repellents
- Food Standards Australia and New Zealand (FSANZ) regulate use as food additives for flavouring

- National Drugs and Poison Schedule Committee (NDPSC) screens essential oils that may be considered hazardous to the public before listing on a schedule of permissible uses

International regulations

The most common definition of naturally occurring chemicals is:

...occurring in nature unprocessed, or processed only by manual mechanical or gravitational means; by dissolution in water or flotation or by heating solely to remove water, or which are extracted from the air by any means.

A major difference has emerged in the definition of 'naturally occurring chemicals' between the Europeans and the rest of the world. The EU has expanded the definition to include "extraction with water, by steam distillation or by heating solely to remove water". NICNAS are recommending that Australia not adopt this definition but use the common definition above, which is also used by the OECD, US and Canadians (NICNAS LRCC Discussion paper no.5).

The main regulatory bodies in other countries are:

- US Environmental Protection Agency (EPA), under the Toxic Substances Control Act, where naturally occurring substances are excluded from compulsory inventory
- European List of Notified Chemical Substances (ELINCS), under the Registration, Evaluation, Authorisation of Chemicals (REACH) legislation

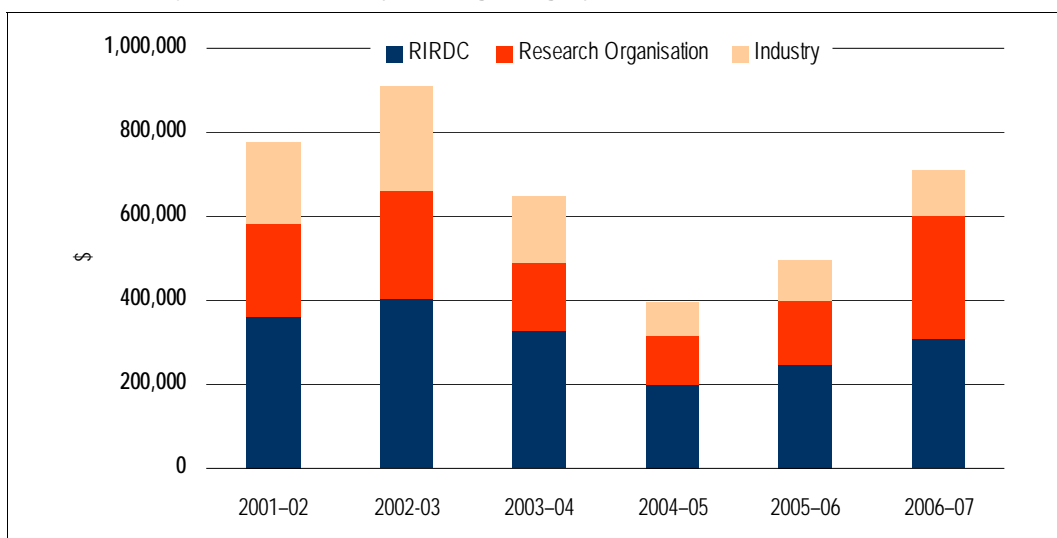
3. The R&D Program

The Program has historically focused most on essential oils, other than the most common citrus oils, which are catered for by Horticulture Australia Limited (HAL). Tea tree oil is a separate RIRDC program and the Joint Venture Agroforestry Program has supported eucalyptus oil R&D. In recent years medicinal herbs have attracted funding from the Program, as have several novel extracts where markets have been identified. The diversity of the industries covered by the Program present a challenge for R&D planning.

The 2002-06 R&D Program

From 2001-02 to 2006-07 the Program has invested \$3.93 million, of which RIRDC provided \$1.85 million or 47 per cent, research organisations 30 per cent and industry 23 per cent (both cash and in-kind contributions direct to projects). There have not been any voluntary contributions from industry paid to RIRDC during this time. Chart 3.1 shows the project expenditure by funding category over the life of the Plan.

Chart 3.1 Project expenditure by funding category



Data source: RIRDC (2007)

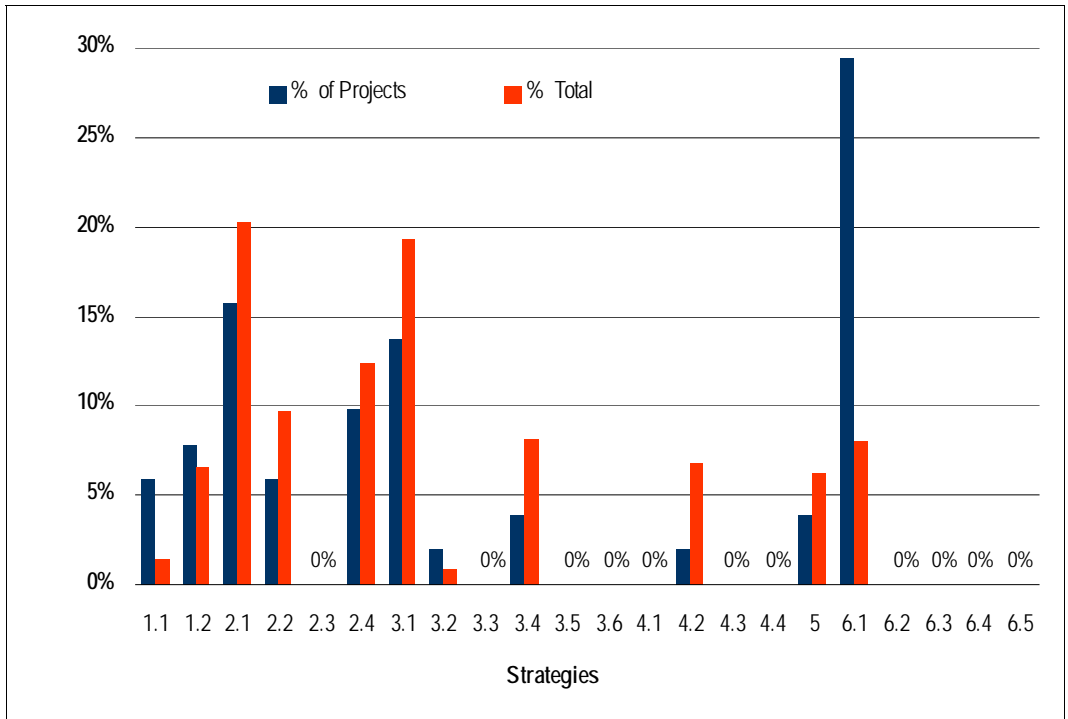
Allocation of Program resources

The Plan identified some priority species but allowed considerable scope for development of less common and new species. It did not set allocations across species, rather this was determined by the relevant industry’s submission of proposals. The co-funding made by industry forms part of the assessment criteria for proposals. The program undertook research on ten essential oils, ten medicinal herbs and four other plant extracts. Of the twenty crops involved in research, lavender, peppermint, boronia and ginseng are relatively well established, five (chamomile, Echinacea, skullcap,

valerian, and saffron) are at the early stages of industry development, and the remaining eleven are at the exploratory stage.

The 2002-06 R&D Plan did set out a desired allocation of resources across the different strategies. Overall the Program has pursued the strategies set out in the Plan. The extent to which strategies have been addressed has been limited by the level of resources available. With only around \$300,000 a year and a wide range of industries, there has been very limited scope to adequately pursue most of the strategies. The review paper provides a mapping of the projects into the R&D strategies. Chart 3.2 shows the distribution of expenditure across the strategies.

Chart 3.2 Allocation of the resources across the different objectives and strategies



Data source: RIRDC (2007)

Assessment of the Program

An industry survey was conducted to assess progress against the targets set out in the 2002-06 R&D Plan. Details are available in the review paper. The results were reviewed at the R&D planning workshop, and the findings confirmed.

Overall, progress was felt to have been below expectations, due in large part to the lower than anticipated level of funding. Nevertheless some important contributions have been achieved, predominantly in two areas - solving on-farm production problems for more established crops, and in improving knowledge of the interaction of the production system, including post harvest treatment, with the characteristics of the extract. R&D in

breeding (selection) are also viewed as being critical for improving productivity for most species, with notable achievements in lavender. These outcomes have been achieved only for selected species, hence industry wide feedback can underestimate the achievements as knowledge of the R&D is limited to the species that the respondent is involved with.

The assessment of the achievements of the Program led to a number of lessons for the next Five-Year Plan

- not all strategies are relevant for each species, and the next Plan should indicate the priority of each strategy for each segment of the industry as a better guide to applicants to the Program
- the diversity of the industries means that there is relatively little potential for generic R&D, that is, projects that will provide valued technologies for most of the industries³. That said, there is potential for pilots in one industry to provide a template for other industries to follow that will reduce the cost of the R&D and improve its effectiveness
- even within industries there is considerable diversity in scale, vertical integration and location, all leading to different R&D priorities for different segments of the industry. This can make it difficult for industry organisations to decide on R&D priorities, which is the basis of an industry being able to establish a levy to support R&D. This suggests that RIRDC and the industries need to look to a different model to raise the industry contribution to the Program. It is clear that greater industry cash contributions are needed to achieve critical mass and ensure RIRDC's continued support for the industry
- any R&D project has a greater impact where it is supported by producers who share a common need that the project is addressing. Combining both the need for funding and ensuring effective adoption pathways are built into projects, leads to clear selection criteria for proposals. These criteria are the willingness of a group of producers to participate in the R&D with both cash and in-kind contributions
- a major concern raised is the decline in R&D capacity, notably in essential oil chemistry. While students can be attracted into the area, there is little on-going research funding to keep them engaged and the technical research knowledge and skills available to the industry is thought to be in decline

³ This refers to the applied end of the R&D spectrum which is where the RIRDC mandate largely lies. There are a number of areas of more basic research which might have greater application across the range of industries, such as work on molecular structures.

4. Analysis of Strengths, Weaknesses, Opportunities and Threats

The analysis of strengths, weaknesses, opportunities and threats (SWOT) was undertaken at the Five-Year Plan workshop held in Sydney on 26 June 2007 and facilitated by Dr Jenny Gordon.⁴ The workshop included representatives from most essential oil and medicinal herb growers and processors, and researchers.

The SWOT analysis

Strengths and weaknesses vary considerably across the industries in the program

Each industry in the Program faces a different market and production environment, and even within industries there is considerable diversity in scale, extent of vertical integration and target markets. The industry can be categorised broadly by:

- source of germplasm – native or exotic species, which maps into a natural competitive advantage for native plants, although in some cases Australian natives are being grown in other countries (for example, eucalyptus oils). Advantage still arises in access to a greater diversity of germplasm, although states have a number of restrictions on gathering of native material
- production system – this is dictated mainly by whether the plant is an annual or a perennial and the agro-climatic zone of production. Annuals have an advantage in that production can be adjusted more rapidly to respond to market fluctuations. However, perennials can survive drought better than some annuals. Australia may also have an advantage where fresh product is valued and production is seasonal
- processing requirements – the major distinction is between essential oils (predominantly steam distillation), medicinal herbs (predominantly dried product) and other extracts (mix of extraction methods). The relationship between scale, technology and quality requirements differs across products, with lack of scale posing a major disadvantage to some sectors of the industry. Australian advantage could lie in quality assurance systems and technology, but this will vary with the location of the main sources of competition
- end use of product – use for human consumption, either as a food additive or a pharmaceutical face considerable regulatory hurdles in the domestic market and the international market. Use as inputs into agriculture or uses that interact with the natural environment (such as pesticides) also face regulatory hurdles. Product listing (CODEX, FEMA, etc) and internationally accepted Australian standards confer an advantage on a product relative to other products

⁴ See Chapter 1, Introduction, Preparation of the Plan.

Common sources of advantage

The main sources of competitive advantage identified in the workshop were as follows:

- **Native Plants (genetic advantage)** – advantage is seen as limited by the need to develop a market for the product, the regulatory barriers involved in this, and the potential for uptake for foreign competition.
- **Scale** – advantage arises in high value, low volume products and the ability to target export. It was noted that such targeting can leave the industry exposed if market sentiment changes (due to changes in tastes, or regulation) or a lower cost competitor can access the market history of mechanisation and yield.
- **Quality** – advantage lies in the grower and processor capacity to deliver a consistent product or tailoring of product to market specifications. This is seen as the biggest source of advantage for the Australian industry. Most industries have not yet established Codes of Practice.
- **Multiproduct** – advantage lies in joint products and alternative uses that strengthen financial viability of production. This advantage is largely for perennials rather than annuals. Multiuse includes carbon, environmental services, energy production (biodiesel, ethanol, methane gas, biomass).
- **Biotransformation/value adding** – Advantage comes from R&D strengths developing new technology for value adding, new products, and new uses.

Common constraints

Industries involved noted a number of common constraints.

- **Skills and research capacity** – there is generally a declining availability of research skills, with the exception of a few areas (notably eucalyptus transgenics). Funding tends to be available on a project basis so few universities can make a bigger commitment to students and researchers in terms of career paths.
- **Fluctuating demand and trendiness** – this is an inherent market characteristic particularly for the higher value end of the market. The advantage of novelty comes with the cost that demand may not be sustained. The relatively high cost of market entry deters growers and investors who are risk averse.
- **Competitor catch up and IP protection** – it is very difficult to control germplasm from being adopted overseas, although this is less the case with improved germplasm, especially where seed is controlled. This limits incentives to seek regulatory approvals at both a firm and industry level. Niche markets are important for many players in the industries, and staying ahead not only on foreign competitors but domestic ones requires on-going internal R&D and marketing effort.
- **Access to genetic resources** – state regulation on collection of germplasm effects Australian natives, while biosecurity requirements for approval of import of plant material affects exotics seeking to improve the germplasm available.
- **Regulatory barriers** – EU registration, US tariff numbers, FEMA and other regulatory listings are expensive to obtain. There is a free rider problem which limits the willingness of firms to make the investment as unless there is IP protection once a use is approved by the regulatory authorities as long as the product is the same, there is no barrier to entry for other producers from supplying for this use.

- **Industry cohesion and action** – The diversity of the industry makes developing representative industry organisations difficult. Industry organisations have to be able to offer their members services that the members value. Marketing, market information, lobbying on behalf of members for regulatory change, and establishing priorities for R&D are some of the services offered to members. Sharing of knowledge is stimulated by common risks, value of an industry reputation, and the advantage of scale over niche marketing. The importance of niche markets for firm profitability and the potential for rapid erosion of such markets inhibits the development of an industry culture and sharing of knowledge. The attraction of ‘hobby farmers’ to the industry can also erode industry cohesion as lifestyle issues are important to these growers. Common ground is likely to be greatest for regionally based groups.
- **Costs of production** – Australian agriculture is highly competitive in the relatively low-input and low-output areas of broadacre cropping and grazing. In horticulture and intensive livestock industries, fewer industries are internationally competitive. Those that tend to be more vertically integrated, take a high tech approach and target high quality product tailored to customer needs. In the essential oil and plant extract industries there are a number of examples of such successful industries (for example the poppy industry). But many still struggle due to the higher underlying costs of production. In addition to labour costs, the location of some growers nearer to major urban centres means higher rates and opportunity cost of land. This cost of land is a factor affecting scaling up to improve efficiency.

Tables 4.1 to 4.6 set out the results of the SWOT analysis at the workshop.

Table 4.1 **SWOT analysis: Lavender**

<p>Strengths</p> <ul style="list-style-type: none"> • Characteristics of product and market well known • Small quantities – potential to scale up • Currently a good price • Low production costs 	<p>Opportunities</p> <ul style="list-style-type: none"> • New markets are developing using lavender as a calmateive for human and animal use, also as hydrosols • Harvesting technology offers scope for productivity improvement • Scope for improved weed management • Breeding/species selection is yielding good prospects • Regulatory environment
<p>Weaknesses</p> <ul style="list-style-type: none"> • Mix of players in the industry – with different market focus and level of knowledge • Unrealistic expectations in industry of prices – lack of awareness of volatility of prices by some entrants 	<p>Threats</p> <ul style="list-style-type: none"> • Low price of large scale imports • Competition in export markets • Impact of up-scaling on production costs is unknown • New pest concerns • Regulatory environment

Source: Industry workshop 26 June 2007.

Table 4.2 **SWOT analysis: Essential oils general**

<p>Strengths</p> <ul style="list-style-type: none"> • Climate – day length, temperature, water (some areas) • Clean and green image • Strong research interest and capability in grower community and links to researchers (Tasmania) • Genetic diversity • Scope to develop new products • Culture of innovation • Formation of a cooperative 	<p>Opportunities</p> <ul style="list-style-type: none"> • Superior product compared with other regions Capacity to differentiate based on origin • Capacity to identify production advantage and tailor products to market demands • Potential to develop a Centre of Excellence • Potential for new market driven compounds • Value adding • Potential to improve production systems, and build infrastructure to support the industry
<p>Weaknesses</p> <ul style="list-style-type: none"> • Support for projects not programs of work • Lack of market intelligence on new product opportunities • Growers (and investors) are cautious about investing in the industry due to perceptions of risk (risk averse) 	<p>Threats</p> <ul style="list-style-type: none"> • Declining human resources to undertake the research

Source: Industry workshop 26 June 2007.

Table 4.3 **SWOT analysis: Sandalwood**

<p>Strengths</p> <ul style="list-style-type: none"> • Good markets for the product – high value • Native sources are wild harvest • Plantation industry is developing – considerable MIS investment • Basic processing know-how 	<p>Opportunities</p> <ul style="list-style-type: none"> • Potential to diversify products from trees – seed product, propagation • New applications of sandalwood oil being developed • Developing the value of the host trees • Potential to improve processing • Potential for current industry players to work together to research best practice and best varieties
<p>Weaknesses</p> <ul style="list-style-type: none"> • Adverse regulatory requirements for any new uses • Limits to wild harvest • Land prices have been driven up by MIS – barriers to new plantations 	<p>Threats</p> <ul style="list-style-type: none"> • Potential future oversupply • Feral animals impact on wild harvest • International competition

Source: Industry workshop 26 June 2007.

Table 4.4 **SWOT analysis: Eucalyptus**

<p>Strengths</p> <ul style="list-style-type: none"> • Australian native • Breeding is delivering large improvements in yield • Strong research base in transgenics 	<p>Opportunities</p> <ul style="list-style-type: none"> • Considerable exploration in new uses, including bulk uses (energy) and medicinal uses (anti-cancer potential) • Moving from state forest to plantation for source material, potential to improve quality and efficiency of harvest and processing • Seed orchard development and active management (eg. culling low cineole content trees) • Cloning has potential • Automation of processing • Possible decline in production from developing countries over time • Genome is well understood (to be published in 2008)
<p>Weaknesses</p> <ul style="list-style-type: none"> • Grown extensively overseas • Diverse industry – members are not working together • Currently importing oil – not cost competitive • A very large amount of work has been done with essential oil bearing plants from families other than Myrtaceae. These studies have resulted in significant patents for genes and gene variants associated with improved oil yields and profiles. There is a significant scientific capability but little interest from industry in engaging with these new approaches. 	<p>Threats</p> <ul style="list-style-type: none"> • Other countries R&D may give them an advantage – Japanese have patented gene (isoprene synthases) • Failure to protect IP • Eucalyptus rust (in high rainfall areas)

Source: Industry workshop 26 June 2007.

Table 4.5 **SWOT analysis: Herbals**

<p>Strengths</p> <ul style="list-style-type: none"> • Existing markets for those currently grown in Australia • Rapidly growing markets globally 	<p>Opportunities</p> <ul style="list-style-type: none"> • Native herbs – indigenous uses offer potential to develop a market based on novelty and trends • Quality premium available if growers can deliver volumes required • Potential for scale economies with the right herbs
<p>Weaknesses</p> <ul style="list-style-type: none"> • High costs of production • Many are not annuals and have a long production time – growers less interested in committing • Growers are leaving the industry 	<p>Threats</p> <ul style="list-style-type: none"> • Indigenous use of native herbs not sufficient for regulatory needs • Markets based on novelty risk losing popularity

Source: Industry workshop 26 June 2007.

Table 4.6 **SWOT analysis: Plant extracts**

Strengths	Opportunities
<ul style="list-style-type: none"> • Uniqueness and untapped potential of plant extracts • Native species • Clean-green image (less pollution) • Large global market and interest • Good QA and QC • Good engineering technology (harvesting, extraction, production etc) • Climatic range and growing seasons 	<ul style="list-style-type: none"> • Potential for product differentiation • Potential for unique products • Great value adding • Availability of land as farmers seek alternative crops • Public perception of products as safe and effective
Weaknesses	Threats
<ul style="list-style-type: none"> • Geographic location – long way from major markets, and production is spread out • High production costs (especially labour) • Small-scale of most production • Lack of critical mass in R&D • Difficulty in protecting IP – both the plants and in the products/uses • Regulatory barriers 	<ul style="list-style-type: none"> • Rising labour costs and labour shortages • International R&D competition • Growing production in lower cost countries (eg. China) • Climatic constraints (especially water) • Declining R&D skill base • Chemical synthesis of plant extracts and erosion of market • Health concerns (side effects) • Public perception of products as safe and effective

Source: Industry workshop 26 June 2007.

Implications for the R&D Plan

Scope for R&D

The SWOT analysis highlighted the importance of tailoring product to the requirements of the market. Underpinning this industry capacity is the in-depth knowledge of the relationship between production systems (at all points on the value chain) and the characteristics of the product. Documented knowledge to meet regulatory requirements and to demonstrate effectiveness and safety were also highlighted as essential for the industry. On these two points alone R&D is critical to improving the profitability of essential oil and plant extract industries.

R&D can be conducted at any point in the product development cycle and on the value chain. The product development cycle starts with the identification of an opportunity. In the New Rural Industries Portfolio this is often identification of new species and new uses for existing species. Key issues that R&D might address are agronomic and economic in nature. Increasingly RIRDC ask proponents to have already undertaken a market analysis – that is to assess the market potential and that proposals are for R&D to address hurdles or issues already identified. Registration or listing of the species and products is a common hurdle for market development for new species and products. With established industries the R&D can be addressing identified constraints (for example, pests and diseases), or continuing to build the stock of knowledge and

technology that improve productivity of an industry. Breeding programs are a major area of investment that have important returns but usually require a long term expenditure commitment. Production issues and quality related improvements are common priorities for both on-going improvement and trouble shooting. Value adding is recognised as a major feature of new industries and for improving opportunities in rural industries.

Areas of R&D identified in the workshop

The workshop identified a number of areas where R&D could assist:

- registration
- addressing policy constraints
- demonstration of efficacy and safety (particularly native species and new products from existing species), including pesticide residues
- production issues
- energy balance
- water efficiency (high value/low water using study currently planned at RIRDC)
- yield breeding genetics – vital for industry but not program
- species varietal evaluation
- basic genetics and physiology of oil formation
- biosynthetic pathway analysis (public arena)
- new applications

Areas falling outside of the ambit of the RIRDC program

The analysis identified a number of areas that fall outside of the possible ambit of the R&D Program. This involves management of risk in particular with the peri-urban/cottage producers and public education. Issues identified in the workshop are:

- linking behaviour of individual producers to the industry reputation
- ensuring safety of related products e.g. sandalwood nuts
- public education requirements for example, with potential misuse of lavender oil

These are not seen as issues for the RIRDC Program unless R&D is needed to provide the knowledge base for addressing an issue.

Capacity of industry to participate in the R&D

In such a diverse industry with a wide range of players, not all the industry is well placed to participate in the R&D. However, there are several strong regional organisations, such as the Natural Plant Extracts in Tasmania, that are well placed to assist in funding and actively participate in R&D. Individual, often vertically integrated, producers have also engaged in R&D, although this needs to be restricted to issues of wider applicability to the industry. Product development and testing requires highly specialised research skills that are currently available in institutions such as University of Tasmania. Agronomic , production, and breeding issues draw on a more general set of skills that are available in state agricultural departments, universities and CSIRO.

5. Five-Year Plan

Vision

A profitable and sustainable industry producing essential oils and plant extracts of the quality and content that meet their customers' evolving demands.

Goal of the Five-Year R&D Plan

To provide the knowledge and skills base for industry to provide consistently high quality essential oils and plant extracts that respond to market opportunities and enhance profitability.

Objectives

The objectives, with indicative budget allocation are as follows:

1. improve production systems to raise productivity and control over product qualities (50%)
2. support the demonstration of safety and effectiveness of Australian products and facilitate the satisfaction of regulatory requirements to enhance market access (20%)
3. support new ideas that provide potential for growing the market for Australian product (15%)
4. improve industry and research capacity (15%)

Objective 1: Improving production systems (50%)

Background

Australian producers face a cost disadvantage relative to many competitors due to high cost structures from lack of scale, distance from urban areas, water costs and labour costs. To overcome this disadvantage, producers have to be able to produce more of the product, or active ingredient per unit input than these competitors. Improved germplasm often provides the best opportunity to increase output per unit input, where output may be measured in terms of the desired quality (compounds) rather than biomass alone.

Improving production efficiency is also important for maintaining and improving the competitive edge for Australian producers. However, the greatest competitive advantage in the essential oils and plant extracts industry comes not from lowering costs, but from being able to supply products of exact known qualities. Both consistency and the ability to tailor the product to meet customer needs provide important advantage for Australian producers. To achieve both requires considerable understanding of the interaction of the plant physiology with the growing conditions and production system. For medicinal herbs and plant extracts, in particular, the latter is a major focus.

Strategies

- 1a. support variety selection trials where there is preliminary evidence of sufficient variability to substantially enhance yields of desired compounds through selection. Aim to integrate classical breeding approaches with new approaches in molecular genetics that can shorten the breeding cycle
- 1b. assist industries/groups of producers who make a substantial financial commitment to a breeding program to establish an efficient and effective program
- 1c. build the knowledge of the interaction of production systems, including harvest timing and post harvest handling on the qualities of a product for selected species in regions where there is grower support and engagement in the research
- 1d. promote the collation, documentation and sharing of best management practice for selected species where there is industry support for dissemination and promotion of the material to members and potential entrants
- 1e. develop knowledge to address production problems such as pests and diseases identified by growers in a region or industry that are demonstrated to pose a significant threat to the viability of the industry or region

Targets

The strategies are contingent on action by researchers, the industry or groups of producers so the Program does not have control over the number of varieties that might seek assistance from the Program. Nevertheless the value of the Program can be assessed by the extent to which it is utilised by the industry. The targets reflect both the R&D target achievements and the Program target achievements.

- Average improvement of 20 per cent in yield.
- Three species achieve significant increases in yield through the R&D supported selection and breeding projects and closer integration of classical breeding with molecular breeding.
- Improved capacity of growers to tailor three products to client needs as a result of knowledge.
- Production of three best management practice (BMP) manuals actively promoted by industry organisations.
- Effective solutions developed in response to demonstrated production threats.

Performance Indicators

- Measures of improvement in yield are provided as part of project reports to RIRDC, and confirmed by the evaluation program or discussions with industry as achieved in the field.
- Number of species supported recorded and yield information noted against each.
- Number of products for which projects on production systems were undertaken, with project reports to report the magnitude of the influence that changes in production systems have over qualities and the enhanced capacity of growers to control qualities. Follow-up survey by growers in the region on changes in practice resulting from the knowledge gained.
- Numbers of BMP manuals distributed in print, and electronically.

- Evaluation reports on threats addressed.

Objective 2: Demonstration of safety and effectiveness and satisfaction of regulatory requirements (20%)

Background

Many markets for essential oils and plant extracts are subject to volatility in consumer tastes. A major risk to any established product is a negative health outcome associated with the use (or misuse) of the product. For new products, demonstration of safety and effectiveness is an essential step in developing the market and in clearing any regulatory hurdles facing market access. These hurdles can be formidable.

Regulation governs the use of most products that enter into the human food chain, as well as pharmaceutical uses. Even household cleaning and other uses may require testing and approval. Many essential oils and plant extracts, particularly non-traditional species, those derived from native Australian species, and novel products and uses, face regulatory hurdles. These generally require evidence of the qualities and potential interactions in intended uses, knowledge of the application processes for listing, certification or other registration, meeting ongoing testing, labelling and packaging requirements and considerable effort in time and money to meet all these requirements. While many of the regulations are in the interests of both the consumer and the industry, regulations can act as barriers to entry, and can be excessive. Industry has a responsibility to their members to ensure that regulation is in the interests of the industry. The R&D can provide essential technical knowledge that may be needed to address regulations.

The testing of products is an expensive undertaking and there is considerable potential for some industry members to 'free ride' on the efforts of others who establish the market. This tends to result in less effort put into demonstration or safety and effectiveness than is optimal. The RIRDC Program can provide an important catalyst for industry members to jointly support research that by its very nature is of benefit to all industry members by improving market access and providing the basis to manage the potential downside risk of adverse events associated with the industry.

Strategies

- 2a. Support testing and evaluation of product qualities and effectiveness in defined uses where lack of information is constraining market opportunities. Industry must be able to explain the expected market impact and provide material support for the testing and evaluation.
- 2b. Provide the knowledge to mitigate the impact of health or other safety claims that threaten the viability of a segment of the Australian industry in response to their request and own financial commitment to the research.
- 2c. Document the industry knowledge to provide advice to industry members on how to meet regulatory requirements for industry distribution to members and potential entrants.
- 2d. Support the assessment of the impact of changing regulatory policies on the development of new industries, and how this may constrain market growth, in cooperation with other new industries.

Targets

- Two products' qualities and effectiveness documented and market access progressed.
- Safety information (including guides on safe use) generated and promoted by industry to counter threats to the markets.
- Information on regulatory processes available to industry members contributing to the efficient application for registration.

Performance Indicators

- Project reports provide required knowledge to progress the product. Industry feedback on product progress through regulation, market access or other progress.
- Evaluation reports on threats addressed.
- Industry reporting use of the information.

Objective 3: Support new ideas for products (15%)

Background

New ideas for products can be new species or new uses of existing species. New products can assist in growing and diversifying the market for essential oils and plant extracts, and in defending market share when threatened with better alternatives. New products generally face a long development period, including considerable testing for safety and effectiveness. Markets take a long time to develop, unless the product is a response to a clearly expressed need, preferably one with no alternative source. But weighted against this is the potential for a new product to become a market leader offering considerable opportunities to rural industries.

Strategies

Support research into new products where Australian producers are well placed to grow the resulting industry in terms of producing the oils or extracts and/or manufacturing and marketing the product. Proposals should demonstrate:

- the novelty of the approach and/or intended product;
- the market potential for the end product; and
- the feasibility of research success for the level of support available.

Targets

- Research into at least four new products is supported, from at least 10 applications that meet the criteria.
- At least one new product progresses to market or has good market prospects.

Performance Indicators

- Monitoring and assessment of proposals.
- Monitoring and follow-up of new product development.

Objective 4: Improve industry and research capacity (15%)

Background

The essential oils and plant extracts industry is highly diverse, with a mix of vertically integrated producers, grower cooperatives, and small players at each part of the value chain. While there is strength in this diversity, EOPAA, the national industry body, needs support to enable it to engage more efficiently with government on member needs, address threats, and promote Australian product. In recognition of the role that industry organisations or alliances can play in improving industry performance and sustainability, the Department of Agriculture, Fisheries and Forestry (DAFF) introduced the Advancing Agricultural Industries Program (AAIP). This provides financial support and guidance for industries to develop strategies and structures that will help industry members to strengthen the industry.

Due to the requirement for specialist equipment, infrastructure and expertise for R&D for these industries, there may be a need to support the consolidation of resources. There is a concern that capacity for R&D in these industries is in decline, and this concern will be addressed through this Five-Year Plan, in the first instance, by a review of research capacity.

Strategies

- 4a. Develop an audit and database of research capacity and support for centres with particular capacity where required.
- 4b. Biennial R&D symposium for industry and researchers.
- 4c. Attendance at international meetings and conferences.
- 4d. Newsletters and workshops where required to provide information to industry and strengthen research capacity and coordination.

Targets

- A database of research capacity.
- R&D symposium for industry and researchers well attended every two years.
- Circulation of information being accessed by 80 per cent of producers involved in the industry across the value chain.

Performance Indicators

- Research results published through various industry communication avenues.
- Survey of industry members on access to information.

Indicator of priority by industry segment

Table 5.1 indicates the priority of the strategies for the different industry segments. More stars indicates higher priority.

Table 5.1 Different industry segment strategies

Strategies	Established essential oils	New oils	Medicinal herbs	Other plant extracts
1a. Variety selection and compound targeting	***	***	***	***
1b. Breeding program	**			
1c. Production systems interaction	***	**	*	***
1d. BMP materials	***	***	**	*
1e. Production problems	***	***	***	***
2a. Safety and effectiveness testing	***	***	**	***
2b. Health/safety claims	***	*	***	*
2c. Regulatory requirements process	***	***	**	**
2d. Assessment of policies	*	*	*	*
3. New products	**	***	*	**
4a. Audit research capacity	***	**	**	**
4b. R&D Symposium	***	***	***	**
4c. Travel support	**	*	**	*
4d. Newsletters/workshops	**	**	**	**

Funding commitment

Reviewing the 2002-06 Five-Year Plan it was clear that funding levels were insufficient to achieve the targets set by the industry members. This Five-Year Plan aims to be realistic about what can be achieved for the funding the program is likely to attract. The budget for 2007-8 is expected to be \$453,000, including \$123,000 from industry. Negotiation is in progress with regional industry and commodity based groups of

growers as well as processors to contribute voluntarily to the Program. The strategies set out above require commitments of resources from grower groups, industries or other groupings as part of the strategy. This commitment not only provides the resources required for the strategies to be viable, but it leads to clear adoption pathways and industry involvement that will improve the knowledge base for the research as well as ensure focus on how the research outputs will be used. The 2008-13 Program is more focused on stage II research that looks to develop and realise market opportunities as well as solutions to current impediments. It aims to support a research capacity that will allow the industry to rapidly respond and manage threats to the industry whether from pests or disease or reports of bad health impacts. To achieve this the Program will work closely with existing producers to ensure a more demand driven program that focuses in areas where it is best placed to make a difference.

6. Essential Oils and Plant Extracts R&D Budget 2008–2013

An indicative Five Year R&D Plan budget has been prepared assuming voluntary industry R&D contributions of over 25% of the RIRDC contribution in year one, one third of the RIRDC contribution in year two and one half of the RIRDC contribution in the following years.

Table 6.1 **Proposed Essential Oils and Plant Extracts R&D Budget 2008–2013**

	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013
REVENUES					
External Contributions	\$100,000	\$120,000	\$200,000	\$200,000	\$200,000
RIRDC Core Contribution	\$320,000	\$360,000	\$400,000	\$400,000	\$400,000
TOTAL REVENUE	\$420,000	\$480,000	\$600,000	\$600,000	\$600,000



Essential Oils and Plant Extracts R&D Plan 2008 – 2013

Pub. No. 08/053

This is the third Research and Development Plan for Australia's essential oils and plant extract industries. RIRDC has been funding research projects under this Program since early 1990. The first Plan was developed in 1995, the second Plan was developed in 2001 to cover the period 2002–2006.

This R&D Plan builds on the previous plans with a focus on the areas of R&D that are of greatest potential value to Australia's essential oils and plant extract industries and where there are capabilities to provide high quality R&D. It was developed in a workshop with industry representatives in Sydney in June 2007.

This R&D Plan is an addition to RIRDC's diverse library

of over 1800 publications and forms part of the Essential Oils and Plant Extracts Program that aims to provide the knowledge and skills base for industry to provide high, consistent and known qualities in their essential oils and plant extracts products that respond to market opportunities and enhance profitability.

RIRDC manages and funds priority research and translates results into practical outcomes for industry. Our business is about new products and services and better ways of producing them. Most of the information we produce can be downloaded for free from our website: www.rirdc.gov.au.

RIRDC Books can be purchased online or by phoning 02 6271 4100.

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