

final report

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Situational Analysis and Options Paper for RMCiC

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Summary

Professor Weston was commissioned by Meat and Livestock Australia in the autumn of 2011 to develop a situational analysis and options paper. Specifically the paper summarizes the recent history in weed research and extension in Australia and reports on the status of initiatives of specific national funding programs supporting weed research in Australia. In addition, the report describes current or planned initiatives for weeds research and extension, the status of current research efforts including the active organizations, researchers and their general focus as this work relates to the needs of livestock producers. It also suggests potential areas for future research investment that will prove critical to successful IWM initiatives in pastures and rangelands. In recent years, the number of weed scientists performing weed management research related to the Australian meat and livestock industry has significantly declined, and capacity to perform related research may be limited in the future by lack of weed science expertise. Gaps have been identified in recent strategic and applied research efforts and delivery of research findings. Currently, research projects involving weeds of pastures and rangelands are performed independently and research efforts are not generally coordinated nationally or regionally. Although significant federal funding was provided for the 2010-2012 RIRIDC National Weeds Program initiative, a limited number of projects address research of relevance to the Australian meat and livestock industry, and project funding will lapse in 2012.

Three recommendations are made for MLA and PISC agency partners: 1) that MLA and associated RDCs address the lack of national funding directed towards IWM programs in pasture and rangeland by developing a focused strategic planning process to initiate research in designated priority areas 2) that new research initiatives be thoughtfully coordinated with pre-existing research programs to address both national and regional needs of the meat and livestock industry 3) that new research initiatives focus on several priority areas which include:

- better methods for surveillance and monitoring of weeds in pastures and rangelands,
- application of novel biocontrol measures in concert with IWM strategies for enhanced weed management
- establishment of competitive and resilient pasture crops and mixtures for each region resulting in long term reductions in weed infestation
- generation of critical information on the biology, spread and containment of recent weed incursions

Introduction

In seeking to understand the targeted space for MLA investments, the MLA board has determined that an immediate need is to develop an understanding of the “weeds organizational landscape”. This specifically refers to ‘who is doing what’ in terms of weeds research, both applied and strategic research efforts, as well as extension outreach in Australia. This information is to be utilized by MLA and its Board along with its partners in research, including state DPI organizations, CSIRO and academics, to develop a potential weed investment program to lead RD &E investment by MLA over the next 20 years. Specifically, following economic evaluation, weeds RD&E has been recently identified as a priority area in the national beef and sheep meat RD&E strategies.

National Weeds Strategies

Two national weeds strategies currently exist that influence investment in Australia by federal and State jurisdictions.

1.1 Australian Weeds Strategy – A national strategy for weed management in Australia (2007)

This strategy has 3 primary goals:

Goal 1: Prevent new weed problems via actions around introduction, early detection and rapid action to reduce spread of weeds and respond to climate change.

Goal 2: Reduce the impact of existing priority weed problems via a priority process on the management issues and determine their causes; Implement coordinated and cost-effective solutions for priority weeds and develop approaches to managing weeds based on the protection of values and assets.

Goal 3: Enhance Australia's capacity and commitment to solve weed problems by raising awareness and motivation; build capacity to address weed problems and improve weed management; manage weeds within consistent policy and monitor and evaluate the progress of Australia's weed management effort.

For each goal and its component program areas, objectives and outcomes have been defined.

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

In the second stage of the second stage of DAFF's National Weeds and Productivity Research Program, RIRDC has been appointed to oversee implementation in 2010. DAFF has provided up to \$12.4 million (inclusive of GST) for the first two years (2010-11 and 2011-12).

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

With a supporting mission focus 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".

Four objectives are being pursued:

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.

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.

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.

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.

The national weeds research plan describes the following research strategies:

- 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;
- 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.

Based on these national strategies, weeds research in Australia has attracted significant funding from the Federal Government for weeds of national significance (WoNS) which is overseen by the Australian Weeds Committee (AWC). The national strategies were developed to support weed research in the past 20 years in Australia; (<http://www.weeds.org.au/aws.htm>), and new strategies (http://www.daff.gov.au/natural-resources/invasive/national_weeds_productivity_research_program) have recently been developed to support research on a national level.

The longer term funding of the Australian National Weeds Program is uncertain. The AWC contract funding has exhausted funds, while the RIRDC strategy is largely a competitive process and the WONS programs under the AWC are not preferentially funded. The AWC has maintained support for national coordination, but no operating funds are available for new research initiatives.

As there may be significant changes in research support to the WONS programs in the future, coupled with reductions in federal funding initiatives, there exists a significant need for support

from other agencies/organizations for nationally directed weed research and extension programs. The NWPRP funding for weeds via RIRDC impacts on the subsequent funding for WoNS, in that the R&D components identified (in WoNS program reviews (2009)) have been considered with other priorities in the NWPRP current round. This has influenced the allocation of funding to WoNS species in order to target priority areas.

In addition, regional investments in weed research are supported by other agencies as well as Research and Development Corporations in projects that address specific industry outcomes. This work covers the breadth of strategic science (eg molecular differentiation of lippia), through to delivery programs and information sheets.

A list of 30 funded projects can be found at http://www.rirdc.gov.au/programs/national-rural-issues/weeds/weeds---phase-2-research-projects/weeds---phase-2-research-projects_home.cfm

1.3 Implications for consideration:

- *Funding for WoNS is being redirected to related priorities*
- *“Delivery” of previous research outputs is very uncertain*
- *Federal funds are aligned to projects addressing priority strategies. Correlation with industry priorities requires assessment*
- *The NWPRP does not have quantified outcomes*

Recent history in Weed RD&E in Australia

In reviewing the recent organizational structure related to weeds research across Australia, one is impressed with the breadth of research which is undertaken by a large country with a relatively small human population, and a large investment in grazing livestock. There are many agencies/organisations which fund agricultural and weeds research in Australia.

The organisational structure for weeds research in Australia is not simple by any means; rather, it is complex and spread across many organisations and divisions which are funded by regional, state and federal agencies.

2.1 Organisations in weed research

It is readily apparent that the number of university academics and agency inputs who are focused on more basic and applied weed science research in Australia has decreased markedly in recent years. This suggests that considerable research, which was once conducted by a larger body of academic researchers and their post graduate students and post doctoral scholars, is now either conducted by state or federal agencies or is not being conducted at all. At the same time, the number of weed scientists conducting research in state DPI agencies and CSIRO has also declined considerably. This has been both a result of changing research priorities as well as declining budgets for basic and strategic research in weed science in Australia. As well the cost of each research project has increased considerably, and so fewer projects can be funded. Although no figures are available for comparative purposes, we estimate that there has been a 30 to 50% reduction in numbers of weed scientists across Australian states from the period of 1980 to 2010.

This trend is also seen in other advanced countries undertaking agricultural research, and in the agrichemical or private industry consultancies which once employed a large number of weed scientists. Unfortunately, agricultural research investment has dwindled, department size has been reduced and global agricultural chemical companies have merged over time, resulting in additional reductions in funding to weed science research initiatives.

A recent study published by PISC (2010) has evaluated the number of organizations with research expertise located across Australia performing research of importance to agriculture. Specifically, a

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large expertise in crop breeding is noted, as well as soils, plant pathology, pest management and weed management, along with farming systems expertise, including grazing systems. Weed science currently represents a significant area of investment, but if one compared investments today with investments in the 1960's-1970's, weed science research as a whole has received significantly reduced investment in recent years. In Australia and abroad, one cannot find weed science departments of research in either universities or federal agencies today; however, this was not the case in the recent past.

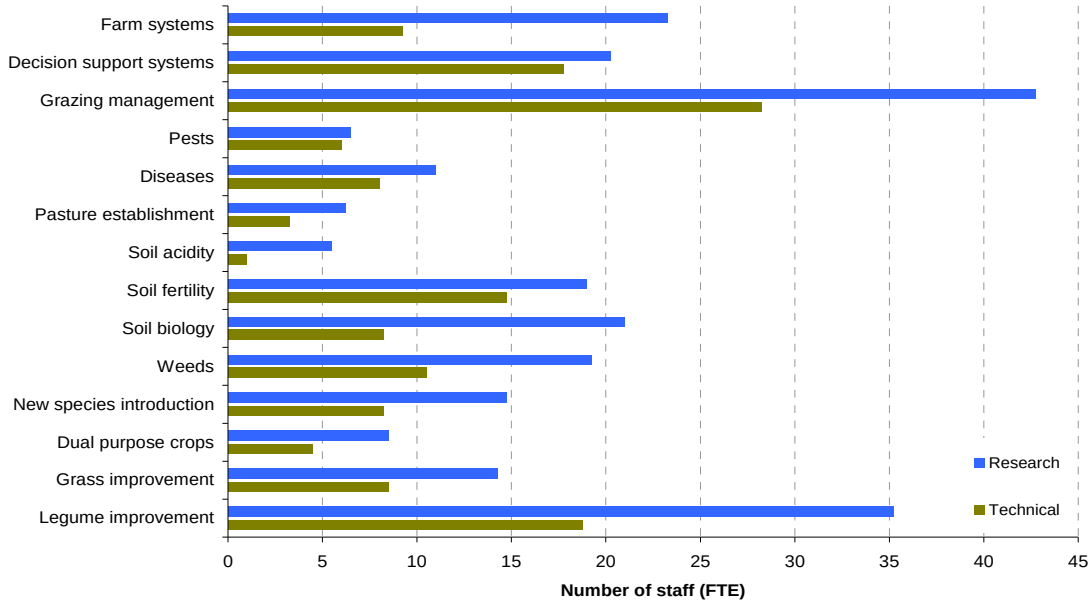


Fig1. Number (full time equivalent) of research and technical or support staff engaged in feedbase component research (Source MLA 2010 feedbase investment plan consultation)

Although total numbers of weed scientists have uniformly declined across Australia, current weed expertise across Australia by region is relatively consistent.

1. Arid interior – 5
2. Temperate planes and slopes – 10
3. Temperate highlands – 8
4. Wet temperate coast – 5
5. Subtropical slopes and plains – 5
6. Semi-arid tropical plains - 6

As with other discipline areas, capacity is a real issue that needs to be addressed in weed science research in Australia, and the relative decline in numbers might be greater than in other fields.

2.2 Academic institutions

There are 5 institutions performing research with one or more academics focused on weed management in agricultural settings (namely UQ, CSU, UNE, UA and WAU) with others (Murdoch, USydney, UTS, UNSW, UMelbourne, UCanberra, UWollongong, LaTrobe, CQU, James Cook U) having staff that conduct related, and often more basic rather than applied, research in weed biology. The largest collection of academic researchers focused on weed science in one place is likely found at CSU in the E.H. Graham Centre, or at U Queensland, but strong programs in terms of project number also exist in Adelaide and Western Australia. Both CSU and UQ have programs which have integrated staff from state DPI departments in recent years, and this has allowed for collaboration and even growth.

Specifically, pasture and rangeland research has not necessarily been a critical focus for research in these academic groups; however, it has been undertaken if reasonable funding sources were provided, with projects supported by MLA and other RDCs. Most reported weed research has tended to focus on broadacre cropping systems, weeds of national significance or environmental weeds of importance; basic research on herbicide resistance and management, biocontrol of weeds, alternative strategies for weed management, spatial analysis and detection of weeds on a landscape scale, weed genetics, weed phenology and management and grazing management strategies has been emphasized.

Fewer academic institutions now teach agriculture on any major scale so the emphasis on pasture and livestock management coursework and research has shifted in recent years to those universities maintaining a strong agricultural focus, and those institutions which maintain an animal science or veterinary science program as well or have links to state DPI departments. Current work in weeds research across universities is generally not well coordinated among universities or coordinated at all, unless a regional project has been undertaken (such as those supported by weed CRCs).

Weed researchers are currently fragmented and working generally in isolation. The former Weeds CRC provided the required coordination of research effort, but since completion of the last CRC this coordination has been lost. The RIRDC open call for research projects has potentially further fragmented research capacity and impaired investment efficiency. Investment efficiency could be achieved by better coordination of this fragmented capacity base

Generally weed research in academia is developed individually and remains regionally focused, or is of national or international interest in projects with a strong basic research emphasis where that researcher has been successful in attracting funding for a WoNS project.

Universities in Western Australia, Southern Australia, NSW and Queensland are now actively involved in MLA and GRDC research supported initiatives which address livestock production and or weed management in agricultural settings. However, there are not large numbers of any of these projects funded in each of these regions specifically focused on weed research (For example, 5-8 projects in WA, with 1-2 projects that would be relevant to pasture, rangeland or livestock management. Fewer projects are funded in other regions however). Work by the academic institutions may be rather basic and directed towards the molecular differentiation of weeds (eg lippia by UNE), bioactive compounds for weed control (CSU and silverleaf nightshade, prairie ground cherry) through to applied research including weed surveys and student project (including PhDs). Much of this work has been published in peer-reviewed journals and occasionally in fact sheets and extension bulletins. Recent examples developed for extension and stakeholder uptake would include work published on silverleaf nightshade, unpalatable grasses (including Parramatta grass, serrated tussock, African love grass, Chilean needle grass), Paterson's curse, thistles, and fireweed. These projects were supported by MLA with input by university academics, or in partnership with others.

2.3 CSIRO

CSIRO has long had an important research emphasis in weed management and specifically in:

- development of effective biocontrol programs for weed management
- modelling to determine impacts of climate change, and movement of weeds across boundaries
- weed biology and alternative management strategies
- key invasive weeds of environmental and aquatic areas
- weed taxonomy and genetics, including DNA sequence analysis for weed identification purposes

- landscape weed detection and population genetics or biology

A significant portion of the work that CSIRO has funded is involved with weeds of strategic importance and efforts on biocontrol and management have occurred with such pasture weeds as Paterson's curse, thistles, serrated tussock, and fireweed; woody plants in rangelands including prickly acacia and mesquite, rubber vine and those influencing livestock and water utilisation including lantana and willow. Much of this work has been published in book chapters, journal articles and also web bulletins and brochures.

Discussion with CSIRO administrators reveals that CSIRO budgets have received considerable cuts in recent years, leading to departmental consolidation and refocus in terms of research priorities and strategies and downsizing in the weed research area. CSIRO continues to maintain a strong focus on research in weeds of national significance related to biocontrol, invasion and spread and strategic management.

2.4 State organizations and agencies

State organizations and agencies including DPI and DAFWA departments with weed scientists and district agronomists, have played a very important role in working with weeds of importance to pasture and livestock management. Regional programs supported by CMAs, RDCs and others have funded work recently describing weed lifecycles, successful management strategies and rotational systems for eradication over time. Many of these projects are short-term and are taken on because of regional weed management issues and they address critical needs for regional weed management strategies. DPI and DAFWA fact sheets (Prime Facts), bulletins, and literature developed with farming systems groups are all generally accessible on the internet and in some cases as hard copies.

However, state organizations have also seen very significant cuts in numbers of researchers actively working on weed management, in both broadacre or pasture management areas. NSW, WA and QLD have active regional programs working directly with livestock producers to address regional weed management issues, but SA, QLD and WA do not have state supported district agronomists. Research performed by these individuals is generally funded by state and regional initiatives, RDCs and less often by larger grants from federally funded programs. Weed management and biocontrol work on weeds is also being supported as a key initiative by DPI Victoria and NSW DPI being focused on management at the state or regional level.

Future investment by DPIS, CSIRO and University sector in weed RD&E is variable across the country, and most agencies cannot predict where funding will head in the future with regards to weed science investment (Fig2).

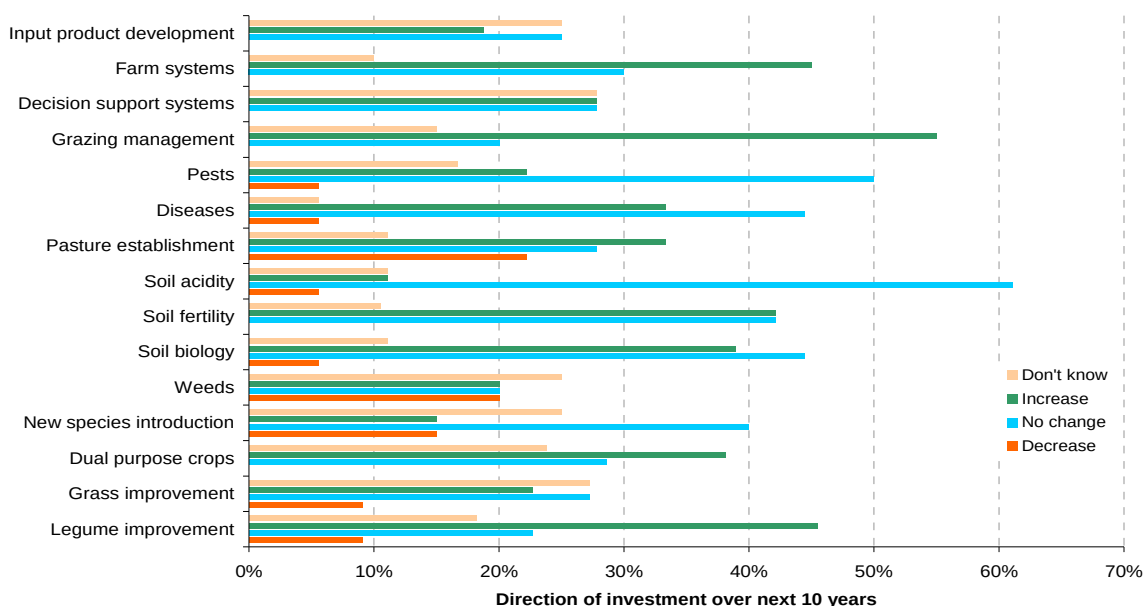


Fig 2 Direction of research investment over the next ten years (start year 2010) for various feedbase components (Source MLA 2010 feedbase investment plan consultation)

2.5 Outreach and Delivery

Extension effort by State agencies is in decline, with weeds being added to the function of the agronomy specialists. A regulatory role serviced by State DPI or associated departments exist, with management recommendations essentially being confined to spray recommendations which constrains effectiveness of longer term control or implementation of IWM strategies. Dedicated technical specialist positions in weeds only exist in NSW DPI.

Partnerships are being developed among interest groups (eg researchers, advisors, spray contractors, community groups and farming system groups) to address weed management.

2.6 Implications for consideration:

A focused national or regional effort on delivery of extension materials related to weed management in pastures or rangelands does not exist. The development of useful extension tools for delivery to larger regional stakeholder audiences could be of great importance in impacting adoption of effective weed management strategies, and MLA should consider a more coordinated approach in development and dissemination of these materials.

Federally Funded Research Programs Involving Weeds

3.1 Weeds of National Significance

From federal programs involving the former Land and Water Australia, DAFF, DEWHA and CSIRO, a much larger research investment has been made into studies detailing plant and animal biodiversity in the bush or in inland Australia. The focus has been on water utilization and water resources in Murray Darling and other river basins, and sustainable land management for the interior of Australia. This investment has been important in surveying and screening for biodiversity and presence of invasive weeds, but also in managing the spread of invasive weeds in the interior of Australia, in range and bushland that is grazed.

Federal funding has resulted in the development of the WoNS or “weeds of national significance” managed by the Australian Weeds Committee. This program has also received significant investment in federal funding to survey and develop successful programs to prevent weed

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incursions throughout Australia, particularly in coastal and inland Australia, through WoNS weeds coordinators and teams. It is difficult to estimate the total amount of funding invested since the mid 1990s in federal weeds programs, as they have been managed by various organizations and agencies both inter and independently. However, total investment in systems and biodiversity initiatives involving weeds as a component, and the WoNS program, has likely amounted to hundreds of millions in funding.

The National Weeds Coordinator has compiled a database of over 300 projects in weeds R&D since 2002.

Investment in weeds research has been significant since 1990 and from the standpoint of prevention of spread or containment of certain weeds, has been successful, in cases such as prickly acacia (prevention of spread into Australia's interior).

Regionally, the Caring for Our Country federal grants program has also supported work performed in communities in participation with local agencies, such as catchments and land management authorities, to solve critical problems related to invasive weed spread and management. This program has funded numerous projects on weed management in the past 3 years, including work on serrated tussock, aquatic weeds and weeds of environmental significance, to the tune of several million dollars in investment. Compared with the 150-175 million invested yearly in CFOC projects, weed research supported in CFOC initiatives, however, receives only a small investment.

3.2 Weed CRC Research

From 1995 to 2008, weed research initiatives across Australia were primarily initiated and funded by organized Weed CRC investments. Two successful weed CRCs were undertaken and managed by CSIRO, academic institutions and state agencies. These CRCs were highly regarded by weed scientists as the life support for weed science research in Australia, and they supported collaborative projects and both basic, and strategic or applied research initiatives. Totalled together, the weed CRCs were funded for up to 80 million in R,D&E initiatives across Australia over 14 years. Although the first CRC emphasized weed management studies in agricultural settings (crops and high rainfall zone pastures), the second focused more on environmental weeds of significance and protecting Australian native species against invasion. However, the Australian Weed management CRC (2001-2008) was supported by GRDC and continued to maintain a core focus on weeds in cropping systems.

The CRCs resulted in development of new technology and collaborative research initiatives across regions and states. They also produced highly significant extension and outreach efforts, including broad based communications, community engagement, training workshops, seminars and programs along with extension publications, websites and manuals. The quality and quantity of outreach materials produced by the last CRC was impressive, and outcomes of these directed weed research initiatives have had significant impacts on weed management in Australia. Many of the projects undertaken initially had strong implications for pasture management and feedbase investment. Later, the emphasis spread to include and emphasize weeds of environmental areas. The development of a third weed CRC (from 2008 onwards) which was primarily focused on "social good" was not supported. The partnership or investment required for a weeds CRC endeavour is large, and successful funding partnerships were not developed to push forward another initiative.

3.3 National Weeds Research Program

The 'Defeating the Weed Menace' program was a national program established by the Australian Government in 2004 to identify Australia's most threatening weeds and to implement measures for their control. Between 2004 and 2008 the Australian Government committed \$44.4 million to Defeating the Weed Menace. Two major calls for research proposals resulted in the funding of 25 projects including

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- assessing the risks of different sources and pathways of weed ingress into and within Australia;
- identifying risks, pathways and their potential weed invasion impacts to prioritise key sectors for future action in early detection, survey and eradication or delimitation of their potential weed impacts on the environment and primary production;
- Identifying and developing biocontrol agents for priority weeds and a framework to improve targeting of biological control projects
- Developing methods for surveying and eradicating priority emergent weeds
- Quantifying the impacts of weeds on sustainability and the environment (including the ecological costs of weeds) and the relative benefits and costs of different control measures.

The Defeating the Weeds menace program provided recommendations including:

- Funding of weed research include a mix of strategically tendered specific core projects and a general call for proposals around the identified themes and priorities
- Specific integration opportunities be provided for and facilitated in weeds research
- That in developing new weeds R&D programs, priority be given to whole systems approaches and landscape-scale perspectives, and climate change impacts
- Future weeds R&D programs include socio-economic and institutional dimensions of weed management.
- All stakeholders jointly progress a nationally agreed information system or process for the collection, collation, storage and management of invasive species data and information.
- That weeds R&D programs be established with at least 4-6 year timeframes and that continuity between funding cycles be planned within portfolio and budget cycles
- Monitoring & Evaluation plans should be developed at the outset alongside the Knowledge & Adoption plan at both program and project levels.
- That the Australian Government provide funding to conduct an 'expert forum' to redesign and enable the monitoring of weeds and the outcomes of their management over periods longer than those usually associated with research funding cycles.

In an independent review of the Defeating the Weed Menace R&D program (Coutts 2009) the priority needs for future research were identified as:

- socio-economic and institutional dimensions of weed management
- whole systems management approaches to weeds
- increased understanding of the interactions between climate change, weed invasion and the control and management

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.
 - adopting whole-of-landscape or ecosystem approaches to weed management
 - understanding invasion processes and species lifecycles, competition mechanisms
 - Determining impacts of land uses and management on nutrient balances, water flows, pasture and other ground-cover retention and the system dynamics that assist invasive plant species
 - placing biological control within a more integrated approach to landscape management, integrating it with other control strategies
 - understanding the influences of climate change on weed spread enabling early detection and management

The report also indicated a need for:

- 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
- assisting researchers to develop knowledge and adoption strategies from the beginning of their projects
- 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.

In 2008 another national initiative has risen to the forefront to support weed research and investment in Australia. Following the unsuccessful rebid for a weeds CRC, federal funding was allocated for a program formerly called the Australia Weed Research Centre but is now referred to as the National Weeds Research Program and is currently administered by RIRDC. The National research strategy, identified earlier in this document, has directed investment. A total of 15 million in research investment has been distributed through this program since its inception in 2008. In 2011, the final 12.5 million was distributed to researchers from universities, federal and state agencies, landcare groups, farming systems organisations and agriculture consultants. In total, 24 open call and approximately 25 commissioned projects were funded and are required to be completed by July of 2012. These projects address a range of weed management issues including studying social implications for weed management in pasture crops, weeds exhibiting herbicide resistance along roadsides, and impacts of climate change on biocontrol agents for Paterson's curse.

Commissioned projects on spatial detection of weeds using hyperspectral imaging systems is also applicable to pasture and rangeland research. The majority of projects, however, addressed work in other cropping systems or environmental weed incursions. The National Weeds Research Program has directly involved personnel from MLA and GRDC in consultation preceding development, and one GRDC representative served as a member of the steering committee overseeing distribution of funding in 2010-2011. This program has also involved a diverse group to assist in development of its strategic plan and national priorities for the future. Although RIRDC would like to manage the program and its portfolios indefinitely, it is uncertain at this time if federal funding will be available in the future to continue to support this initiative.

It is clear that the lack of a continuous nationally funded weed CRC initiative has made it very difficult for weed scientists to continue to develop both regional and national collaborative initiatives and perform longer-term research projects, leading to significant research and extension outcomes. In addition, it has led to a lack of focus for weed science priorities nationally and a need to refocus our strategies regionally, as federal funding is not likely available in the future or is uncertain at best.

Of the research funded by Weed CRCs since 1995, several initiatives have had strong implications for uptake by livestock producers and pasture managers. However, emphasis on weed research has often been on broadacre cropping systems or weeds of considerable economic or social importance. Pasture weeds often do not fit this bill, for several reasons.

- Pastures are often considered to be low value and low input in terms of management
- Research projects gravitate towards work involving high value cropping systems or weeds of critical environmental significance because funding has supported these initiatives

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- Certain people consider research in pasture and rangeland management to be less prestigious or inferior to work in high value or economically more important commodities
- Strategic research committees which fund national and regional projects often see research in pasture and rangeland areas to be less important to fund than other projects considered to be more economically important
- As pasture and rangeland research and cropping systems research are considered to be the domain of RDCs such as MLA, RIRDC, Australian Wool and GRDC, federal programs often choose to overlook research in this area.

If one discusses this issue with weed scientists in Australia, many feel that although the work in this area may be of importance and of interest, they choose preferentially not to engage in feedbase research initiatives if they are not supported by good funding.

Exceptions do exist, and areas which have been generally well supported by state and federal agencies include pasture crop development for Australian conditions, and study of weeds of national significance which are pasture or rangeland weeds, such as serrated tussock or prickly acacia. Australian researchers have successfully bred and selected for unique legumes and grasses which can now be efficiently utilized in both high and low rainfall areas across Australia. However, work remains to be done in low rainfall regions in terms of a) selection of competitive grasses that can be paired with lucerne in mixed forages and b) for sustainable grazing systems which suppress weeds, and also support livestock production goals. In addition, many longer term studies have been performed on weeds of significance in pastures and rangelands, and we have gained much information about the biology of critical pasture weeds. Some weeds recently focused upon in directed research efforts include fireweed, lantana, silverleaf nightshade and ground cherry, mesquite, prickly acacia, annual ryegrass, vulpia, and windmill grass.

3.4 Implications for consideration

- The NWPRP provides a framework for investment
- Ongoing funding (post 2012) is not assured, and investment can lever the NWPMP, if there is alignment with priorities
- Funding rounds encourage applications based on capability of research providers and are assessed on a range of criteria which means that it is possible that vital R&D “building blocks” may not get undertaken because there is no application lodged.
- Targeting commissioned research is required to ensure projects which may be deemed appropriate for DAFF/RIRDC funding are not overlooked; MLA could contribute to these submitted projects
- Prevention of weed/weed propagule spread is a priority area yet providers have not expressed much interest in funding this area
- Selection and funding of the federal programs as it stands is now simply utilising the DAFF/RIRDC funds, rather than developing the total pool by harnessing the RDCs potential investment through engagement in project selection. Greater engagement with this decision making could be progressed in the planning stage, instead of the RDCs being requested later to support/develop the projects RIRDC have initiated under the NWPRP.
- the lack of a nationally funded weed CRC initiative has made it very difficult for weed scientists to continue to develop both regional and national collaborative initiatives and perform longer-term research projects
- the lack of national coordination in project development has led to a lack of focus for weed science priorities nationally and a need to refocus our strategies regionally

Evaluation of initiatives

In addition to a series of individual project milestone reports, and LWA reports to the LWA Board, DAFF and the Australian Weeds Committee, LWA also contracted an independent evaluation of the DWM R&D program. The consultants completing that evaluation open their report with a statement that “The Defeating the Weed Menace (DWM) R&D Program and its projects performed very highly against the objectives, scientific outcomes and performance indicators”. The reviewers go on to identify a series of administrative and other improvements that could be made in future national weeds R&D programs. These include the need to work with researchers to develop programs to improve uptake and adoption of their research findings, as the research is planned and then initiated. This is a serious consideration for many of the R&D programs which have successfully generated high level research results. It is also difficult to determine if any of the recent research projects funded have had strong and direct economic impacts on agricultural productivity or have resulted in changes in weed management strategies. The inclusion of economic analyses components to large research projects are further suggested.

Future Emphasis for Meat and Livestock Australia

5.1 Producer priorities

Very few if any studies have been recently undertaken to determine, from a market research perspective, what weeds are the most important concerns for feedbase producers, from a national perspective. However, Brian Sindel at UNE has identified 10 species of importance as ranked by graziers in a national survey, with number 1 representing species of greatest concern, in 2008.

The weed species in order of concern were:

1. Thistles
2. Perennial grasses
3. Woody weeds
4. Paterson's curse
5. Blackberry
6. Bathurst burr
7. Capeweed
8. Ragwort
9. Parthenium weed
10. Gorse

Market-based research like this will be needed to establish strong national priorities for future research and should likely include specific areas of research to be emphasized, such as weed detection and assessment, herbicide application systems, alternative management strategies, pasture crop selection, grazing management, rotational systems etc.

Topics of current research performed by weed scientists across Australia that relate to feedbase production systems can be summarized and include the following areas of research:

- Herbicide screening for control of weeds in established and newly established pastures/rangelands
- Biology and ecology of specific pasture and rangeland weeds
- Biocontrol strategies for weeds of pastures and rangelands
- Spatial analysis of weeds in pastures and rangelands
- Site specific herbicide application for pastures and rangelands
- Selection/breeding of new pasture crops that are both valuable and competitive with weeds
- Impact of perennial weeds on pasture/livestock quality; perennial weed management systems research

Situational Analysis and Options Paper for RMCiC

- Impact of grazing system management upon pasture quality and weed infestation, livestock productivity

5.2 CMA, Agency, Community group priorities

From development of the NWPRP, a consultation workshop identified the following opportunities in addition to those in the NWRPR:

- Weed impacts upon ecosystems and adopting a systems approach to managing weeds including ecosystem restoration
- Whole systems approaches to weeds management
- Linkages with climate change research
- Multi-disciplinary approaches to solve R&D challenges
- Better understanding of 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
- Identifying opportunities that may exist by partnering and integrating with other issues (e.g. natural resource, food security, biosecurity)
- An integrated weed research component into the wider natural resource management environment
- R&D into bio herbicides

5.3 Future Research Initiatives for MLA

In 2011 interviews with over 35 people comprising researchers, crop consultants, producers and farming systems group representatives across SA, VIC and NSW to discuss strategic planning initiatives for GRDC weeds research, several areas were repeatedly discussed as needing attention from a research perspective.

The following are areas that stakeholders reported needed more immediate research attention:

- New and emerging weed issues, including summer fallow weeds
- Perennial weed management including thistles, silverleaf nightshade, blackberry
- Aerial/spatial detection of weeds and site specific weed control
- Systems studies on the economics of crop and grazing rotational systems and weed management in mixed farm settings, where pastures are considered one option for IWM
- Use of integrated weed management strategies such as burning, mowing and grazing, besides herbicide application, on weed seed set and seedbank dynamics

In addition, other areas were also noted of potential interest for future research and included:

- Study of chronic impacts of weed and crop toxicity (ryegrass staggers, Paterson's curse, capeweed, phalaris, fireweed) upon livestock longevity and reproduction, as well as acute impacts upon livestock behaviour and productivity
- Continued research on selection of new pasture crops for forage across temperate and dryland grazing systems, with emphasis on both livestock production/performance and weed suppression over time
- Development of new biocontrol options for emerging weed species and grass weeds
- Development of GMO pasture crops for weed management

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- Use of molecular tools to characterize weed populations, reproduction systems and understand their response to stress and climate change parameters
- Economic/social incentives for weed management over longer term
- Farm systems studies in mixed farming systems where pastures are one option for IWM
- New biocontrol initiatives
- Breeding/establishment of pasture crops for weed suppression/livestock production
- Invasive weed toxicity and long term impacts on pasture/livestock productivity

By taking a broader national approach to the development of research priorities and research collaborations/partnerships across regions and agencies, one can potentially develop feedbase initiatives which are well-funded, from multiple sources, and impact upon weeds of national and regional significance.

Key researchers have also suggested:

- that comprehensive surveys of key pasture weeds be conducted in both areas of high rainfall and low rainfall for comparative purposes in SA, VIC and NSW. This could also be done in QLD, WA and Tasmania. Based on these outcomes, and broad surveys of researchers and stakeholders, appropriate research teams and collaborations could develop across regions and states, with longer-term investment and research outcomes.

Producers have stated:

- they see a real need for long term studies with economic analyses to validate techniques and research demonstration findings.
- like to see interaction with research teams at field days, workshops and study sites and want this interaction supported
- they see a need for a more systematic approach to studying livestock production as a whole, including plant toxicity-based problems.

This systems approach would involve stakeholders, veterinarians, weed scientists, agronomists and animal scientists to gain effective solutions to managing livestock production and pasture issues which impact feedbase for young animals but also reproductive success/longevity of breeding animals.

5.4 Implications for consideration

- By forming a research committee to develop and prioritize research initiatives led by the MLA, a strategic planning process can be addressed.

- The use of longer time frames for research trials and multidisciplinary groups to address research initiatives will also result in better outcomes for complicated weed management issues that are influenced by cropping systems and grazing systems choices.

- Research problems which cross RDC boundaries and are of interest to mixed farming systems could be supported by all of MLA, GRDC and RIRDC, or other logical agencies. Larger sources of pooled funding are needed to fully address issues which require long term studies or large study areas, or collaborative research across states.

- By taking a new approach to the study of weeds in feed-based systems, rather than asking only questions in one dimension the national weeds research initiative could more fully embrace investments in research upon feedbase systems.

5.5 Positioning of MLA investment given the organisational environment

Situational Analysis and Options Paper for RMCiC

In recent years, the number of weed scientists performing weed management research related to the Australian meat and livestock industry has significantly declined, and capacity to perform related research may be limited in the future by lack of weed science expertise. Gaps have been identified in recent strategic and applied research efforts and delivery of research findings. Currently, research projects involving weeds of pastures and rangelands are performed independently and research efforts are not generally coordinated nationally or regionally. Although significant federal funding was provided for the 2010-2012 RIRIDC National Weeds Program initiative, a limited number of projects address research of relevance to the Australian meat and livestock industry, and project funding will lapse in 2012.

Three recommendations are made for MLA and PISC agency partners:

- 1) that MLA and associated RDCs address the lack of national funding directed towards IWM programs in pasture and rangeland by developing a focused strategic planning process to initiate research in designated priority areas
- 2) that new research initiatives be thoughtfully coordinated with preexisting research programs to address both national and regional needs of the meat and livestock industry
- 3) that new research initiatives focus on several priority areas which include:
 - better methods for surveillance and monitoring of weeds in pastures and rangelands, with an emphasis on determination of which weeds are critical to livestock production efficiency today in each region, and which weeds are likely to become problematic in the future
 - development and application of novel biocontrol measures used in concert with IWM strategies for enhanced weed management; a coordinated approach to understanding the weed problem and addressing management using a targeted approach with several strategies that will eventually lead to a successful outcome
 - establishment of competitive and resilient pasture crops and mixtures for each region resulting in long term reductions in weed infestation; if pastures are effectively managed from a systems approach involving crop and livestock rotation, weeds are less likely to be a limiting factor in achieving efficient livestock production
 - generation of critical information on the biology, spread and containment of recent weed incursions, with a need to address impact of climate change on spread and potential for future management strategies for newly invasive plants

Meat and Livestock Australia could serve an important role in development and facilitation of weeds research from a national and regional perspective by acting as a coordinating body for funding of larger longer term investments in systems based research directed towards effective pasture and rangeland production systems, in mixed farming systems across Australia. By developing a strategic approach considering the current research conducted in Australia, the needs of regional producers and current research capacity, MLA could effectively develop a research network involving academics, state organisations, CSIRO and national funding bodies, besides other RDCs to facilitate effective long-term investment in research on pastures, rangelands and both agricultural and environmental weeds that impact production of livestock in Australia. Further, this work could lead to the development of targeted extension outreach efforts, including written materials, workshops and field days that are nationally and regionally coordinated to address critical weed research and outreach priorities. This coordination of research and extension will be critical to serve the future needs of the producer and related stakeholders working in the feedbase area.

Therefore, the first step in initiating this coordinated plan is to commission a development project to assemble a strategic panel to work with MLA and its feedbase investment plan to implement the three recommendations outlined above.

About the author

Professor Weston's background includes 25 years of work in weed biology research, development and extension in the USA at 3 different academic institutions. Along the way, she developed strong relationships with both industry and stakeholder groups. She is well positioned to take an open-minded look at research investment and development in weeds research in Australia, since moving to Australia in 2008. She has also been commissioned to develop a strategic research plan for weeds research across the southern region of Australia by GRDC in 2011, and this process is now reaching completion as well.

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