Australian Government

Rural Industries Research and Development Corporation

National Weeds and Productivity Research Program

R&D Plan 2010 to 2015

RIRDC Shaping the future

Australian Government

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Foreword

Weeds create many costly challenges for the Australian primary production sector and to our natural environment. These challenges require Australia to continually improve knowledge of weeds and to adopt practices that lead to the prevention, mitigation or adaptation to invasive weeds.

Research plays a valuable role in increasing knowledge and developing the information, tools, management options and resources that will enable Australia to better manage the weed challenge.

The Rural Industries Research and Development Corporation (RIRDC) is pleased to be appointed as the manager of the National Weeds and Productivity Research Program by the Minister for Agriculture, Fisheries and Forestry.

The Australian Government has provided up to $12.4 million (inclusive of GST) for the first two years of the Program with the goal of reducing the impact of invasive weeds on farm and forestry productivity as well as on biodiversity. A significant challenge for RIRDC will be to build partnerships between industry and government for extending the funding and institutional arrangements for investment in weeds R&D over the longer term.

RIRDC has extensive experience in investing in R&D that meet the needs of governments, industries or other stakeholders. In delivering this Program, we will draw on our well-tested investment approaches which include:

- identifying priority R&D requirements through the development of a 5-year R&D plan (this document);
- engaging with farmers, other land managers and relevant stakeholders on research and development needs;
- drawing on the expertise and insights from an Advisory Committee set up specifically for the National Weeds and Productivity Research Program;
- facilitating collaboration between researchers;
- encouraging and facilitating the adoption of research results by rural industries, land managers and other stakeholders; and
- monitoring the impact of the R&D through regular evaluations of research.

This five-year R&D Plan has been developed through extensive consultation and a national workshop. It aims to build on previous R&D achievements and focus its effort on common national needs that will position Australia well in responding to weed challenges in the short and long-term.

Craig Burns
Managing Director
Rural Industries Research and Development Corporation

Snapshot of the National Weeds and Productivity Research Plan, 2010-15

Context

The Australian Government has provided up to $12.4 million (inclusive of GST) for the first two years (2010-11 and 2011-12) of this second stage of the National Weeds and Productivity Research Program.

This second stage will be managed by the Rural Industries Research and Development Corporation (RIRDC), but will build on and complement previous weeds research and the first stage of the National Weeds and Productivity Research Program which was managed by the Department of Agriculture, Fisheries and Forestry (DAFF).

This Plan for the second stage of the National Weeds and Productivity Research Program addresses the broad research priorities that have been set for the Program by the Minister for Agriculture, Fisheries and Forestry. These are to:

a) investigate and solve the most serious invasive plant problems focusing efforts to improve productivity and the environment;

b) investigate new methods which reduce reliance on herbicides and promote integrated approaches which also help to reduce energy and chemical inputs in agriculture;

c) refine landscape-scale integrated weed management strategies to manage the risks associated with invasive plants in agriculture, forests, pastures and native vegetation, including addressing climate change mitigation and adaptation issues;

d) identify motivators and barriers to the uptake of cost-effective integrated weed management strategies and options to encourage the uptake of integrated practices;

e) improve understanding of economic, social and environmental impacts of invasive plants; and

f) ensure better coordination and information exchange between researchers, land managers and regulatory agencies about integrated approaches for priority management of invasive weeds.

The implementation of the Program is governed by a Service Agreement between RIRDC and the Department of Agriculture, Fisheries and Forestry. The key elements of the Service Agreement and program implementation are outlined below.

Vision, mission and stakeholders

Vision

RIRDC's vision for Australian weeds research and development:

"Australia is equipped with the knowledge, resources and technology to successfully prevent, mitigate or adapt to weeds in our agricultural systems, ecosystems and landscapes."

Mission

In pursuing this vision, RIRDC's mission in managing the National Weeds and Productivity Research Program is to:

" Invest in R&D that enhances knowledge and management options that will improve Australia's capacity to respond to the on-going weed challenge effectively"

Research in the context of the National Weeds and Productivity Research Program means R&D as interpreted in the Primary Industries and Energy Research and Development Act 1989.

Stakeholders

The improved knowledge and management options for dealing with weeds will support a range of stakeholders involved in land and water management in Australia. The stakeholders in the National Weeds and Productivity Research Program include:

- the Minister for Agriculture, Fisheries and Forestry;
- the Department of Agriculture, Fisheries and Forestry;
- policy makers, legislators and regulators at all levels of government;
- key land managers including farmers, public land managers and Aboriginal and Torres Strait Islander land holders as managers of crops, pastures, timber plantations, native vegetation and natural ecosystems;
- land and water planners in government, private and community organisations;
- service providers including landcare groups, farmer groups, farm advisors, agribusiness, consultants; natural resource management facilitators, and philanthropic and conservation organisations that manage land and water resources; and
- research funders, purchasers and providers.

Objectives, outcomes and investment priorities

In addressing the Government's priorities, this Plan will pursue four key objectives .

Objective 1: Improve knowledge for effective risk management of weeds.

Outcome: Improved likelihood of effective integrated weed management strategies being adopted, particularly at a landscape scale to manage the risks associated with invasive plants in agriculture, forestry and natural resource management including aquatic weeds. This includes preventative, mitigative and adaptive strategies including the impact of climate change.

Priority: Investing in R&D that fills key knowledge gaps which contribute to more effective risk management of weeds. RIRDC will collaborate with key agencies including Plant Health Australia, the Biosecurity Services Group of the Department of Agriculture, Fisheries and Forestry, CSIRO, other rural research and development corporations, and state and territory government agencies in identifying knowledge gaps and commissioning the necessary research.

Resource Allocation: The Plan envisages allocating up to 25% of the Program budget to this objective.

Objective 2: Reduce current and future impacts of weeds on Australia's productive systems and environments.

Outcome: Improved tools, methods and technology that can solve the most serious invasive plant problems impacting on primary industry productivity and the environment including aquatic weeds. This will include new methods that reduce reliance on high cost and potentially harmful herbicides and promote integrated approaches to weed management. This objective will be aligned to the needs of Australian agriculture to address energy and chemical inputs in production and also the impact of climate change on the spread and invasive intensity of existing and potential weeds.

Priority: Investing in R&D to investigate the most serious invasive plant problems and to provide the knowledge and methods to solve those problems.

Resource Allocation: The Plan envisages allocating up to 40% of the Program budget to this objective.

Objective 3: Support improved adoption of weed management approaches.

Outcome: Outputs of R&D facilitates improved adoption by stakeholders of the National Weeds and Productivity Research Program.

Priority: Investing in R&D that improves understanding of economic, social and environmental impacts of invasive plants; that identifies the motivators and barriers to the uptake of cost-effective integrated weed management strategies and options; and ensures better coordination and information exchange between researchers, land managers and regulatory agencies about integrated approaches for management of invasive weeds.

Resource Allocation: The Plan envisages allocating up to 30% of the Program budget to this objective.

Objective 4: Plan for future funding and institutional arrangements for national investment and management of weeds R&D.

Outcome: A well-researched plan for future investment and institutional arrangements for national weeds research and development that can be presented to governments and other potential investors prior to the ending of the current funding for the National Weeds and Productivity Research Program.

Priority: Investing in research and development that identifies options, the pros and cons of those options and how the preferred option or options can be implemented.

Resource allocation: The Plan envisages allocating up to 5% of the Program budget to this objective.

Research Strategies

Key strategies that will be implemented to achieve the Plan's objectives are:

- **Advance foundational knowledge** - develop new, or advance existing, knowledge in strategic areas that allow Australia to better manage identified weed challenges or identify possible future challenges;
- **Develop tools, methods and technologies** - develop tools, methods and technologies that support risk management and decision making across all levels of weed management (national, state, regional, local and on-farm);
- **Evaluate current social, economic and institutional influences** – develop better understanding of the social, economic and institutional influences that determine weed management practices across the spectrum of land managers and stakeholders and use this information to improve future R&D and extension initiatives; and
- **Test and translate existing resources and make them more accessible** - facilitate the testing of existing resources and enable stakeholders to have better access to existing knowledge and resources in formats that suit their needs.

Implementation

This five-year R&D Plan, which has been approved by the RIRDC Board and by the Minister for Agriculture Fisheries and Forestry will be implemented through annual operational plans, with the first being for 2010-11. It will also be supported by a communications plan that promotes the Program and raises public awareness about the opportunity and conditions to apply for national weeds and productivity research funding. The communications plan will keep researchers, land and water managers and policy and regulatory agencies informed of research aims and progress and to help translate research findings into practical tools that can be adopted in the management of weeds. It will address the most appropriate media for delivering information to stakeholders about the research conducted under the Program.

A key aspect of the communications plan will be the development of a world class weeds website to provide information to users and to allow for interaction between stakeholders.

The Services Agreement requires RIRDC to invest in R&D through projects that are directly commissioned by RIRDC or sought through expressions of interest. Other R&D will be sought through a merit-based open call that is advertised nationally.

The commissioned R&D projects will address identified gaps in current knowledge and tools. They will be delivered through a combination of approaches such as addressing priority weed management needs of focus regions or landscapes; focus industries; public land managers for Crown land, national parks, conservation reserves and transport or infrastructure corridors; and managers of Indigenous held land (such as Prescribed Body Corporates for Native Title land).

In some cases, research may be directed at priority weed issues such as the impact of invasive weeds on agricultural productivity, ecosystem health or human health. Some research projects will be to build collaboration with key stakeholders such as catchment management authorities or natural resource management organisations, landcare groups, farmer groups, Indigenous land councils and local governments.

Another area of focus for the Program will be land and water resources which are vulnerable to weed invasion due to economic, social and environmental changes. This includes land that may be vacated following the sale of water licenses (eg, in the Murray Darling Basin), pastoral leases or other land that has been acquired by mining companies, land held or managed by government agencies such as the Department of Defence for military training and properties that are held by absentee landowners or hobby farmers and lifestylers whose primary interest in the land is not commercial agriculture. The Program will also cover peri-urban areas which are subject to intense land competition and multiple uses in close proximity.

Open call grants will be directed by guidelines approved by the Minister for Agriculture, Fisheries and Forestry and will be linked to the commissioned R&D.

Key Milestones

Key milestones for the first two years of the Program will be as follows:

Activity	Details	Date
Program initiation	Contract signed, Chair Advisory Committee announced	30 June 2010
Stakeholder workshop	Workshop held	4 August 2010
Plans and open call guidelines	Five-year R&D Plan, Annual Operational Plan, program applicant guidelines for open call submitted for Ministerial approval.	30 October 2010
Call for expressions of interest in commissioned research and the open-call grants	Advertised call for expressions of interest in commissioned research and open-call grants.	1 November 2010
Completion of grant project proposal assessment and publication of 2008-10 research outcomes	Open call for grant projects and grant assessment completed, recommendations of grant projects to Minister, publication of research outputs from 39 projects managed by DAFF.	4 January 2010
Commissioned research implemented	Contracting of commissioned research	31 January 2011
Progress report on all commissioned projects and grant projects.	Report outlining progress of projects against their objectives and progress in establishing collaborative partnerships for the Program	1 June 2011
Final report on all commissioned and grant projects	Final report on outcomes of projects and future directions for the Program	10 May 2012
Publication of all commissioned and grant project reports	All reports published on RIRDC website	1 January 2013

Governance and Reporting

The Services Agreement requires RIRDC to establish the National Weeds and Productivity Research Program with the existing National Rural Issues Portfolio. Within RIRDC, the Program will be managed by a Senior Research Manager assisted by a Program Coordinator and oversighted by the relevant General Manager.

There will be strategic oversight by an Advisory Committee appointed by the RIRDC Managing Director and comprising members with expertise related to weeds research and land and water management. The Committee will comprise a majority of users of weeds research to ensure the Program is driven by the needs of land and water managers and policy makers.

The primary role of the Committee is to provide strategic investment advice on weeds research and extension priorities to address the impacts of invasive plants on the farm and forestry sectors and biodiversity under a changing climate.

The relationship between the Advisory Committee and RIRDC management will be set out in a governance framework document that will include a code of conduct for Advisory Committee members and relevant RIRDC managers.

As part of the governance of the Program, RIRDC will prepare an evaluation and monitoring plan which will set out the measures to be used to report to the Australian Government and public on achievement of the objectives of the Program.

RIRDC will submit annual reports against the monitoring and evaluation plan to the Department of Agriculture, Fisheries and Forestry. It will also publish all individual project reports on the RIRDC website and these will be accessible directly from the website or through Australian Research Online.

Program Budget

The total funding for the Program is up to $12.4 million (inclusive of GST) over the two years to 30 June 2012. A total of between $5.2 million and $7.6 million will be received from the Department of Agriculture, Fisheries and Forestry for projects commissioned by RIRDC and for administration, strategy development and program management (up to $1.98 million).

The balance of between $4.8 million and $7.2 million will be for projects selected through the open call. These funds will be provided on a reimbursement basis after the projects have been approved.

The specific division of the funds between the two categories (commissioned and open call) will be determined by the cost of the commissioned projects up to the maximum specified in the Services Agreement.

Revenue of $3.8 million (inclusive of GST) was provided from the Department in 2009-10. This will be carried over into 2010-11 and will be supplemented by a further payment from the Department of $3.9 million (inclusive of GST).

The 2010-11 budget for the Program will be $7.3 million (exclusive of GST). This does not include open call grants reimbursed by the Department.

A high priority for RIRDC in managing the Program beyond 2011-12 will be to establish collaborative relationships with other agencies that will lead to funding the Program over the five years of this Plan (ie, to 30 June 2015)

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1. Introduction

Weeds, or invasive plants, are identified as one of the major threats to both Australia's primary production and to the natural environment. They have major economic, environmental and social impacts, namely:

- they reduce the quantity and quality of Australia's agricultural, horticultural and forestry products;
- they are estimated to cost Australian agriculture around $4 billion per annum; and
- they cause damage to the biodiversity and system function of natural landscapes, waterways and coastal areas.

In response to this challenging threat, the Australian Government is providing a foundational investment of up to $12.4 million (inclusive of GST) to a National Weeds and Productivity Research Program.

The Rural Industries Research and Development Corporation (RIRDC) will administer the National Weeds and Productivity Research Program as part of its National Rural Issues portfolio. The broad research priorities set by the Australian Government for the National Weeds and Productivity Research Program are:

- investigate and solve the most serious invasive plant problems focusing efforts to improve productivity and the environment
- investigate new methods which reduce reliance on herbicides and promote integrated approaches which also help to reduce energy and chemical inputs in agriculture
- refine landscape-scale integrated weed management strategies to manage the risks associated with invasive plants in agriculture, forests, pastures and native vegetation, including addressing climate change mitigation and adaptation issues
- identify motivators and barriers to the uptake of cost-effective integrated weed management strategies and options to encourage the uptake of integrated practices
- improve understanding of economic, social and environmental impacts of invasive plants
- ensure better coordination and information exchange between researchers, land managers and regulatory agencies about integrated approaches for priority management of invasive weeds.

RIRDC has a sound track record in guiding and managing research specific to rural industries and cross-cutting issues impacting on multiple industries and the environment. A five-year R&D plan will guide the National Weeds and Productivity Research Program which will draw on the foundational investment by the Australian Government and also seek to provide opportunities and scope for other collaborators to invest in its objectives and strategies.

The National Weeds and Productivity Research and Development Plan provides:

- a snapshot of key challenges that weeds cause the Australian productivity sector and the environment;
- a history of weed initiatives in Australia;
- information on previous weeds-related R&D ;
- context on how the program will align with national research priorities and weed initiatives;
- objectives and strategies that will guide R&D investment by the National Weeds and Productivity Research Program;
- key principles and goals for how the program will facilitate applied, collaborative and multi-disciplinary research; and
- the Program budget and delivery arrangements.

A four stage approach was used to develop the R&D Plan:

- significant desktop review and analysis of relevant weed related initiatives;
- consultation with over 50 weed stakeholders including researchers, agriculture and forestry industry representatives, natural resource and environmental sector managers, extension officers, facilitators and government officials;
- a national workshop held 3-4 August 2010 involving approximately 60 weed stakeholders which provided an opportunity to discuss the key weed R&D needs and priorities and identify practical approaches to delivering the National Weeds and Productivity Research Program
- development of a plan for approval by the RIRDC Board and the Australian Government Minister for Agriculture, Fisheries and Forestry.

The plan was developed during July and August 2010.

2. Overview of the weed challenge in Australia

There are many definitions of a weed but the simplest way to consider them is as a plant that is growing in a place that it is not wanted. They are also referred to a invasive plants. The Australian Weed Strategy (2007) defines a weed as:

> "a weed is considered pragmatically as a plant that requires some form of action to reduce its harmful effects on the economy, the environment, human health and amenity."

Weeds have repeatedly been identified as one of the major threats both to Australia's primary production and to the natural environment. They have major economic, environmental and social impacts, causing damage to natural landscapes, agricultural and pastoral lands, waterways and coastal areas.

Impacts

Agriculture

Weeds can impact both the quantity and quality of agricultural products. They affect quantity through yield loss due to competition, and by acting as alternate hosts to pathogens, viruses and insect pests.

In 2004, Sinden and his colleagues at the University of New England measured the economic cost of weeds to Australian agriculture to be between $3.4 billion and $4.4 billion per year in lower farm incomes and higher food costs (Sinden J *et al*., 2004). This equates to 14% (approximately $1 in every $7) of the value of agriculture to the Australian economy.

Sinden *et al* (2004) estimated financial costs (costs of chemicals, associated money costs such as fuel for vehicles and the costs of hired and contract labour), yield losses (estimated from the percentage loss in each agricultural industry and the existing average gross margin in the industry) and mean loss to economic surplus for three different agricultural sectors – crops, livestock and horticulture (Table 1). This analysis shows that the cropping and livestock sectors incur the most significant impacts from weeds either through high costs to manage weeds or significant yield losses resulting from the weeds.

Table 1 - Estimate of Weed Impact on Agricultural Sector

Agricultural Sector	Financial Costs*	Yield Losses*	Mean loss of economic surplus
Crops	$1033 million	$346 million	$1518 million
Livestock	$315 million	$1870 million	$2409 million
Horticulture	$17 million	$2 million	NA
Total	$1365 million	$2218 million	$3927 million

Note: * Low and high estimates were provided as part of the study. The low estimate is quoted in this table.

Source: (Sinden J *et al*., 2004)

The Australian Bureau of Statistics Natural Resource Management (NRM) Survey 2004-05 of Australian farmers identified:

> "At the national level, weeds were the most commonly reported NRM issue. Weed-related issues affected 73% of Australian agricultural establishments during 2004-05. Similarly, weed-related activities were the most commonly reported NRM activity at the national level, with 80% of agricultural establishments undertaking activities to either prevent or manage weeds."

For the same time period, Australian Bureau of Agricultural and Resource Economics (ABARE) researchers Hodges and Goesch (2006) as part of the Australian Farms Natural Resource Management 2004-05 Report identify that Australian farmers reported that their expenditure on animal pest and weed control was consistently the highest NRM cost, with this expenditure doubling between the 2001-02 and 2004-05 surveys (ABARE, 2006).

Environment

While the costs to the environment are less well documented, they are thought to be of a similar magnitude to the impacts on the agricultural sector. Weeds are identified as second only to land clearing as a threat to Australia's biodiversity (Coutts-Smith and Downey, 2006).

Public amenity of natural areas is substantially reduced by weed invasions which reduce biodiversity through direct competition and adverse impacts on ecosystem function, changed fire and water regimes and the harbouring of pests and diseases.

In an assessment of species listed as threatened in New South Wales, Coutts-Smith and Downey (2006) found that 45% of the 972 listed threatened species were at risk from the hazards posed by weed invasion. Setterfield and her colleagues (2009) have demonstrated a more than twelve-fold increase in the costs of managing fire in northern savanna landscapes as a consequence of invasion of exotic tall grasses. Sinden *et al* (2004) estimated that at least $19.6 million is spent each year just on weed control in National Parks and other protected areas. This figure takes no account of the environmental services provided by natural areas that are adversely affected by weeds nor of a substantial voluntary effort by Bushcare and related community groups.

While control options are available for environmental weeds during the early stages of invasion, challenges remain in restoring biodiversity once the weed has been removed.

Who is affected?

Because of the pervasive impacts of weeds on both Australian agricultural and forestry production and landscapes, all Australians are affected, either directly or indirectly by invasive plant species.

Weeds impact adversely on pasture and grazing lands, intensive agricultural areas and the natural environment. They have profound effects on the livelihoods of those in agricultural, forestry and horticultural production, degrading product quality and

reducing yields in both cropping and livestock industries. Primary producers bear a substantial proportion of the costs of these losses, while consumers are also affected.

Added to that are the indirect impacts of weeds on animal production through losses due to weed poisonings, competition and predation by feral animals for which weed invasions provide habitat, and decreased fisheries production due to stream smothering.

Both private landholders and public land managers invest millions of dollars each year in time and resources to control weeds, yet for many the battle seems never-ending.

The impacts of weeds on the environment are equally wide-ranging. Public amenity of natural areas is substantially reduced by weed invasions which decreases biodiversity through direct competition and adverse impacts on ecosystem functioning, changed fire and water regimes and the harbouring of pests and diseases.

Weeds pose a threat to nationally and internationally significant natural areas, including National and World Heritage areas, Ramsar-listed wetlands and to National Parks and Nature Reserves. In doing so, they impact on the growing numbers of both Australians and international visitors who rely on these areas for recreational activities. Interested individuals, tourism operators and the wider community which relies on significant natural areas for the provision of a diversity of ecosystem services are thus all affected.

Weeds also pose a threat to many of Australia's Indigenous lands and the original Australians who live there, clogging waterways and preventing access to food collection and places of cultural significance.

Through the accumulation of heavy fuel loads, weed infestations increase the risk of high intensity bushfires which threaten both biodiversity and many in nearby communities.

Finally, some weed species affect both human and animal health. Asthma and other severe respiratory problems, allergies and dermatitis, as well as poisonings affect some exposed to problem species.

3. History of Australian weeds' initiatives

Responsibility for weed management rests heavily with private landholders and public land managers. This has long been recognised through state-based legislation. However, where weed problems are extensive collective action is often needed.

There are many sectors for which weed management is important. These include all three levels of government and more recently Regional NRM Bodies, primary industries, research organisations and community groups concerned for the environment and natural resources in Australia.

For some time it has been acknowledged that successful weed management requires a coordinated national approach involving all these interests.

The Australian Weeds Committee (AWC) or its predecessor was established in the mid-1960s, bringing together national, state and territory agency representatives involved in weed control and management. The purpose of the AWC is:

> "To provide an inter-governmental mechanism for identification and resolution of weed issues at a national level for Australia on behalf of the Natural Resource Management Ministerial Council."

The AWC and its members are responsible for overseeing the implementation of the Australian Weeds Strategy (Natural Resource Management Ministerial Council, 2006).

Since 2002, the AWC members have been responsible not only for agricultural weeds, but for weeds affecting other primary industries, forestry and the environment. Members are responsible for legislation and institutional arrangements relevant to weed management within their jurisdiction.

Australian Government

The Australian Government provides national policy leadership and direction in weed management, working with the state and territory governments through the Natural Resource Management Ministerial Council (NRMMC) and its AWC.

Responsible for international border protection, including regulating the import and export of plant material, the Australian Government also manages Commonwealth lands, such as defence establishments and Commonwealth National Parks.

In cooperation with other governments and landholders, the Australian Government administers legislation, policies, programs and associated activities to manage weeds at the national level.

Through its obligations under international conventions and agreements the Australian Government is responsible for the conservation and wise use of Australia's rich and unique biodiversity, wetlands of international significance and World Heritage areas.

Within the provisions of the Environment Protection and Biodiversity Conservation Act, the Australian Government is also responsible for the management of Matters defined as being of National Environmental Significance. This includes:

- World Heritage Areas
- Wetlands of national importance (i.e. declared Ramsar wetlands)
- Listed threatened species and communities
- Listed migratory species.

Key among Australian Government weed management initiatives in recent years have been:

- Weeds of National Significance (2000-)
- The 'Defeating the Weed Menace' Program (2004 – 2008)
- the 'Caring for Our Country' Initiative (2008-)[1]
- National Biosecurity.

Weeds of National Significance

In 1998, the Australian, state and territory governments endorsed a framework to identify which weed species could be considered Weeds of National Significance (WoNS). From an initial candidate list of 71 species nominated by the states and territories, 20 species were agreed for national attention, based on their invasiveness, impacts, potential for spread, and socio-economic and environmental significance (Thorp JR & Lynch R, 2000).

Since 2000 each of the 20 WoNS species has been subject to national coordination and cooperation across jurisdictions, resulting in coordinated on ground action to define core infestations, detect and eliminate outliers and put in place early detection of new outbreaks. For some species active containment lines are used, supported by ongoing monitoring to prevent the species expanding to uninfested areas. The 20 species, were selected for their ability to impact on primary production, the environment, social and amenity values, and have not reached the full extent of their potential distribution in Australia.

National strategies have been developed in consultation with key stakeholders for all species which are implemented by a coordinator guided by a national management advisory group comprised of state and territory officials, industry and community

[1] Prior to Caring for our Country the Natural Heritage Trust and National Action Plan for Salinity and Water Quality played a role in providing funding in a range of ways that supported weed management and control.

representatives. Each species is supported by best practice management guides and extensive control information. The WoNS have been embraced by public and private land owners as they can identify with the national goals of the strategies.

Implementation of a National Strategy developed for each WoNS species has been overseen by a management committee involving state and community representatives assisted by a WoNS coordinator.

The 20 species have been recently reviewed and are being managed with varying levels of national coordination, with a view to expanding the list of species to include additional major invasive weeds that could benefit from national action.

It is understood that the WoNS are currently being updated and more may be added to the list in the near future.

Defeating the Weed Menace program

Between 2004 and 2008 the Australian Government committed $40 million to a national program to address Australia's most threatening weeds. Managed jointly by the Department of Agriculture, Fisheries and Forestry and the Department of Environment and Heritage, the Defeating the Weed Menace program sought to tackle Australia's most invasive weeds through:

- research
- biological control
- community awareness
- on-ground action.

Partnerships and co-investment were recognised as important contributors to the success of the Defeating the Weed Menace program.

Caring for Our Country Initiative

The Australian Government's Caring for Our Country initiative commenced in 2008. It builds on previous NRM program successes and seeks to address some of the shortcomings of previous programs, which included the challenge of demonstrating achievements and the view that the limited available funding was spread too thinly to make a real difference to landscape-scale change.

The Caring for our Country initiative aims to be strategic and has set six national priorities:

- National Reserve System
- Biodiversity and natural icons
- Coastal environments and critical aquatic habitats
- Sustainable practices
- Natural resource management in northern and remote Australia
- Community skills, knowledge and engagement.

Weed invasion represents a key pressure on biodiversity and natural icons; coastal environments and critical aquatic habitats; sustainable farm practices; and the sustainable management of northern and remote Australia. Given the essential role played by individual land owners and by voluntary conservation initiatives, community skills, knowledge and engagement also have direct links to successful weed management.

The Caring for our Country 2010-11 Business Plan under the Biodiversity and Natural Icons priority area makes funding is available for "reducing the impact of Weeds of National Significance on high quality native vegetation on public land and private land (including agricultural land)." This funding is not intended to support research.

National Biosecurity

In recent years, the Australian and state and territory governments have been working together to develop stronger partnerships directed to improving emergency responses to exotic plant pests that have significant impacts on the environment and/or social amenity. There are several national eradication cost-sharing programs underway. The objective is to ensure that Australia maintains its favourable biosecurity status.

Decision-making and investment frameworks; information sharing; monitoring, surveillance and diagnostics; and response preparedness all form part of the recently adopted National Environmental Biosecurity Response Agreement.

As the governments together work towards an Intergovernmental Agreement on Biosecurity, strong links to the Australian Weeds Strategy see a growing focus on science-based decision-making in which research and development will increasingly support necessary emergency responses to plant invasion.

States and Territory Governments

Under Australia's federal system of government, primary legislative and policy responsibility for natural resources management (including weed management) lies with the individual state and territory governments.

State and territory governments encourage responsible weed management by providing a suitable institutional and legislative framework, developing and implementing effective policies and programs, and providing positive support through financial incentives and assistance schemes as well as appropriate standards and regulation. They also support weed management through weed programs, enforcement of weed controls on targeted species, research and awareness activities and are responsible for managing weeds on public lands. All states and territory governments implement measures to prevent the sale and trade of a range of weeds, including WoNS.

Weed management and control in state and territory government departments' areas of responsibility appears to be moving towards both areas responsible for biosecurity and natural resource management.

Local Governments

The role of local government in each state and territory differs and is guided by state government legislation. In general, their role has expanded significantly from their traditional role of rates, roads and garbage disposal to include areas such as management

of public lands and environmental management. Local governments are generally responsible for land use planning and regulations which can impact significantly on natural resource management. Most also have a regulatory role in relation to weeds declared to be noxious.

Local governments undertake substantial efforts in weed control and management on public lands. This can be the council taking on the challenge or them facilitating community action in relation to weed management and control.

4. History of R&D in responding to the Australian weed challenge

Role of R&D

The impacts of weeds on the Australian landscape and the factors (both environmental and social) that influence those impacts are complex and despite extensive research often remain poorly understood. Weeds create challenges that will require Australia to continuously improve and like many other natural resource issues require adaptive management.

Adaptive management necessitates continuously updating and improving knowledge, applying this knowledge to decision making and institutional arrangements and enabling adoption of this knowledge through changed management practices.

Investing in the development of knowledge and on-going monitoring to support weed management in relation to productive systems and environmental ecosystems is thus vital. This investment however must be targeted and strategic so that it is aligned with decision making needs and priorities.

In considering the type of knowledge, information and monitoring that is required to support management and planning of weed mitigation and eradication, it is important to recognise that natural systems are complex and made up of a large number of interacting components and forces that impact on their condition and functioning. Human use and management of this system is also diverse and complex.

This complexity means that there are needs to understand (among other aspects):

- the characteristics of specific weeds or potential weeds
- how weed/s will impact on different ecosystems
- how weed/s will impact on the productivity of a system and human interactions with the system
- options to control or reduce the impact of the weed
- possible risks for future triggers that will exacerbate a weed and its impacts
- ways to coordinate and manage on-going monitoring and surveillance of weed threats
- how to motivate different land managers to control weeds effectively
- the role and suitability of institutional arrangements, policies and incentives for effective weed management

- practical, interactive approaches to encourage adoption of best practice weed management.

R&D has a key role in boosting understanding of the above areas and developing user focused information, tools, management options and resources that will enable Australia to better manage the weed challenge.

There are a range of initiatives and research programs that have played a role in obtaining knowledge and developing systems and management approaches that help to understand the above aspects for many weeds. However, realistically for an area such as weeds that require continual uptake and adaptive management this is an on-going task that requires longer-term commitment.

Previous research achievements

As the Australian Weeds Strategy identifies (Natural Resource Management Ministerial Council, 2006):

> "Weed management is an essential part of the sustainable management of natural resources for the benefit of the economy, the environment, human health and amenity.
>
> Good science underpins the effective development, monitoring and review of weed management strategies."

Cooperative Research Centres (CRC)

Recognition that the issues associated with invasion of exotic plant species are complex and multi-faceted has occurred over recent years. Furthermore, the benefits of collaborative research to address the complexity of issues surrounding weed control and management have been identified at least since the establishment of the CRC for Weed Management Systems in 1995.

Both the CRC for Weed Management Systems and its successor, the CRC for Australian Weed Management, hosted and coordinated a diverse program of research addressing areas including:

- weed biology and ecology
- weed risk assessment
- pasture management
- crop agronomy.

The Weeds CRCs focused on enhancing the sustainability of farming systems and the conservation status of natural ecosystems across Australia through research that targeted generic control problems using integrated approaches.

The Weeds CRCs demonstrated both the benefits of collaborative research across disciplines, jurisdictions and institutions and the importance of involving both

knowledge brokers and end-users in the research program design, implementation and delivery. They, reinforced the principle, highlighted in the Australian Weeds Strategy, that "Weed management requires coordination among all levels of government in partnership with industry, land and water managers and the community, regardless of tenure."

Some examples of achievements of the CRCs include:

- a major economic assessment of the costs of weeds to Australian agriculture
- an economic evaluation of weed biological control in Australia which demonstrated, among other things, that over the past 30 years the benefit:cost ratio for biocontrol programs averaged a $23 return for each $1 invested
- a series of technical reports, such as that authored by Spafford Jacob and Briese, which addressed improvement in selecting, testing and evaluating weed biological control agents
- significant developments in Weed Risk Assessment for Australia
- collaborative work on the management of glyphosate resistance in agricultural production systems
- a commercial seed furrow opener 'StubbleStar' which was designed to sow crops in ways which provide the seed with a competitive advantage over weeds
- a series of Weed Management Guides designed to summarise current knowledge for a diversity of major weeds and translate this knowledge into management advice.

The CRCs attracted funding for the Australian Government, the Grains Research and Development Corporation, Landcare Research New Zealand and the Australian Government Department of Agriculture Fisheries and Forestry. Between 2001-02 and 2007-08 more than $26 million was invested.

Industry-based Research and Development Corporations
Weeds in agricultural production systems

Several of the Rural Research and Development Corporations (e.g. Grains, Cotton, Horticulture and Meat & Livestock) have invested in weeds research, often in collaboration with scientific institutions and with funding support from government programs.

The Grains Research and Development Corporation has led the way in weeds research in agricultural production systems. Concerns about herbicide resistance have been a strong driver of this research and in recent years the emphasis has been on better understanding and managing to avoid resistance problems.

Better understanding the ecology of invasive plant species and adopting a suite of integrated weed management strategies within ever-changing production systems is an ongoing focus of commodity-based weeds research (Grains Research and Development Corporation, 2007).

As Reeves highlighted in his keynote address to the 16th Australian Weeds Conference in Cairns (2008):

> "A range of global changes will significantly impact on Australian crop production systems, and the management of weeds in these systems. Changes in climate; availability of land and water, energy costs; demographics; and markets, will necessitate new strategies and technologies for crop weed management during the coming decade."

There are new and emerging issues to which weeds research could be directed.

Weeds in pastoral production systems

For both the wool and meat industries, the focus of weeds research is on invasive species that compete with pasture, degrading its nutrient value and limiting access to grazing areas. Both Australian Wool Innovation and Meat & Livestock Australia (Dyer, 2008) have invested in collaborative research directed to the discovery of new biological control agents for problem weeds and in better understanding the ecology of some of these species to assist in improving their management.

Defeating the Weed Menace R&D program

The Defeating the Weed Menace R&D program was directed to "national priority weed issues across Australia that are having an impact on extensive land systems and conservation areas".

The Defeating the Weed Menace R&D program invested in 27 projects in themes which aligned with the Australian Weed Strategy. The program encouraged collaborations across jurisdictions and institutions.

In addition to the research outcomes of this program, the benefits of encouraging and facilitating collaboration and end-user engagement in projects from their inception, and in including planning for adoption of knowledge generated were apparent throughout. Strongly identified as a gap in the Defeating the Weed Menace R&D program was the omission of a research theme addressing social and institutional factors that influence adoption of improved weed management strategies.

The mix of 'open call' and strategically commissioned research was also identified as a strength of the program.

A series of synthesis reports generated from this R&D program include:

- an evaluative commentary on funded biological control projects
- an integrative framework for controlling weeds within natural resource management
- a survey-based analysis of the diversity of end-users of information on weeds and the needs of each of these groups
- a discussion paper on policy, institutional and management considerations for weeds that also have commercial value
- preliminary work on the likely spread of 'sleeper' and 'alert' weeds under changed climatic conditions
- innovative new uses of robotic aircraft, spectral analysis and machine learning in detecting significant weeds.

National Weeds and Productivity Research Program – Stage One

The Australian Government committed $15.3 million over four years, from 2008-09 to 2011-12, to establish a new comprehensive National Weeds and Productivity Research program that will reduce the impact of invasive plants on farm and forestry productivity and also on biodiversity.

The Australian Government Department of Agriculture, Fisheries and Forestry led a first stage of this Program by investing in 39 projects valued at nearly $3.6 million. The projects were short term and are in the process of being completed at the time of the development of this Plan. They covered a variety of themes and aimed to build on existing effort in this area:

- surveillance and detection;

- herbicide resistance;
- biological control;
- integrated Weed Management Strategies;
- future risks (climate change);
- impact of weeds on biodiversity; and
- maximise knowledge for adoption of existing research.

This five-year R&D Plan relates to stage two of the National Weeds and Productivity Research Program. RIRDC, as part of administering the remainder of the Program, will publish reports for the 39 research projects completed under the first stage.

State/ Territory Government research

While much of the focus in this section of the R&D Plan is on R&D initiated by the Australian Government, it is important to recognise that state and territory government agencies responsible for the environment, natural resource management and rural production also play a key role in both commissioning and conducting weeds R&D.

Reference to recent conferences hosted by state-based Weed Societies and by the Australian Weeds Society demonstrate the breadth of weeds R&D being undertaken by state-based agencies. Some example achievements from this R&D include:

- work by Downey and his colleagues to develop assessments of the impact of weeds on Australia's biodiversity
- an extensive body of cross-jurisdictional work to develop a reliable Weed Risk Management System for Australia
- a diversity of studies of herbicide resistance in cropping systems
- several programs which include community-based weed detection and management.

Academic institutions

Similarly, reference to the proceedings of biennial Australian Weeds Conferences, state-based Weeds Society conferences and the scientific literature on weeds, clearly demonstrates the important role played by scientists within CSIRO and in universities and other academic institutions around the country.

Lessons from previous research

In addition to the lessons learned from research projects, the successive phases of the Weeds CRCs work provided valuable lessons in improving the efficiency and effectiveness of weeds R&D.

Throughout its work, the Weeds CRCs brought together Australian Government and state and territory government agencies, research scientists and various end-users of knowledge. The CRC model was effective in gaining collaborative effort and outcomes for the diversity of stakeholders in weed research and management. Strong efforts were made to ensure that linkages were built between weeds research, communication and the practical management of weeds. Although not itself in the business of managing weeds, the CRC sought to ensure that its research programs resulted in practical resources to assist those responsible for on-ground management.

In general, the Weeds CRC sought to target big issues in weeds research and in so-doing avoided spreading its effort thinly across individual weed problems.

A focus on community empowerment also saw the CRC focus on targeted communications. Through the creation of a broad range of products and tools useful to different end-users from the scientific community through policy-makers, to on-ground weed managers and the wider community, the CRC helped raise awareness and expertise in weed management. One important element of this focus on effective communication was the extent to which the CRC engaged with education at all levels i.e. from secondary school students through to doctoral research candidates.

In an independent review of the Defeating the Weed Menace R&D program (Coutts & Samson, 2009), completed as the program was drawing to a close, the priority needs for future research were identified as:

- socio-economic and institutional dimensions of weed management
- greater emphasis on whole systems management approaches to weeds – better understanding the drivers of weed invasion and control
- increased understanding of the interactions between climate change, weed invasion and the control and management of weeds.

These priorities generally align well with those emerging from a series of state-based workshops conducted by Land & Water Australia in collaboration with state Weed Society conferences during 2009. Key among those priorities were:

- Social research directed to improving weed management. This included understanding perceptions of invasive species impacts, enhancing capacity to better engage key target groups and the wider community in gaining improved uptake of existing weeds research finding and management.
- Adopting whole-of-landscape or ecosystem approaches to weed management – understanding invasion processes and species lifecycles, competition mechanisms. The impacts of land uses and management on nutrient balances,

water flows, pasture and other ground-cover retention and the system dynamics that enable invasive plant species to take over.

- Related to the need to adopt whole-of-systems approaches to weeds research and management was an identified need to place biological control within a more integrated approach to landscape management, integrating it with other control strategies and improving understanding of the weed species targeted in order to enable better targeting of control agents.
- Understanding the influences of climate change on weed spread and enabling early detection and management. Both the importance of investing in early detection based on sound predictive information, and the need to better understand climate change impacts as part of developing capacity to build resilient ecosystems were a focus of this need.

Added to the priorities identified by Coutts & Samson (2009) was the need to improve spatial distribution information through finer-scale mapping and modelling for all key weeds (including but extending beyond the WoNS). Related to this was the need to identify areas of high conservation value so that they can be prioritised for management to exclude weeds from these areas.

Identified across the state-based forums as being of only slightly lesser priority were the following:

- improved understanding of the life cycles and characteristics of invasive plant species in order to improve landscape restoration in already degraded areas
- benefit/cost analysis in relation to species that have both commercial value and strong invasive properties, of longer-term v. short-term investment in research and land management for weed control
- the development of new technologies, including both remote sensing and the use of unmanned aircraft with digital imaging and related techniques for the detection and management of weed species.

Recognising the long-term nature of many weed problems and the time taken for landscapes to recover from such invasions, development of and ongoing support for monitoring methods that enable longer-term tracking of landscape invasion and recovery from weed infestations was also identified as an important aspect of effective monitoring, evaluation, reporting and improvement strategies.

Several of these future research themes have strong congruence with the key principles of weed management identified in the Australian Weeds Strategy (Natural Resource Management Ministerial Council, 2006).

Coutts & Samson, in their review of the Defeating the Weed Menace R&D program, also identified some key messages for the conduct of future weeds R&D. These included:

- the importance of longer-term investment and program continuity for effective weeds R&D

- the value of rigorous project selection and interactive program management in building and sustaining multi-stakeholder engagement
- the value of encouraging and assisting researchers to develop knowledge and adoption strategies from the beginning of their projects
- the benefits of developing monitoring and evaluation plans for both individual projects and research programs, to ensure sound data collection and reporting of projects and their impacts
- using a mix of general call and strategically tendered projects around identified program themes and priorities
- increased effort to encourage those from the broader NRM and farming systems communities to actively engage in weeds R&D funding calls
- allocation of time within the program to enable referring of tendered projects and major project proposals.

With the closure of both Land & Water Australia and the Weeds CRC, it is also important to ensure that provision is made for ongoing and accessible archiving of project and program reports for the benefit of future weeds R&D.

5. Key Challenges for the National Weeds and Productivity Research Program (SWOT)

The following Australian weeds research Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis was developed from a review of the literature, industry consultation and outputs from the
3-4 August 2010 R&D planning National Workshop.

The SWOT analysis

Strengths

- Current and recent "weed research" initiatives have established a valuable platform of information, knowledge and research capacity upon which any future weeds research initiative can draw upon
- A history of success with biocontrol as a cost effective approach to manage some weed species
- An understanding of the importance and potential of integrated weed management in agricultural systems
- Dedicated and enthusiastic environmental stewards keen to adopt research outcomes relevant to the management of biodiversity on public lands
- A secure and generous initial budget to fund the National Weeds and Productivity Research Program

Weaknesses

- Short term discontinuous funding which risks loss of momentum and research capacity
- Weeds research is a large area and very diverse and different groups/organisations have different agendas. Determining priorities for weeds across states, government departments and interest groups will always be a challenge
- Too many issues under the ‘weeds umbrella’ and risk of spreading limited R&D funds too thinly to achieve meaningful outcomes
- Lack of understanding on economic, social and institutional drivers that guide weed management actions by different stakeholders. This includes motivations and aspirations for change

- Loss of key chemical tools – resistance to glyphosate and other chemicals 'falling off' label
- Agricultural and forestry industry identified barriers to translating basic pure research into practical field applications
- It is a cross-sectoral issue that is not currently effectively coordinated across the sectors and this risks duplication of effort or the emergence of significant gaps
- The absence of an entity such as a "CRC" which acted as a vehicle to bring the research community together to exchange view and communicate weeds information
- Under-utilisation of already established networks

Opportunities

- Weed impacts upon ecosystems and adopting a systems approach to understanding and managing weeds including ecosystem restoration
- Whole systems approaches to weeds management
- Linkages with climate change research to better understand long term risks and implications of climate change for weeds in Australia
- Multi-disciplinary approaches to solve R&D challenges
- Better understand social, economic, policy and institutional drivers
- Spread models and damage functions to ensure control efforts are efficient and cost effective
- Improved identification and economic valuation of environmental values (eg biodiversity) affected by weeds
- Robotics to achieve more cost effective weed control
- Ongoing and accessible archiving of project and program reports for the benefit of future weed R&D and use by different land managers
- Identifying opportunities that may exist by partnering and integrating with other issues (e.g. natural resource, food security, biosecurity) that may better position weeds-related R&D
- Need to build an integrated weed research component into the wider natural resource management environment, so weed research can provide knowledge for a wide range of end-users
- R&D into bio herbicides offers the prospects for no chemical control and management systems. Research has taken place in the arena of bio insecticides with positive outcomes and more R&D is needed to extend this field into the weeds area

Threats

- Complacency by private land managers and other decision makers
- Climate change resulting in the need to 're-do' our research – including both spread and control options
- Sleeper weeds and transformer weeds. Transformer weeds have the potential to disrupt whole ecosystems
- Ecological weeds that are agriculturally valuable – resulting in conflicts between propagation and control
- Lack of information on weed status in Northern Australia
- The spread of peri-urban landscapes and a consequent lack of land and weed management knowledge
- Weeds pose a threat to many of Australia's Indigenous lands and the original Australians who live there by clogging waterways and preventing access to food collection and places of cultural significance
- Failure to convey the importance of weeds research, and ongoing funding is not forthcoming.

6. Relevant Research Priorities and Weed Initiatives

The National Weeds and Productivity Research Program aims to play a role in responding to, or being consistent with, a range of national priorities and initiatives:

- National Research Priorities
- National Rural Research Priorities
- The Australian Weed Strategy
- Broad priorities set by the Australian Government for the National Weeds and Productivity Research Program.

National Research Priorities

The Australian Government announced National Research Priorities in 2002. The National Research Priorities aim to highlight particular areas of social, economic and environmental issues that are important to Australia, and where a national focus of effort will help to improve the quality, usefulness, collaboration and multi-disciplinary approaches utilised for the development and implementation of research activities.

There are four National Research Priorities:

1. An Environmentally Sustainable Australia
2. Promoting and maintaining good health
3. Frontier technologies for building and transforming Australian industries
4. Safeguarding Australia.

Protecting Australia from weeds and their impacts cuts across all four of the National Research Priorities. As noted in previous chapters, weeds impact on productivity, the environment and human health and industries and resource managers need to be adopting improved knowledge and approaches to reduce their negative impacts.

National Rural Research Priorities

The Australian Government established research priorities specific for the rural industry sector in 1994 as a process to articulate government objectives for R&D that would allow the Rural Research and Development Corporations, or other related rural industry research areas which attracted public investment, to better meet the public benefit goals for supporting such research. The rural research priorities were updated in 2007 (DAFF, 2010):

- Productivity and Adding Value - Improve the productivity and profitability of existing industries and support the development of viable new industries.
- 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.
- Natural Resource Management - Support effective management of Australia's natural resources to ensure primary industries are both economically and environmentally sustainable.
- Climate Variability and Climate Change - Build resilience to climate variability and adapt to and mitigate the effects of climate change.
- Biosecurity - Protect Australia's community, primary industries and environment from biosecurity threats.
- Supporting the Rural Research and Development Priorities - Improve the skills to undertake research and apply its findings.

The majority of these priorities have been considered in the development of this R&D Plan for the National Weeds and Productivity Research Program. In particular, productivity, natural resource management, climate change and biosecurity all play a big role in the priority Research Themes identified for the National Weeds and Productivity Research Program.

In 2009, the Australian Government Minister for Agriculture, Fisheries and Forestry set up a Rural R&D Council as a key advisory body on rural R&D. The Council provides high level advice and coordination to better target and improve the effectiveness of the Australian Government's investment in R&D.

The Rural R&D Council is expected to develop a National Strategic Rural R&D Investment Plan, set up a performance measurement and reporting framework and provide advice on enhancing cross-sectoral, cross-disciplinary, cross-jurisdictional and international cooperation and collaboration. The Rural R&D Council will progress these agendas which will potentially impact on the National Weeds and Productivity Research Program but at the time of the development of this plan there is no information that can be used to guide its direction. There may be opportunity for this program to provide feedback to the Rural R&D Council particularly in areas of cross-sectoral, collaborative and multi-disciplinary research approaches.

The Australian Weeds Strategy

The Australian Weeds Strategy provides a framework to establish consistent guidance for all parties, and identifies priorities for weed management across the nation with the aim of minimising the impact of weeds on Australia's environmental, economic and social assets.

The three Australian Weeds Strategy goals and sub-objectives are:

1. Preventing new weed problems
   - prevent the introduction into Australia of new plant species with weed potential
   - ensure early detection of, and rapid action against, new weeds
   - reduce the spread of weeds to new areas within Australia
   - implement weed risk management practices to respond to climate change.
2. Reducing the impact of existing priority weeds problems:
   - identify and prioritise weeds and weed management problems and determine their causes
   - implement coordinated and cost effective solutions for priority weeds and weed problems
   - develop approaches to managing weeds based on the protection of values and assets.
3. Enhancing Australia's capacity and commitment to solve weed problems:
   - raise awareness and motivation among Australians to strengthen their commitment to act on weeds
   - build Australia's capacity to address weed problems and improve weed management
   - manage weeds within consistent policy, legislative and planning frameworks
   - monitor and evaluate the progress of Australia's weed management efforts.

The National Weeds and Productivity Research Program could potentially play a role across the three goals and sub-objectives. It raises the issue of the need for a national focused R&D program to coordinate efforts and ensure duplication with other activities being resourced associated with the Australian Weeds Strategy does not occur. It also raises the importance of the role R&D has in informing actions that may be undertaken to respond to the three Australian Weed Strategy goals. A risk is that the R&D program tries to achieve delivery and actions in areas that other parties are and should take responsibility for.

It is recommended to ensure the R&D that is undertaken as part of the National Weeds and Productivity Research Program complements the Australian Weed Strategy that a suitable representative from the Australian Weeds Committee be consulted during project selection stages.

Broad priorities set by the Australian Government for the National Weeds and Productivity Research Program

The broad research priorities for the National Weeds and Productivity Research Program are:

- investigate and solve the most serious invasive plant problems focusing efforts to improve productivity and the environment
- investigate new methods which reduce reliance on herbicides and promote integrated approaches which also help to reduce energy and chemical inputs in agriculture
- refine landscape-scale integrated weed management strategies to manage the risks associated with invasive plants in agriculture, forests, pastures and native vegetation, including addressing climate change mitigation and adaptation issues
- identify motivators and barriers to the uptake of cost-effective integrated weed management strategies and options to encourage the uptake of integrated practices
- improve understanding of economic, social and environmental impacts of invasive plants
- ensure better coordination and information exchange between researchers, land managers and regulatory agencies about integrated approaches for priority management of invasive weeds.

These broad research priorities cover types of research (e.g. develop new approaches to weed management to reduce reliance on herbicides, climate change mitigation and adaption issues), focus areas (e.g. most serious invasive plants), the approach to the research (e.g. better collaboration and information exchange between researchers and users) and the target users of the research outputs (e.g. agriculture, forests, pastures, environment). All have been considered and are incorporated into this 5-year R&D Plan.

7. Key Messages from Consultation

Over fifty people were consulted as part of the development of this plan including researchers, agricultural and forestry industry representatives, natural resource and environmental sector managers, extension officers and facilitators and government officials (Appendix 2 provides a list of people consulted). A summary of key inputs from consultation from the different stakeholder groups is presented below.

Agriculture and Forestry Industry Representatives

Representatives from agricultural and forestry industry consulted included national and state level representative organisations, farming systems groups and national industry focused associations. Frequently the research priorities reported by these people related to specific weeds many of which are not on the Weeds of National Significance list.

Not surprisingly, chemical resistance was identified as a common high priority issue that most productivity sectors will need to identify solutions for in coming years. Some other common areas of priority research were (in random order):

- applied farming systems research – integrating weed management into other production system approaches, incorporating it into the whole farm system approach
- develop effective biological control options
- spray technology and ways to improve application of chemicals for weed management
- aerial or spatial survey of weeds to help improve ability to manage and reduce spread risk
- cost of getting chemical approval was high. Interested in ways to improve access to herbicides for minor uses
- processes for reducing weed spread from transport of produce and contracting machinery
- molecular approaches to breed spray resistance into the crop so herbicide can be used more effectively to target weed species
- improved information and extension approaches with growers so they understand the significance of the problem and effective and cost efficient ways to manage weeds for their circumstances
- economic assessments on the costs of weeds in different farming systems to set priorities and assist with adoption
- examination of both chemical and non-chemical control options

- ways to manage pastures and landscapes better so weeds are not allowed to establish
- risk management and ways to get other land managers to take responsibility for their weed problems to reduce overall costs to the agricultural sector
- issues surrounding chemical use and residues on farm is a possible emerging issue that needs research to communicate impacts on food safety and off-farm impacts.

A small number of representatives were consulted from the forestry sector who reported that weeds research was not a high priority for them. Most forestry organisations managed weeds during site preparation. Investing in weed specific research for their system was not something that they were currently considering.

Agricultural and forestry industry identified barriers to translating basic pure research into practical field applications. This was partly attributed to insufficient funding for weed related R&D and the stop start nature of funding arrangements in recent years. There was also an issue relating to the need to better target and translate information for use by people at the local level once it has been field tested.

Some reported that they felt the state and territory institutional arrangements differed significantly, which created risks for some weeds where in one state they were a high risk and being managed and in another state were not even on the radar. Examples were provided on how this could impact trades for some produce if not effectively managed.

Many felt that weeds were a cross-sectoral issue that was not effectively coordinated across sectors and his risked duplication of effort or the emergence of significant gaps.

Researchers

Researchers from a range of institutions and disciplines were consulted as part of the development of this R&D 5-Year Plan. A large suite of research gaps were identified by the research community. This included areas relating to (in random order):

- current status and impact of weeds in Australia
- social, economic and institutional information needed to improve future research and design of effective extension initiatives
- decision support information and systems to improve future decision making and institutional requirements
- risk management tools and information
- post weed management control and management options particularly for public lands
- biocontrol research and integrated biocontrol into system management approaches
- fill gaps in ecology knowledge for specific weeds

- weed species spread in areas of the natural environment
- herbicide resistance for both productive systems and public lands
- options to manage conflict weeds between environment and agriculture.

Researchers identified that there is a significant barrier to effective research in the area of weeds due to lack of long term funding, which created challenges for building capacity of the research community. They noted that it also limited the type of research that could be undertaken and many gave the example of biocontrol research as an area that often could not be effectively resourced in short term funding approaches. The high return from biocontrol research was also noted. Many also commented on the need to better integrate traditional weed sciences with that of economics and social sciences.

It was noted that the development of alternate weed control strategies had been neglected by publicly supported research and tended to be led by private sector weed control industry, which not surprisingly has resulted in herbicide companies leading R&D. Some thought that this trend had resulted in current reliance on the herbicides as a weed control option. The key message in relation to this was the need to consider the development of control options for productive and environmental systems.

Several researchers also commented on the gap in knowledge for northern Australia as much of the research effort has focused on the south.

Researchers also stressed the importance for setting up long-term arrangements that would enable improved collaborations and multi-disciplinary research in relation to weeds. It was also felt that long-term arrangements would better position the research sector to build their capacity and attract good people to the area of research required to better position Australia for on-going weed challenges.

Rural Research and Development Corporations

Consultation with Rural Research and Development Corporations identified different level of interest to weeds for their respective sectors. The key cross cutting issues were related to herbicide resistance, minor chemical usage issues and opportunities to incorporate weed management into the farming system approaches. There was also interest in translating existing knowledge for use by farmers and local land managers. A short summary of key messages from Rural Research and Development Corporations consulted are presented below.

Australian Wool Innovation

Australian Wool Innovation reported that weeds-related R&D was not a priority issue for them at the current time. They identified that weeds did not get brought up as an issue in recent consultations with farmers for the development of their National Research, Development and Extension Plan. They noted that in the past they had invested in specific species (e.g. biocontrol for Paterson's curse) but now they tended to target effort on grazing management holistically instead. It was identified that the Meat and Livestock Australia and Australian Wool Innovation's *Making More from Sheep*

program includes weeds extension this is incorrect, there is no "weed extension" in Making more from sheep, rather it conveys only principles of good pasture management (that will preclude weed invasion). I suggest:

It was identified that the Meat and Livestock Australia and Australian Wool Innovation's *Making More from Sheep* program includes principles of improved pasture management to prevent wed incursions. They noted that getting farmers to adopt research in this area was challenging.

Cotton Research and Development Corporation

The Cotton Research and Development Corporation has a long and rich history of R&D into weeds research noting that it invests approximately $500,000 per annum into weeds related R&D. The protection of the cotton industry from biosecurity threats is a critical platform within its farming systems program. The industry already deals with a range of pests, weeds and diseases all of which pose some degree of risk. Research informs their ability to manage these threats (e.g. Heliothis resistance to BT cotton, grass weed resistance to glyphosate and threat posed by silver leaf white fly).

They noted that their capacity to invest more extensively in sort of research had been affected in recent times due to prolonged drought and reduced funding. They have an interest in collaborating or being a partner in future R&D in this area where they see there might be value. However, this would need to be judged on a case by case basis.

Forest and Wood Products Australia

The Forest and Wood Products Australia identified that weed control was not a key issue for the industry. They identified that current management regimes were in place to manage weeds. It was noted that weeds competed for water and nutrients but they primarily controlled this through site preparation and eradication strategies that include the use of herbicides. The Industry and the Forest and Wood Products Australia formalised the Forestry Industry Cooperative Research Consortium in April 2010 and weeds research is part of the Consortium's agenda. They are unlikely to invest further in this area in the short term.

Grains Research and Development Corporation

Weed management has always been a big impost on the Australian grains industry. It is estimated that weeds are costing the industry more than $1.4 billion a year. The Grains Research and Development Corporation (GRDC) have been actively investing in weed R&D for some time. They were involved in the Weed CRCs and have continued effort in this area since the CRCs ended. They have three weed investment areas:

1. Increase diversity of weed control options
2. Improve the management of weed control options in changing farming systems
3. Coordinate national approaches to weed management

The key issue impacting on the grains sector is that of herbicide resistance. The sector is undertaking significant research in this area at both strategic and practical application

levels. The GRDC has invested in the National Integrated Weed Management Initiative (NIWMI). GRDC have a key role in driving strategy in the grains industry and currently coordinate the NIWMI advisory committee which includes scientists from all the key weed management research providers, many of which were former CRC AWM program managers. The NIWMI Advisory committee play a role in providing advice on national coordination and investment to the GRDC.

GRDC are also active members and co-funders of the Glyphosate Sustainability Working Group (GSWG) - a collaborative industry reference group who promote and provide advice on the sustainable use of glyphosate in Australian agriculture. Participants involved in the AGSWG are from across the industry (Monsanto, Syngenta, Nufarm, WA Herbicide Resistance Initiative (University of WA), University of Adelaide, Charles Sturt University, Queensland DEEDI, Department of Agriculture and Food, WA, Industry & Investment NSW, CRT/Town &Country, the Crop Life Herbicide Management Committee of AVCARE, Horticulture Australia Ltd, Cotton Research and Development Corporation, Independent Consultants Australia Network and the Grains Research and Development Corporation (GRDC)).

GRDC identified that there were some gaps in herbicide resistance research for public lands. They noted that if weeds are not managed well on public lands it will impact on the agricultural sector. They also identified a possible gap in the area of pasture based crop rotation systems.

An emerging challenge for the agricultural sector was noted as the impact of regulatory arrangements in relation to chemical use and spray drift legislation. It was recommended that R&D included under this program consider and incorporate regulatory issues before providing information for industry use.

GRDC note a priority need for long term National collaboration and capacity development of the Australian research community in relation to weeds.

Grape and Wine Research and Development Corporation

Grape and Wine Research and Development Corporation (GWRDC) identified that R&D into weeds represents a very small level of investment against much higher priorities in areas such as water use efficiency and factors which influence grape pricing and returns. Weed control is approximately 95% met by approved herbicides. They note that resistance to herbicides looms as a potential issue of the industry. Over the last 10 years, there have been 3 weed projects funded by GWRDC and these have all been less than $10,000 each.

Horticulture Australia Limited

Horticulture Australia Limited identified the main problems associated with weeds are a lack of available herbicides for use within different horticultural sectors and the emergence of herbicide resistance. Horticulture Australia Limited has invested in specific weed projects over the years, mainly focussed in the areas of annual cropping systems (through vegetables programs) and concerning herbicide availability. Overall,

the horticulture sector does not face the same weed problem as evident in broad acre agriculture industries and has the added benefit of being able to regularly cultivate.

They noted that the horticulture sector had a reasonable high level of weeds awareness and so availability of suitable and approved herbicides would be viewed as the major problem. HAL's investment in weeds R&D is mainly focussed on underpinning approved herbicide availability. Scale issues often lie behind chemical company support for investment in herbicides for horticulture.

More recently, issues of herbicide resistance have surfaced. Specifically, resistance to glyphosate resulting in the spread of herbicide resistant "escapees" has prompted HAL's input into the Australian Glyphosate Sustainability Working Group.

Two key areas were identified as possible areas for future R&D:

- Bio herbicides offer the prospects for no chemical control and management systems. Research has taken place in the arena of bio insecticides with positive outcomes and more R&D is needed to extend this field into the weeds area. This is an opportunity to also work in collaboration with other agricultural industries
- Application systems is a gap. More effective targeting and delivery of herbicides has important benefits for industry.

Meat and Livestock Australia

Meat and Livestock Australia (MLA) has a strong interest in weed RD&E. Priority areas include development of improved weed management practices, biological control agents for intransigent weeds, and improving the way weed research is presented to assist adoption. There is a need to translate existing information and research into formats that provide a compelling case for change.

They identified that a lot of R&D has been undertaken but the challenge was to equip advisors, regulatory officers, agronomists with an array of management technologies (not just herbicide) to ensure weed management is achieved.

For the livestock industries there are two areas of emphasis:

1) Pasture management RD&E is focused on ecological principles to prevent weed incursions.
2) Weed management using an array of control methods - grazing management, tactical use of herbicide and fertiliser and herbicide and biological control

They noted that a systems approach was required incorporating the farming system and natural ecosystems. They note there is a need for longer term R&D and extension addressing the fragmentation of the research and delivery base.

Priority areas for weed research for Australian production systems include:

- Management and control of priority weeds for the livestock industries

- Significant focus on biological control for extensive systems
- Applications of remote sensing and robotic technology to automate landscape weed detection, mapping, monitoring and control (aerial and ground based)
- Tools for determining economically optimal weed management and control strategies
- Adoption of existing processes – developing and delivering a compelling case for adoption
- Integrated weed management (utilising the opportunities of mixed enterprises, and associated diversity of "tools"- herbicide, grazing management, fertiliser & biological control).

MLA has identified Weeds of Significance to the Grazing industries. This report listed: 119 priority weeds, comprising, 48 weeds of greater significance and 24 emerging weeds (sleeper weeds). There are overlaps with the WoNS listing, and collaboration is sought.

Specific outcomes need to be identified in weed control and management then deploy resources to achieve that change – rather than just "more research". By implication this requires a focused "pipeline approach in research and delivery"

Sugar Research and Development Corporation

The Sugar Research and Development Corporation identified that the majority of their R&D in relation to weeds was in herbicide application and this was generally handled by BSES Ltd, an organisation owned exclusively by Australian sugarcane growers and millers. This research was undertaken with the support of herbicide manufacturers.

The SRDC's own effort in relation to weeds tended to be confined to generic studies of application technologies (such as weed detection and spot spraying), timing of weed management and grower driven studies into local issues. It was noted that most weeds are managed through green trash blanketing but some (particularly vines) can emerge through the trash blankets and these require herbicide treatment.

Natural Resource, Environmental and Public Land Managers

Natural resource, environmental and public land managers includes people from Regional Natural Resource Management bodies (e.g. Catchment Management Authorities), environmental organisations, natural resource extension officers or facilitators and local government representatives.

These representatives reported that weeds were a significant issue for biodiversity and natural ecosystems as they had negative impacts on desirable plant and animal communities due to the weeds competing for nutrients, water and light. They noted that the number of people involved in the management of weeds at the local level was high and included local councils, Bushcare/ Landcare and other community groups, nurseries, national/state parks and private land holders.

Many consulted as part of this group reported the need for more accessible and practical information on how to manage weeds for different circumstances. Whole of landscape approaches to managing weeds was stressed as an area requiring greater R&D effort. It was noted that many felt that R&D in relation to weeds on public lands was a gap. Some noted that there was some commonality of the needs for environmental and public lands to the extensive grazing sector.

Some areas noted as priority for research include:

- information on social behaviour and attitudes for a variety of land managers in relation to weeds was thought to be of value to help guide the development of practical extension approaches and translating relevant information for a range of needs
- social and economic research that identifies the costs of weeds to all parties include the environment, economy, industry, society, health etc
- development of biological and landscape control options
- greater understanding of seed bank dormancy as it was noted that seeds often lay dormant for long time periods (~30 years) and then something triggers them. This creates a management challenge for on-going maintenance requirements.
- challenge associated with plants that are considered to be weeds in one location but not another (e.g. eastern state plant species such as acacia and Victoria tea tree are big problem around Western Australian roadsides and reserves)
- management options for areas where there is limited access
- herbicide resistance for roadsides and public areas
- identification of key risk areas and ways to manage these risks for the benefit of many stakeholders (e.g. peri-urban sector was identified as a possible high risk as they were not aware of weed issues and consequently were not managing them effectively)
- aquatic weeds R&D.

Some of the barriers identified by these stakeholders was the lack of understanding of the roles and responsibilities of different organisations, which often as a resulted in some aspects of weed management being neglected.

The short term nature of funding was again reported to be an issue, not only for research capacity, but in the case of where money was provided to manage a particular weed in a specific location there was usually not enough funding to allow for follow up resulting in the weed reoccurring.

State and Territory Governments

Consultation with State and Territory government officials occurred with two key areas – NRM line areas and biosecurity. Both appear to be actively involved in weed management and policy. However, it appears that most states are moving to grouping weed management within the biosecurity portfolio as many felt that weeds as the natural resource issues were being managed at the Regional NRM Bodies' level. This was a general trend noted by many government representatives.

This increased biosecurity focus in relation to weeds make the biosecurity continuum of pre-border, border and post-border functions the main path for considering weed R&D needs. Priority research needs reported by state and territory governments include (in random order):

- fill gaps in understanding of key weeds (weed ecology)
- identify emerging risk/s and analysis of risk pathways, vectors and dispersal for specific weeds
- improved detection, surveillance, containment, control and eradication approaches and the links between these approaches
- understand the impacts of weeds on ecosystem function and type of ecosystem restoration is required. Undertake R&D to inform what we need to do to restore ecosystems and make them resilient is a gap.
- biological controls – development of effective biological controls and species recovery strategies
- monitoring approaches for use after control to ensure intervention has been successful and reoccurrence does not occur
- social attitudes to weed management: need more research into why different sections of the community do and do not manage weeds effectively and the effectiveness of particular policy tools
- better understanding of the impact of weeds - economic, biodiversity and social (eg human health) impacts. Information in this area could be used to help raise public awareness and develop effective extension approaches
- there is a need to transform existing research knowledge for use by different weed managers. Currently people are not aware of a lot of research outputs
- managing weed implications for changed land use or changed land manager (e.g. from commercial farm to hobby/ peri-urban farm)
- develop improved treatment and control technologies
- identify opportunities to restore ecological function after weeds have been controlled.

State and Territory government representatives have similar concerns to other stakeholder with regards to weeds research capacity. They note that their own funding availability for supporting researchers within their organisations is continually reducing.

Future effort in whatever model is developed for improved weeds R&D needs to ensure a collaborative approach and identify opportunities to build the capacity of the research sector for conducting effective weed related research in 10 – 20 years time.

It was noted that the issue of weeds is never going to go away and therefore part of the strategy for all parties is to collaborate and ensure that policy, research and land managers can make informed decisions regarding weed risks.

Note the comments presented here are from government officials and do not represent official views by their respective Ministers.

8. The National Weeds and Productivity Research Program

Vision, mission and stakeholders

Vision

RIRDC's vision for Australian weeds research and development:

"Australia is equipped with the knowledge, resources and technology to successfully prevent, mitigate or adapt to weeds in our agricultural systems, ecosystems and landscapes."

Mission

In pursuing this vision, RIRDC's mission in managing the National Weeds and Productivity Research Program is to:

" Invest in R&D that enhances knowledge and management options that will improve Australia's capacity to respond to the on-going weed challenge effectively"

Research in the context of the National Weeds and Productivity Research Program means R&D as interpreted in the Primary Industries and Energy Research and Development Act 1989.

Stakeholders

The improved knowledge and management options for dealing with weeds will support a range of stakeholders involved in land and water management in Australia. The stakeholders in the National Weeds and Productivity Research Program include:

- policy makers, legislators and regulators at all levels of government;
- key land managers including farmers, public land managers and Aboriginal and Torres Strait Islander land holders as managers of crops, pastures, timber plantations, native vegetation and natural ecosystems;
- land and water planners in government, private and community organisations;
- service providers including landcare groups, farmer groups, farm advisors, agribusiness, consultants; natural resource management facilitators, and philanthropic and conservation organisations that manage land and water resources; and
- research funders, purchasers and providers.

Objectives, outcomes and investment priorities

In addressing the Government's priorities, this Plan will pursue four key objectives.

Objective 1: Improve knowledge for effective risk management of weeds.

Outcome: Improved likelihood of effective integrated weed management strategies being adopted, particularly at a landscape scale to manage the risks associated with invasive plants in agriculture, forestry and natural resource management including aquatic weeds. This includes preventative, mitigative and adaptive strategies including the impact of climate change.

Priority: Investing in R&D that fills key knowledge gaps which contribute to more effective risk management of weeds. RIRDC will collaborate with key agencies including Plant Health Australia, the Biosecurity Services Group of the Department of Agriculture, Fisheries and Forestry, CSIRO, other rural research and development corporations, and state and territory government agencies in identifying knowledge gaps and commissioning the necessary research.

Resource Allocation: The Plan envisages allocating up to 25% of the Program budget to this objective.

Objective 2: Reduce current and future impacts of weeds on Australia's productive systems and environments.

Outcome: Improved tools, methods and technology that can solve the most serious invasive plant problems impacting on primary industry productivity and the environment including aquatic weeds. This will include new methods that reduce reliance on high cost and potentially harmful herbicides and promote integrated approaches to weed management. This objective will be aligned to the needs of Australian agriculture to address energy and chemical inputs in production and also the impact of climate change on the spread and invasive intensity of endemic and potential weeds.

Priority: Investing in R&D to investigate the most serious invasive plant problems and to provide the knowledge and methods to solve those problems.

Resource Allocation: The Plan envisages allocating up to 40% of the Program budget to this objective.

Objective 3: Support improved adoption of weed management approaches.

Outcome: Outputs of R&D facilitates improved adoption by stakeholders of the National Weeds and Productivity Research Program.

Priority: Investing in R&D that improves understanding of economic, social and environmental impacts of invasive plants; that identifies the motivators and barriers to the uptake of cost-effective integrated weed management strategies and options; and ensures better coordination and information exchange between researchers, land managers and regulatory agencies about integrated approaches for management of invasive weeds.

Resource Allocation: The Plan envisages allocating up to 30% of the Program budget to this objective.

Objective 4: Plan for future funding and institutional arrangements for national investment and management of weeds R&D.

Outcome: A well-researched plan for future investment and institutional arrangements for national weeds research and development that can be presented to governments and other potential investors prior to the ending of the current funding for the National Weeds and Productivity Research Program.

Priority: Investing in research and development that identifies options, the pros and cons of those options and how the preferred option or options can be implemented.

Resource allocation: The Plan envisages allocating up to 5% of the Program budget to this objective.

Research Strategies

For each of the first three objectives, there are four types of research strategies that could be employed.

Research Strategy 1 - Advance foundational knowledge

The Program aims to develop new, or advance existing, knowledge in strategic areas that allow Australia to better manage identified weed challenges or identify possible future challenges. The knowledge developed should be recognised by researchers and target users as providing a foundation for future management decisions and priorities, developing appropriate detection and surveillance approaches, eradication or control options and/or providing information on how to reduce the impact of the weed/s on different assets/systems.

Projects that fall into this category should, as part of their project, identify how the knowledge developed as part of the project provides a foundation for future areas of research or management actions. The project should include a component that provides information on what needs to happen next, why, who would use this information and how. Where practical and useful possible users of the foundational knowledge should be included in discussions that determine how the foundational knowledge or resources would be used.

Examples of outcomes in relation to projects undertaken in relation to this strategy include:

- Projects result in advancing knowledge in key areas recognised as such by the research community and/or by key weed decision makers
- Projects have filled identified knowledge gaps in key areas
- The foundational knowledge that is created is complemented with information on possible next steps or information on how the knowledge can be used within the weed management context.

Research Strategy 2 - Develop tools, methods and technologies

The Program aims to play a role in developing tools, methods and technologies that support risk management and decision making across all levels (national, state, regional, local and on-farm). Where possible and practical projects that are developing tools, methods and technologies should engage end users in developing and trialling them to ensure they are practical and meet their intended needs.

Examples of the sorts of tools, methods and technologies that are envisaged to be supported under the research objectives could include:

- Practical decision support information and tools are developed that will enable land managers to understand the risks, economic costs and benefits and options available to manage specific weeds
- Improved guidance on approaches to manage specific weeds/ systems are developed
- Technology is advanced in relation to efficient monitoring, detection and/or surveillance of specific weed threats

- Coordination methods for weed detection and management, perhaps utilising communities of practice, are evaluated and lessons are drawn out for future application.

Research Strategy 3 - Evaluate current social, economic and institutional influences

This research area focuses on better understanding the social, economic and institutional influences that drive weed management practices across the spectrum of land managers and influencers. It is important that the improved understanding be directed towards specific purposes and guide other actions. Thus, the research in this area should be about identifying potential levers (policy signals, information and resource needs, who the key influencers are) or barriers that need overcoming that will improve weed management.

Examples of the outcomes from this type of research should include:

- Opportunities to improve policy arrangements that could result in improved weed management are identified
- An improved ability to customise information and resources for different target groups based on their needs and help to address any barriers to adoption of improved weed management
- Examples of improved social, economic and/or institutional understanding incorporated into research projects and products developed to support decision making in relation to weeds.

Research Strategy 4 - Test and translate existing resources and make them more accessible

This R&D Program aims to facilitate the testing of existing resources and enabling different stakeholders to have better access to existing knowledge and resources in formats that suit their needs. A key need identified during the development of this plan was in translating existing information and resources and increasing their use for decision making across a range of stakeholders. Projects undertaken in line with this research strategy require significant input from target users of research. This will be a requirement within research projects and also is an area that RIRDC, as research managers of the program, will facilitate by hosting forums with key users to grasps their varying needs and testing existing knowledge and information with them. It may be more cost effective for groups of projects to work with key users/ weeds stakeholders.

Examples of outcomes in this area include:

- Improve public accessibility of existing knowledge and resources in relation to weed management
- Increase use of existing knowledge and resources in decision making by a range of weed stakeholders
- Provide forums for users to adequately articulate their needs and provide feedback on gaps in knowledge for future investment and the practical use of knowledge and resources for their decision making.

Management of Objectives 1-3

The following provides more information on Objectives 1-3 and the types of research strategies that could be employed for each objective.

Objective 1: Improve knowledge for effective risk management of weeds.

Managing the current and future impact of weeds in Australia requires a sound risk management approach. There are significant roles that national focused R&D could provide to improve Australia's ability to manage risks posed by weeds now and in the future.

The national biosecurity continuum - pre-border, border and post-border functions – include risk management at all stages. This program will predominantly focus effort on border and post-border functions; however, there are some areas where science could provide foundational knowledge, technology to support monitoring and surveillance and identify opportunities and techniques for improved coordinated approaches for all aspects of this continuum.

The Program aims to support the development of foundational knowledge that will help to scope and identify future risks and challenges. For example, climate change, changing patterns of land use, limitations both to the use and effectiveness of chemicals and herbicides, and increased risk of new weed introductions as a result of increased international trade and travel all contribute to the challenge of managing weeds and reducing their impacts across Australia.

It also aims to contribute to improved detection and surveillance within Australia. It is anticipated that this will be through the advancement of technology such as the use of satellite and remote sensing for detecting weeds and observing their spread or identifying their potential spread. It should also consider approaches used by different people across the country to detect weeds and ways that this could be better coordinated or lessons could be learnt from one jurisdiction to another or between different stakeholder groups.

The National Workshop held as part of the development of this plan identified a range of information and tools that are already available that would enable improved risk management for weeds. There is an opportunity to identify these resources and bring them together to make them more accessible and in a format that can be used by a range of stakeholders.

Strategies

Advance foundational knowledge

- Improve understanding of ecology of identified sleeper and/or alert weeds species.
- Fill gaps in understanding the ecology of key identified high risk weed species (particularly for northern Australia).
- Undertake pathway analysis, weed mapping, spread models and damage functions for serious weed problems or potential problems.

- Improve understanding of the impacts and possible scenarios that could result from land use changes in relation to specific weeds or for identified ecosystems (climate change, fire, drought).
- Continue to improve understanding of the impact climate change may pose on identified weed species and on productive and environmental systems. Analyse whether the current control techniques will be affected by different climate change scenarios.
- Draw on existing knowledge and information from the scientific community to identify possible future national high risk weed species and their characteristics and how the risks from these species could be minimised.
- Improved understanding of the life cycles and characteristics of invasive plant species in order to improve landscape restoration in already degraded areas.

Develop tools, methods and systems

- Develop decision support frameworks which include spatial analysis, risk assessments in relation to serious weed challenges.
- Develop improved decision support information that provide land managers guidance on where and when to act in relation to - eradication, control and management of the assets.
- Support the development of advanced detection and surveillance technology (e.g. remote sensing and the use of unmanned aircraft with digital imaging and related techniques for the detection and management of weed species).
- Identify opportunities to improve detection and surveillance national networks and coordination.
- Develop effective containment options for "conflict species."
- Develop predictive tools for future weed risks.

Evaluate current social, economic and institutional influences

- Evaluate the effectiveness of current approaches used in jurisdictions for surveillance, detection and monitoring of weed risks. Identify strengths and weaknesses from the approaches used and any options for improved national coordination which will reduce the potential impact of weeds in a cost effective manner.
- Improve understanding of different land managers and their attitudes, motivators and barriers for weed management. Analyse their responses in relation to weed surveillance, detection, monitoring and management of weed risks. Identify specific stakeholders that may be increasing the risk of weed spread and any options to work with these stakeholders to improve their likelihood to respond to weed risks for the benefit of the landscape and other land managers.
- Draw together information on the current state of play in relation to current weed challenges and their economic, social and environmental impact. Collate

this information in a format that could be used by a range of decision makers and interested parties.

- Identify options and a national approach for addressing areas of conflict for weeds that impact on the environment while also providing benefits for pastures or other productive purposes.

Test and translate existing resources and make them more accessible

- Undertake a stock take of existing knowledge and resources in relation to risk management. Where possible trial the usefulness of these tools with specific stakeholders and identify what might need to occur to improve their applicability and use in improving weed management.
- Develop an approach to make knowledge and tools more accessible to key stakeholders.
- Establish an approach that will improve public accessibility of existing research and approaches (e.g. National Toolbox).

Objective 2: Reduce current and future impacts of weeds on Australia's productive systems and environments.

The agricultural sector experiences significant impacts to their productivity caused by weeds. The sector has a range of needs in relation to being able to reduce risks and costs imposed by weeds specifically by having access to practical control options and relevant decision support information that can enable effective uptake of weed management approaches.

This research objective aims to boost efforts to identify practical integrated control options for farmers in different circumstances. The objective aims to complement and build on existing efforts in this area and where possible measurably advance the development of practical control options. It is acknowledged that developing control options can take a long time period, beyond the timeframe of this R&D plan, and therefore the approach for contributing to the development of these needs to be targeted and enable further future effort.

Adoption of effective weed management approaches varies significantly across the agricultural sector and by other land managers. A greater understanding of land managers' behaviour in relation to weed detection, management and control would be of value in enabling the development of practical and accessible information and resources that can support decision making at the local and regional scales. Policy and institutional arrangements also have an impact on how weeds are managed at the local level by farmers and other land managers, these arrangements need to send appropriate signals to different land managers that ultimately reduce the risks weeds pose for the land uses and ecosystems services that are valued.

In relation to natural systems, lessons from previous research initiatives identified the need for greater emphasis on whole systems management approaches to weeds by better understanding the drivers of weed invasion and control options in natural systems and at the landscape scale. This research objective also aims to improve awareness and

understanding of the interactions between invasive plants and the natural and managed systems within which they occur. With this knowledge, landholders and managers will be better equipped to design management strategies that result in healthy production and ecosystems.

The influences of water quality and flows, native vegetation health, biodiversity and soil condition are important considerations in planning more effective weed management. However, weed management has traditionally been researched largely in isolation from these elements of the landscape.

Weeds also have negative impacts on plant and animal communities, on food webs, and on ecosystem processes such as fire and flooding regimes, nutrient cycling and hydrology.

As initial studies have shown, removal of a highly invasive weed will not necessarily bring about recovery of an invaded system.

Strategies

Advance foundational knowledge

- Undertake research into the ecology of weed species that are having or are likely to have a significant impact on productive systems where gaps in our knowledge exist in this area.
- Scope future risks for the productivity sector related to Australia's food markets increasingly demanding food produced with little to no chemical use or residues on farm as part of food production system. This may be a longer term risk for trade of food but it is also a risk for Australian landscapes as there are implications for weeds and their impacts if weed management and control approaches are not available.
- Develop understanding of how weed species could take over in natural environments. Initially targeting key priority weed species and/or focusing on high value environmental ecosystems/landscapes.
- Improve understanding of seed bank ecology in natural systems.
- Fill gaps in understand the ecology of high impacting weed species in natural systems and landscapes.
- Improve understanding of 'transformer' and 'conflict' species.
- Evaluate the effectiveness of weed management as it impacts on the recovery of natural systems after initial control has occurred.
- Improve understanding of the effect of weeds on water quality and systems.
- Improve spatial distribution information through finer-scale mapping and modelling for all key weeds (including but extending beyond the WoNS).

Develop tools, methods and systems

- Develop new, highly effective techniques and systems for controlling nationally serious weeds.
- Develop integrated weed management systems that maintain diverse options for effective management in cropping systems.
- Enhance biological control R&D in strategic areas[2].
- Undertake complementary R&D which supports existing efforts in relation to herbicide resistance.
- Identify new methods which reduce reliance on herbicides and promote integrated approaches which also help to reduce energy and chemical inputs in agriculture.
- Develop improved integrated control options incorporating, where appropriate, biological and landscape control as part of the integrated solution.
- Undertake research that complements research being undertaken for agricultural systems on herbicides resistance on public lands.
- Develop effective management options to restore landscape and its biodiversity after weed control has occurred.
- Identify options to address minor use chemical issues for environmental weed management.

Evaluate current social, economic and institutional influences

- Profile various land managers, including farmers from different sectors, behaviour and practices in relation to weed management. Identify opportunities to enhance uptake of improved weed management by different land managers and the sort of tools and information required to support this increased uptake.
- Identify practical options to address minor use chemical issues for emerging industries.
- Develop mechanisms for valuing the impact of weeds outside of agriculture systems.
- Improve understanding of the connections and the relationship between natural landscapes and human interactions in relation to weed risks and management.
- Prepare case studies of different community-led weed approaches and draw out the lessons from these approaches and any implications for policy/institutional arrangements. Create options to incorporate community delivery of weed management at the landscape level.

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2 The Defeating Weed Menace Program – two projects will provide information to help guide investment in biological control – Auld B, Commentary on Funded Biological Control Projects (2009) and by Paynter Q et al Improving targeting of weed biological control projects in Australia (2009)

Test and translate existing resources and make them more accessible

- Undertake a stock take of existing knowledge and resources for different sectors within the agricultural sector. Where possible trial this knowledge and resources with different users and identify ways to enhance its use. Develop practical revisions and formatting of existing knowledge and tools that will improve likelihood of information uptake.
- Enhance information for agricultural producers to understand conflict weeds and change the incentives to manage them.
- Develop a national resource centre (database/ toolbox/ data storer) of existing research information and decision support tools, systems and approaches.
- Develop a resource kit for extension officers, industry associations and other land managers who have a role in influencing others on how they detect, manage and control weeds. Initially this resource kit should draw on existing information but be set up so new information and resources can be added as it becomes available.
- Stocktake and trial existing knowledge and resources in relation to natural systems and environmental managers and communities.
- National database/toolbox of existing research and approaches.

Objective 3: Support improved adoption of weed management approaches.

The consultation and national workshop that occurred to develop this 5-year R&D plan provided a strong message that greater effort is needed to create information and resources that will improve the uptake of improved weed management. It was widely acknowledged that the adoption of weed management options in some areas is low and greater understanding is required to understand why and identify possible levers that could improve uptake. The CRCs and Defeating Weed Menace Program also identified the need to improve the uptake of research by better understanding the social and economic interactions with the weed knowledge and management options.

This research objective has two main priorities. The first is to consolidate existing information and resources and package it up in ways that it is more useful and accessible to key users. The other is about trying to better understand the social, economic and institutional drivers of different land managers in relation to weed management. This may result in developing information in a more useful way for particular target stakeholders but it also may result in a need to consider changing the policy drivers and incentives for improved weed management where there is a public benefit. The program can also play a role in providing information on the current effectiveness of existing policy signals in relation to weed management and enable lessons to be shared across jurisdictions and between different land users. However, to do this effectively a collaborative approach with state and territory governments and local governments would be important.

Strategies

Advance foundational knowledge

- Obtain additional baseline information on different stakeholder groups and their attitudes, aspirations and approaches in relation to weed management.

Develop tools, methods and systems

- Develop and facilitate integrative approaches to research project design, enabling participation of a diversity of end-users from project initiation through to post-project delivery of outcomes
- Develop new best practice extension materials and approaches for specific target audiences based on improved information on their preferences and needs
- Develop cost effective approaches for long term monitoring of restoration and weed management
- Develop improved policy options and codes of practice for different land managers in relation to weeds. Identify information that can be shared between jurisdictions and industries.

Evaluate current social, economic and institutional influences

- Profile various land managers' behaviour and practices in relation to weed management. Identify opportunities to increase uptake of improved weed management by different land managers and the sort of tools and information required to support this increased uptake
- Undertake a project that aims to improve our understanding of the social and economic dimensions of the weeds problem. Ensure the outputs can be used to inform the development of future tools, methods and information, the format of knowledge for different users and as an input to developing effective extension materials
- Understand evolution and lessons from community weed approaches
- Evaluate institutional and policy arrangements for weeds by drawing together information on what each state/territory's arrangements are and undertake some case study assessments on different approaches.

Test and translate existing resources and make them more accessible

- Develop a national resource centre (database/ toolbox/ data storer) of existing research information and decision support tools, systems and approaches
- Develop improved strategies for adoption of weed management options. Drawing on R&D that has tested control options and information on social and economic drivers and motivators for adoption
- Translate research information and tools into formats appropriate for adoption by different end-users.

Performance Indicators

Performance Indicators have been developed for the National Weeds and Productivity Research Program (Table 2). These are based on priorities identified during the National Workshop held 3-4 August 2010 and areas identified by people consulted as part of the development of this plan where tangible outputs can be achieved within 2 to 5 years.

Table 2 - Performance Indicators for Research Themes

Objectives 1-3	Performance Indicators
Improve knowledge for effective risk management of weeds.	• Within 18 months a full stock take of existing risk management knowledge and resources is completed. The stocktake should analyse information and resources to identify any gaps and where possible prepare the information in a format to allow it to be better utilised by land managers. • Decision support information be compiled on where and when to act in relation to - eradication, control and management of the asset cycle. The project/s should draw on existing information and resources. Any gaps in knowledge in relation to these management pathways should be identified. It should ensure that it is in a format for use by key land managers. • A practical project on the potential risks posed by climate change for identified weed species and on productive and environmental systems is completed within two years. The project/s should target key land managers particularly at national, state and regional scales and be utilised as an input for future investment considerations and institutional arrangements. • Within 2 years, complete a stocktake and host a forum of key researchers that draws on existing knowledge and information from the scientific community that identifies possible future national high risk weed species and their characteristics and how the risks from these species could be minimised. This information provides the opportunity for the research community to inform on the possible future risks that need consideration by all levels of government and by industry. • Improved detection and surveillance technologies are developed and where possible tested. This new technology is drawn on in future detection and surveillance approaches employed by governments and other land managers within 5 years.

Reduce current and future impacts of weeds on Australia's productive systems and environments.	• A national resource centre (database/ toolbox/ data storer) of existing research information and decision support tools, systems and approaches is developed and made publicly available within 18 months. • Measurable advances are made in developing integrated management options for the control of weeds in agricultural systems. • Investment supports enhancing biological control R&D in strategic areas. Advances in this area are built on in future R&D or strategies adopted by industries within 5 years. • Alliances are developed in relation to herbicide resistance within 6-8 months. The purpose of the alliances is to ensure that the investments from this program are integrated and aligned with other activities within this area. • A scoping study occurs in relation to identifying practical options to address minor use chemical issues for emerging industries. Collaborations with emerging industries and sectors requiring minor used chemical issues to be addressed are involved in the scoping exercise. • Improve understanding of how weed species could take over in natural environments. Initially targeting key priority weed species and/or focusing on high value environmental ecosystems/landscapes. • Develop improved integrated control options incorporating, where appropriate, biological and landscape control as part of the integrated solution. Projects in this area should build on existing work in this area and fill gaps. It is anticipated that within 4 years integrated management control options be communicated to key stakeholders. • Undertake research that complements other research being undertaken for agricultural systems on herbicides resistance on public lands. Scope opportunities in this area involving key land managers such as local governments, natural resource management bodies, and community based groups. • A national resource centre (database/ toolbox/ data storer) of existing research information and decision support tools, systems and approaches is developed and made publicly available within 18 months.

Support improved adoption of weed management approaches.	• Complete a project that examines social and economic dimensions of the weeds problem in Australia ensuring a range of land managers are included in the study. It should profile various land managers' behaviour and practices in relation to weed management within 8-12months. Identify opportunities to increase uptake of improved weed management by different land managers and the sort of tools and information required to support this increased uptake. Identify any land managers that pose a high risk in relation to weed impacts. • Complete a stock take of existing knowledge and resources for different sectors within the agricultural sector. Where possible the knowledge and resources should be trialled in case study areas by different users and the outcomes of these trials should inform improving the resources and how future resources could be created. • A national resource centre (database/ toolbox/ data storer) of existing research information and decision support tools, systems and approaches is developed and made publicly available within 18 months.

9. Program delivery

The RIRDC has extensive experience delivering R&D initiatives that are multi-sectoral and require a national coordinated response. The challenges associated with weeds in Australia are multi-sectoral and involve a large number of different land managers. RIRDC are well placed to administer the National Weeds and Productivity Research Program and will draw on its well tested investment approaches which include:

- identifying priority research and development through the development of a 5-year R&D plan (this document)
- drawing on expertise and insights from an Advisory Panel set up specifically for the National Weeds and Productivity Research Program
- facilitating collaboration between researchers
- encouraging and facilitating adoption of research outcomes by rural industries and stakeholders
- monitoring the impact of the R&D through regular evaluations of research.

In addition to RIRDC's well tested approach to delivering R&D programs, some further actions are identified to ensure investment in the National Weeds and Productivity Research Program is optimised for long-term benefits. The consultation and national workshop that occurred as part of the development of this 5-year R&D plan identified a strong interest from all stakeholders in:

- developing a weeds-related R&D approach that will enable long-term R&D investment and activities to occur
- building the long term capacity of the weeds research community
- for research to occur in a collaborative fashion (cross institutional and across jurisdictions)
- enabling multi-disciplinary research to occur in key areas (particularly traditional ecological based sciences with social, economic and institutional research areas)
- improving the adoption of R&D knowledge and tools
- involving target users of the research in shaping projects and providing regular feedback.

Long-term weeds related R&D (Objective 4)

In delivering this Program, RIRDC will endeavour to undertake actions that will better position researchers and target users of weeds related R&D for improved approaches. This could consider identifying appropriate mechanisms and models that weeds R&D could be completed. The emphasis of considering these mechanisms and models will be that options are developed that will improve the long-term nature of weeds R&D activities for the benefit of productive land managers and the environment. Areas that will be considered in developing models for long-term R&D in this area would include:

- examining overseas approaches to weed R&D
- identifying lessons from other public good environmental research areas and how they have set up longer term R&D arrangements
- the needs of potential investors in weeds knowledge development
- opportunities that may exist by partnering and integrating with other issues (e.g. natural resource, food security, biosecurity) that may better position weeds-related R&D.

Building research capacity

To improve research capacity requires a range of strategies that aim to improve individual researchers' skills and abilities, attract good people to the research area and provide career paths and opportunities for researchers. No one strategy will achieve these things. RIRDC will consider incorporating the following strategies to build R&D capacity as part of the National Weeds and Productivity Research Program:

- support for student academic fellowships
- attract international high calibre experts to Australia to work with Australian researchers for 12 month periods
- providing opportunities for researchers with differing levels of experience and backgrounds to work together on key priority weed challenges (this could be through forums, advisory groups or networks developed for specific projects)
- facilitating researchers and potential users of the research to work together on aspects of projects (this could include testing of different methods, developing improved understanding of the needs and possible ways research could address these needs).

The short timeframe for funding available under the program does create limitations for the types of research capacity development opportunities that can be undertaken successfully. This will be considered in identifying opportunities to improve research capacity.

Collaboration and multi-disciplinary research

For collaboration and multi-disciplinary research to work effectively there needs to be an identified goal and rationale for why the approach would be of value and what different parties would bring to the approach. RIRDC is interested in establishing effective collaborations between institutions and between researchers based in different jurisdictions as well as creating opportunities for useful multi-disciplinary research to occur where the research area would obtain value.

Not all projects will require this sort of approach but where the research community, key target users and/or RIRDC identify there could be value in establishing improved collaboration and multi-disciplinary responses to key research questions these will be favourably supported.

It is recognised for effective collaborations and multi-disciplinary research to occur requires commitment from all parties concerned, this commitment needs to be documented in institutional and governance arrangements that will enable and facilitate

collaborative and applied research. Some of these institutional and governance arrangements will need to occur between research organisations and/or different user groups. RIRDC could play a facilitative role in helping to enable these institutional and governance arrangements to be set up in an efficient manner.

It also needs to be recognised that resources are required to enable the collaboration and multi-disciplinary discussions to occur. The intention is not to have projects running in parallel and occasional meetings, rather where this approach is deemed to be of value active participation in key stages of the project needs to occur and be resourced to occur. This active participation will, in part, require discussions about methodologies, terminology and language and ways to interpret findings utilising different research perspectives.

Where projects of this type are supported by the National Weeds and Productivity Research Program there would be value in ensuring that information is collected about the value of these approaches and lessons for the future. It would be useful in considering longer term research requirements for any capacity development that has resulted from collaborative and multi-disciplinary research be captured to demonstrate its value to future investors.

It is important to note that all research will not be collaborative and multi-disciplinary. The needs for this sort of approach are case by case. RIRDC will identify areas where they are particularly interested in collaborations and multi-disciplinary research as part of its research call.

Improving coordination and information exchange between researchers and target stakeholders

The National Weeds and Productivity Research Program aims to be applied. Thus, the research should meet a particular need of its target stakeholders. Where there is opportunity to involve target stakeholders in the design, testing or communication of R&D projects this would be of value. Not all projects will require end user involvement but many identified in the priority Research Themes would obtain significant value from having different people involved in guiding the project and providing feedback to the research team.

There are a variety of ways that RIRDC would be interested in working with end users, for example:

- playing a legitimate and valued governance role for specific projects where there would be value
- by hosting forums or demonstration events specifically for end users to communicate achievements of the program and obtain their feedback and perspectives in relation to what has been achieved and what their future requirements are
- facilitating opportunities for end users to communicate and provide feedback with researchers in particular areas.

10. Communication Plan

The aim of the National Weeds and Productivity Research Program Communication Plan, consistent with the RIRDC's corporate mission, is to maximise knowledge outcomes from its R&D investments. A separate communications plan will be developed at the commencement of the Program.

As noted previously in this Plan, the nature of the impacts of weeds on both Australian agricultural and forestry production and landscapes, all Australians are affected, either directly or indirectly by invasive plant species. There are a significant number of stakeholders involved in weeds and the challenges they can cause in Australia.

Feedback received during the development of this plan stressed the importance of ensuring that the valuable knowledge and resources created by weeds-related R&D initiatives is in a practical format for use by different stakeholders. It was identified that there was a wealth of information and resources created from previous initiatives that was not being used by stakeholders for a variety of reasons, some reasons unknown and are the intended purpose of a priority research project in this plan.

The project aims to play a role in coordinating communication of existing and new research in relation to weeds for the benefit of Australia. The approach developed needs to consider long-term communication requirements of the target stakeholders and ensure that the program develops an approach that can exist beyond the life of this program.

Emphasis in the delivery of the National Weeds and Productivity Research Program is:

To ensure every project identifies target users at the outset of the project and how they envisage the outputs to be used

To actively involve weed stakeholders in R&D activities where they are the likely target for using the R&D outputs

To translate existing information and resources and increase its accessibility for key weed stakeholders

To assist researchers to develop R&D outputs specific to key target weed stakeholders.

Target Audience

There are a significant number of weed related stakeholders including (but not limited to):

- Federal, State and Territory and Local governments
- primary industry associations and advisors
- forestry industry and businesses

- farmers and other land managers
- Regional NRM Bodies
- nursery and garden industry
- National and State forests managers
- managers of public lands (including roadside-corridors)
- Indigenous people
- researchers
- community groups such as Bushcare and Landcare groups
- managers of national environmental assets
- natural resource facilitators and coordinators
- peri-urban land managers.

The great diversity of knowledge and ability of these stakeholders in relation to weed management and control is high and as a result targeting them requires information on their current approach and goals in relation to weed mitigation.

Communication Tools

The National Weeds and Productivity Research Program includes four primary communication approaches:

- Incorporating learning from social and economic profiles of weed stakeholders into future communication and adoption strategies
- Involving users in the research themes and program
- Program knowledge adoption advisor
- National resource centre.

It is envisaged that throughout the program to complement the above communication approaches there will be value in hosting events and forums that provide updates from the research to key user groups and to different regions and communities. There would also be value in preparing a short research update that could be directly sent to key stakeholders via email or hard copy.

Incorporating learning from social and economic profiles of weed stakeholders into adoption strategies

A priority research project recommended as part of this R&D plan is to undertake social and economic profiling of the weed stakeholders to better understand their role, motivations, barriers and intentions in relation to weed risk management and control. It is anticipated that the information generated from this strategic project will be used by

other projects to help identify the most appropriate communication methods and adoption pathways for the different stakeholders.

It is recommended that the above noted strategic project be used to guide communication goals and adoption approaches for all other projects supported by this program.

To do this, it is recommended that a national workshop be held (approximately 12-14 months after research has been initiated) when results of the social and economic profiling of different stakeholders in relation to weeds has been completed. The focus of the workshop should be on informing researchers active in the program on the findings and develop approaches for communicating outputs from each Research Theme. Coordinated adoption strategies should be an output from this event.

Involving Users in the Research Themes and Program

The National Weeds and Productivity Research Program will be guided by an Advisory Group who it is envisaged will be made up of a cross section of weed stakeholders particularly target users of research products such as agricultural sector and environmental managers.

The program Advisory Group should be supported in the first two years by focus groups or sub-advisory groups set up specific to each of the four Research Themes. The role of these groups is to provide practical information to the researchers undertaking projects within the theme and where required help to test or ground truth aspects of the research. These groups should be set up following selection of the research projects and the detailed advisory needs are established for each of the Research Themes. Formal and informal approaches can be used for these groups.

It is thought that this approach would be a more efficient way of seeking user involvement rather than requiring every project to set up their own steering committee. It is expected that some projects and researchers would value their own advisory group/steering committee in addition to the above but this can be determined on a case by case basis.

Table 3 identifies a starting point on who should be targeted in guiding the Research Themes.

Table 3 - User Involvement in Research Objective

Research Objectives 1-3	Priority Target for involving and shaping the R&D projects
Improve knowledge for effective risk management of weeds.	• Local Government • agricultural industry representatives to provide insight into the practical nature of risk management approaches • Regional NRM Bodies or extension support areas related to natural environments • Nursery and garden industry due to the potential risks that this sector can pose to the introduction of weeds and to approaches for managing weeds. • Researchers from different disciplines
Reduce current and future impacts of weeds on Australia's productive systems and environments.	• Primary industry associations and advisors • Farmers and other land managers • Regional NRM Bodies • Australian Government representatives from a farming systems and natural resource perspective • State and Territory Government representatives from a farming systems and natural resource perspective • Extension officers and facilitators • Researchers from different disciplines • Regional NRM Bodies • Community groups such as Bushcare and Landcare Groups • Managers of public lands (including roadside-corridors) • Indigenous people • Researchers from different disciplines • Primary industry associations and advisors • Managers of national environmental assets
Support improved adoption of weed management approaches.	• All stakeholders are relevant here. Information needs to be developed for specific target audiences rather than a one-size-fits-all approach.

•

Program Knowledge Advisor

It is recognised that bringing in specific assistance to support researchers in communicating and translating R&D outputs to key target audiences would be of value. Researchers have a big role to play in developing their project approaches, analysis and reporting in relation to specific needs and possible end-user requirements. Their focus should be on completing cutting edge R&D. It is acknowledged that researchers are not necessarily skilled at presenting research findings in the most appropriate format to its uptake and use.

It is recommended that the National Weeds and Productivity Research Program engage a person who will play a role in supporting all researchers in considering their communication requirements and where possible playing a role and bringing complementary research together to allow it to be communicated as a package.

This person should be engaged in advance of project selection and should work with researchers early in projects to consider how the research they are undertaking could be targeted to meet different needs. They should also play a role in steering the social and economic profiling work to ensure that the outputs from this work are practical and play a legitimate role in informing how to increase adoption of weed management.

National Weeds Resource Portal

Another of the strategic projects identified for the National Weeds and Productivity Research Program is the need to develop a national weeds resource portal (database/ toolbox/ data storer) which makes existing research information and decision support tools, systems and approaches more publicly available. This National Weeds Resource Portal could play a valuable role in communicating outputs from the National Weeds and Productivity Research Program and therefore needs to be considered as both a research project and a part of the program's communication approach.

The development of such a resource should draw on the scoping work completed in the Defeating Weed Menace R&D program by Auricht and Yapp (2009) in "End-user needs for developing a national information system for weeds" and the work completed by the National Land and Water Resources Audit (2008) in relation to "The distribution of some significant invasive plants in Australia 2007."

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Appendix 2: List of people consulted as part of R&D Plan development

Jenny Connolly	ACT Government
Colin Peace	Australian Fodder Industry Association
Stephen Powles	Australian Herbicide Resistance Initiative (AHRI) and University of Western Australia
John Thorpe	National Weeds Facilitator
Brenda McGahan	Australian Wool Innovation
Jane Prider	Biosecurity SA
Alex Gartmann	Birchip Cropping Group
John Rolfe	Central Queensland University
Jodie Dean	Central West Farming Systems
Sally Troy	Australian Government Department of Agriculture, Fisheries and Forestry
John McKillop	Corporate Agricultural Group
Tracey Levin	Cotton Research and Development Corporation
Dr Andy Sheppard	CSIRO Entomology
Dr Rieks van Klinken	CSIRO Entomology
Jeanine Baker	Australian Government Department of Agriculture, Fisheries and Forestry
Keith Ferdinands	Northern Territory Department of Natural Resources, Environment, the Arts and Sport
Chris Love	Dow AgriScience
Chris Lafferty	Forest and Wood Products Australia
Ian Wilton	Grain Corp
Rohan Rainbow	Grains Research and Development Corporation
Troy Fisher	Grape and Wine Research and Development Corporation
Brad Wells	Horticulture Australia Limited
Shirley McPherson	Indigenous Land Corporation
David Galvin	Indigenous Land Corporation
Chris Auricht	Land Systems
Brian Furze	LaTrobe University
Geoff Hudson	Local Government Associations
Charlie Crozier	Lucerne Australia
Cameron Allan	Meat and Livestock Australia
Darro Stinton	New Rural Industries Australia
Debb Kerr	National Farmers Federation
Hillary Cherry	New South Wales Department of Environment, Climate Change and Water
Pete Turner	New South Wales Department of Environment, Climate Change and Water
Robert Prince	Nursery & Garden Industry Australia

Bruce Wilson	Biosecurity Queensland
Gabrielle Viviansmith	Queensland Department of Employment, Economic Development and Innovation
Frank Keenan	Queensland Department of Primary Industries
Ian Mason	Ricegrowers' Association
Rob Edkins	South Coast NRM
John McDougall	Southern Farming Systems
Robert Troedson	Sugar Research and Development Corporation
John Carse	Sydney Metropolitan Catchment Management Authority
Kris French	University of Wollongong
Yvonne Buckley	University of Queensland
Brian Sindel	University New England
Nigel Ainsworth	Victorian Department of Primary Industry
Dr Fiona Ede	Victorian Department of Primary Industry
Jon Dodd	Western Australian Department of Agriculture and Food
Dr David Minkey	Western Australian No-Tillage Farmers Association
Daniel Ferguson	Wheatbelt NRM Incorporated
Averil Bones	World Wide Fund for Nature

Appendix 3: List of attendees at National Workshop 3-4 August 2010

Name	Position	Organisation
Adrian Harris	Project Manager	Rural Industries Research
Alan McGufficke	Program Manager - Advisory and Ecosystems	Lachlan Catchment Management Authority
Alex Arbuthnot	Policy Advisor- Land Management	Victorian Farmers Federation
Alison Dugand	Biodiversity Co-ordinator	Cradle Coast Natural Resource Management
Andy Sheppard	Leader, Invasive Species & Plant Biosecurity Theme	CSIRO Entomology
Anna Carr	Landscape Social Science	Australian Bureau of Agricultural and Resource Economics
Anthony Kachenko	Environmental and Technical Policy Manager	Nursery & Garden Industry Australia
Belinda Mitterdorfer	Plant Biosecurity (Grains & Forestry) – Plant Division	Australian Government Department of Agriculture, Fisheries and Forestry
Ben Callaghan	Portfolio Manager	Horticulture Australia Limited
Bob Granger	Associate	Garland Outcomes Pty Ltd
Brian Sindel	Agronomy and Soil Science	University of New England
Bruce Auld	Adjunct Professor	Charles Sturt University
Bruce Wilson	General Manager	Queensland Department of Employment, Economic Development and Innovation
Cameron Allan	Project Manager, Pastures & Resource Management	Meat & Livestock Australia
Charlie Crozier	Executive Officer	Lucerne Australia
Christian Wythes	Advisory and Ecosystems	Lachlan Catchment Management Authority
Christine Munday	Research Scientist - Weed Risk	Future Farm Industries CRC
Christopher Preston	Associate Professor, Weed Management	The University of Adelaide
Craig Burns	Managing Director	Rural Industries Research and Development Corporation

Darro Stinson	Manager	New Rural Industries Australia
David McLaren	Principal Research Scientist - Weeds	Victoria Department of Primary Industries
David Minkey	Executive Director No-Till Farming Association	University Western Australia
Drew English	Regional Manager	Conservation Volunteers Australia ACT/S NSW region
Gabrielle Vivian-Smith	Invasive Pest and Plant Biosecurity Science	Queensland Department of Employment, Economic Development and Innovation
Geoff Hudson	Senior Policy Officer - Natural Resource Management	Local Government and Shires Associations of NSW
Hillary Cherry	Weeds of National Significants co-ordinator	New South Wales Department of Natural Resources, Environment, the Arts
Jeanine Baker	Weeds and Pest Animals Section	Australian Government Department of Agriculture, Fisheries and Forestry
Jim Cullen	Board Member	
Jo Slattery		CRC for National Plant Biosecurity Plant Health Australia
John Balfour	Invasive Plants and Animals Operations Branch	Victoria Department of Primary Industries, Biosecurity
John de Majnik	A/General Manager	Rural Industries Research and Development Corporation
John G Virtue	Manager - NRM Biosecurity Unit	Biosecurity SA
John Kerin	Chair of National Weeds and Productivity Research Program	Participated on behalf of the Rural Industries Research and Development Coproration
John Powell	Principal	Optimal ICM
John Thorp	National Weeds Facilitator	
Judy Lambert	Director	Community Solutions
Keith Ferdinands	Weed Risk Manager	Northern Territory Department of Natural Resources, Environment, Arts & Sport
Ken Moore	Acting General Manager	Rural Industries Research and Development Corporation
Kris French	Conservation Biology and Environmental Management	University of Wollongong
Leslie Weston	Plant Biology	Charles Sturt University
Malcolm Taylor	Farmer	Rice Growers Association
Matthew Kennewell	Invasive Species Coordinator	South Coast Natural Resource Management Inc
Michael Clarke	Director	AgEconPlus

Michael Williams	Facilitator	Michael Williams & Associates
Mike Cole	Office of the Chief Plant Protection Area	Australian Government Department of Agriculture, Fisheries and Forestry
Nigel Ainsworth	Principal Policy Officer Invasive Plants	Victoria Department of Primary Industries
Owen Graham	A/General Manager	Sydney Metropolitan Catchment Management Authority
Paul Downey	Plant Ecology –Plant Invasions	University of Canberra
Richard J Carter	Manager Invasive Species Strategy & Planning	Industry & Investment NSW
Richard Stafford-Bell	Policy Officer - Invasive Plants	Victoria Department of Primary Industries
Rieks van Klinken	Tropical Invasive Plants (leader)	CSIRO Entomology
Roger Cousens	Professor, Resource Management & Geography	School of Land and Environment, The University of Melbourne
Rohan Rainbow	Manager, Crop Protection	Grains Research and Development Corporation
Roslyn Prinsley	General Manager	Rural Industries Research and Development Corporation
Russell Ford		Rice Growers Association
Samantha Setterfield	Associate Professor	Charles Darwin University
Stephen Powles	Australian Herbicide Resistance Initiative	University Western Australia
Steve Taylor	Ranger-in-charge - Environmental Weeds	National Parks, Reserves & Rural Land
Steve Walker	Weed Sciences Team Leader	Queensland Department of Employment, Economic Development and Innovation
Tracey Levin	Manager Farming Systems Investment	Cotton Research and Development Corporation
Vicki Woodburn	Director	Garland Outcomes Pty Ltd

National Weeds and Productivity Research Program R&D Plan 2010 to 2015

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Weeds create many costly challenges for the Australian primary production sector and to our natural environment. These challenges require Australia to continually improve knowledge of weeds and to adopt practices that lead to the prevention, mitigation or adaptation to invasive weeds.

Research plays a valuable role in increasing knowledge and developing the information, tools, management options and resources that will enable Australia to better manage the weed challenge.

The Rural Industries Research and Development Corporation (RIRDC) has been appointed as the manager of the National Weeds and Productivity Research Program by the Minister for Agriculture, Fisheries and Forestry.

The Australian Government has provided up to $12.4 million (inclusive of GST) for the first two years of the Program with the goal of reducing the impact of invasive weeds on farm and forestry productivity as well as on biodiversity. A significant challenge for RIRDC will be to build partnerships between industry and government for extending the funding and institutional arrangements for investment in weeds R&D over the longer term.

This five-year R&D Plan has been developed through extensive consultation and a national workshop. It aims to build on previous R&D achievements and focus its effort on common national needs that will position Australia well in responding to weed challenges in the short and long-term.

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