



To the Prime Minister of Australia

Restore the Soil: Prosper the Nation

The National Soil Advocate

Major General the Honourable Michael Jeffery, AC, AO(Mil), CVO, MC (Retd)
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Executive Summary

There is no doubt that many agricultural areas of the world are facing substantial soil, water, food and nutrition problems. More than thirty percent of the world's land is moderately to highly degraded, due to erosion, salinisation, compaction, acidification, hot fires and chemical pollution of soils, and much of the land potentially available for agricultural expansion is not suitable.

The combined effects of global insecurities (population increase, finite resource depletion, soil loss and the effects of climate change) mean that protecting and improving the condition of the world's agricultural soils and carefully managing the intensification of agricultural production have become imperatives for global security. This view is supported by the recent submission by the Department of Defence, along with many others, to the Senate inquiry on *Implications of climate change for Australia's national security*, due to report in March 2018.

In my role as National Soil Advocate, many of the thousands I have consulted reminded me that Australian agriculture also faces the global imperative to do more with less (less productive land, less water, lower inputs). They also emphasised the need to address declining levels of soil carbon, increasing soil acidification and loss of soil and nutrients resulting from erosion. Immediate and ongoing action is needed to ensure that Australian agriculture can continue to be productive, clean and profitable, to demonstrate the use of sustainable management practices our trading partners are now looking for, and to build the resilience we need to live with climate change and associated extremes in weather.

The emerging concept of 'soil security' also underpins the world's six existential challenges: food, water and energy security, climate change abatement, biodiversity protection and human health. I believe that soil and water security will increasingly underpin global social stability and security. Soil is a critical national strategic asset, and it is surprising to me that the scientific advances of the last 20 years in understanding the role that soil plays in each of these challenges have only recently been recognised.

Australia leads the world in our approach to water management. While there is more work to be done particularly in respect to excessive evaporation and run off, water policy is an example of a national response that is possible when the public and political importance of a fundamental and finite natural resource is recognised. I believe that along with our water, our soil and vegetation assets are so important, all three should be declared as key national, natural strategic assets, to be managed accordingly and in an integrated way. Mismanaging any one invariably means the other two also fail.

Australia could play a leading role in showing the rest of the world how inherently infertile soils in a difficult climate can be managed to meet the world's Sustainable Development Goals for land and soils.

Here I draw together the ideas gathered during my extensive consultations as the National Soil Advocate to make 10 recommendations to protect and improve the health of Australia's soil, water and vegetation for the benefit of all Australians

Recommendations

1. **Agree to a national soils policy with the objective of maintaining and restoring the health of the Australian agricultural landscape** through a coordinated and integrated approach involving the portfolios responsible for agriculture, environment, health, education, defence, Australian Aid, Indigenous affairs, regional development and industry.

The policy will recognise Australia's **soil, water and vegetation as key national natural strategic assets, better support our 130,000 farmers as stewards of about 60 percent of the Australian continent, and seek to reconnect urban Australians with their rural roots through establishing school gardens in every primary and junior high school through the National Curriculum.** The policy will support long term research directed at priorities identified through a stocktake of our scientific knowledge of soils and RD&E capacity, and where possible encourage regulatory consistency for farmers.

2. **Establish a permanent role for the National Soil Advocate as an independent advocate for the importance of soil,** its key role in food and water security, and the importance of the agricultural sector. As with other national functions whose managers have been appointed by the Prime Minister, this position is best placed with the Department of Prime Minister and Cabinet. The role has a national focus with a proven potential to contribute to international coordination of good agricultural land management practice.
3. Establish a long term, permanent soil, water, vegetation and agricultural knowledge program that encourages collaboration between scientists and successful farmers to **build knowledge, collate the evidence to support successes and improvements, provide improved extension services to share the information and promote the wider use of regenerative farming techniques,** which will inform and educate a broad range of stakeholders about leading regenerative land management practices. This will expand the initial 21 Soils for Life case studies which have proven the concept, to include around 100 best practice and innovative farm sites Australia wide.
4. Ask the Rural Research and Development Corporations to direct funds to expand the work on extension undertaken through the Extension Hub website, and that the Research and Innovation Committee (which advises the Agriculture Senior Officials Committee) be tasked with deciding how best to implement the strategic actions identified in RIRDC's report "Consolidating targeted and practical extension for Australian farmers and fishers".
5. Increase the funds available through the National Landcare Programme to encourage more farmers to adopt regenerative land management practices.
6. Ask Rural Research and Development Corporations to direct a proportion of their research funds to improve understanding of the plant and soil microbiome processes underlying regenerative farming practices.

7. Have Australian government agencies (including relevant portfolio agencies) state and territory governments and the CRC for High Performance Soils agree to contribute funding or in-kind support for an Australian Soil Network endorsed proposal for an Australian National Soil Information Facility.
8. Task the Soil Education Working Group of the National Soil Research, Development and Extension Strategy Committee (The National Soil Network) with developing recommendations for national adoption of the Soil Science Teaching Principles, and conveying these for consideration by the Australian Council of Deans of Agriculture, followed by endorsement by Soil Science Australia's Certified Practising Soil Scientist accreditation scheme.
9. Through the Deans of Agriculture, stocktake and where appropriate, improve government owned extension service capacity to guarantee timely, accurate and transparent information delivery to farmers Australia wide, including improving the career planning prospects for potential and current agricultural scientists.
10. Agree to the preparation of an annual alert report to the Australian Government on the global soil, water and food situation from an Australian perspective through the auspices of Future Directions International and in collaboration with the Office of National Assessment and other relevant organisations.

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Introduction

I was appointed as the National Advocate for Soil Health by the then Prime Minister, the Honourable Julia Gillard MP, in October 2012 (Terms of Reference at **Appendix A**). My mission is to provide strong leadership and advocacy on the importance of healthy soil, water and vegetation, and the underlying benefits for all Australians.

There is little doubt that many agricultural areas of the world are facing substantial soil, water, food and nutrition problems (FAO 2015). Globally, the rapid frequency and scale of global soil loss far outpaces the natural cycle of soil formation. At this rate, one prediction is that the world's agricultural soils will be gone within the next 200 years (Wilkinson and McElroy 2007). Current demographic trends and projected growth in global population are estimated to result in a 60 percent increase in the demand for food, feed and fibre by 2050.

Globally, and particularly in India, China, sub-Saharan Africa, the Middle East, Turkey and even California, arable land is being lost at a rapid rate, and the soil carbon levels are at very low levels. Aquifers are running dry or have run dry, ground water assets, including major rivers supplying developing countries in particular, are now polluted, or with flows so restricted that both agriculture and towns are severely impacted. These issues are further compounded by climate change impact.

In the past, agriculture has been able to significantly increase productivity through clearing, cultivating and irrigating more land, and intensifying production using chemical fertilisers and enhanced breeding of crop varieties and animals. This situation is now changing. Today, 33 percent of the world's land is moderately to highly degraded, due to erosion, salinisation, compaction, acidification, hot fires and chemical pollution of soils, and much of the land potentially available for agricultural expansion is not suitable.

The combined effects of global insecurities (population increase, finite resource depletion, soil loss and the effects of climate change) mean that sustainable management of the world's agricultural soils and sustainable production intensification have become an imperative for global security. It is critical that we work towards more productive, sustainable, healthy food systems. Along with Jim Yong Kim, President of the World Bank and the UN Secretary General, His Excellency Antonio Guterres, and international and Australian experts (Morgan et al. 2017), I believe that soil and water security will increasingly underpin global social stability and security.

The emerging concept of soil security, underpins the world's six existential challenges: food, water and energy security, climate change abatement, biodiversity protection and human health. Soil plays a pivotal role in each: for example the world's soil contains more than twice as much carbon as the atmosphere, 97 percent of the world's food comes from agricultural soil and more than 98 percent of terrestrial biodiversity is found in soil (McBratney et al. 2017). It is surprising to me that the scientific advances of the last 20 years in understanding the role that soil plays in each of these issues has only very recently been recognised internationally. The United Nations 17 Sustainable Development goals, adopted in 2015, identify the importance of sustainable soil and land management, noting that there are well recognised links between soil degradation and poverty, which are often associated with socio economic and governance issues.

Australian agriculture also faces the global imperative to do more with less (less productive land, less water, lower inputs), while building resilience to climate change. We export more than \$30 billion worth of food annually, feeding some 40 million people outside Australia on a daily basis. To remain a net exporter of food and fibre, Australian farmers will need to achieve real productivity gains over the long-term, while adapting to climate change, and protecting the natural resources, including biodiversity, which underpin sustainable agricultural productivity.

During my time as the Soil Advocate I have been troubled in part but also excited and inspired by what I have seen and heard. We have problems with our soil and its management and although there is much happening to address these problems, much more needs to be done on a properly coordinated basis. Australia has world leading earth and environmental scientists. We also have a strong history of on-farm innovation, together with proactive government support for industry, which has allowed us to develop to this point, a generally successful agricultural sector in the face of an often hostile environment.

In my time as Soil Advocate, I have met with a great many farmers, scientists, Indigenous interest groups, policy makers, consultants, students and community groups, all actively working to meet land management challenges across the country. I have seen first-hand the merging of new and old skills and technology, the collaboration of disciplines and the willingness to work together towards shared challenges. I am in no doubt that if we harness and develop this considerable expertise, we will build healthy, well managed soils, which are resilient to climate change and support productive ecological and agricultural systems over the long term.

I believe that Australia can play a leading role in showing the rest of the world how inherently infertile soils in a difficult climate can be managed to meet the world's Sustainable Development Goals for land and soils. This also provides a great opportunity for the Australian Government to respond to the 9 Actions for Governments in the June 2015, FAO Revised World Soil Charter of which Australia is a signatory. It may well be, that the targeted export of good agricultural landscape management knowledge could help to feed hundreds of millions with important ramifications on how Australia is viewed both regionally and globally.

For all Australians, I believe there are substantial potential benefits which will flow on from a more focused approach to the health of our soil and landscape. The whole of community will be healthier in terms of the food we eat, the air we breathe and the water we drink. A national soil policy, when implemented, will create new industries, develop new skills and hence create new jobs. This will in turn strengthen the fabric of Australian communities and our society.

Here I draw together the ideas gathered during my extensive consultations (**Appendix B**) as the Soil Advocate to make a series of recommendations to improve the health of Australia's soil, water and vegetation for the benefit of all Australians.

1. A National Soils Policy for Australia

Australia's soil is a major national asset. It is the engine for our food production, has a fundamental role in the carbon and water cycles, and hosts an extraordinary biodiversity, the activities of which are essential to plant growth. The future management of our soil will determine whether our farmers can continue to produce food and fibre for the domestic market, as well as through exports. Australian farmers can improve their profitability and the resilience of their farming systems, even in the face of more frequent and extreme droughts and climate change, if they are supported in nurturing their soils. This will in turn assist Australia to meet its international obligations to the Four per Thousand Initiative in relation to carbon storage.

Australia is one of the countries most affected by climate change, with agriculture among the most vulnerable sectors. Increasing world demand for food and land management knowledge will create major opportunities for Australia. Excellent soil management which increases soil water storage, builds carbon, slows rates of soil acidification and minimises soil lost through wind and water erosion, will be required if we are to make the most of these opportunities.

There have been significant improvements in Australia's soil management, notably the reductions in wind erosion and dust storms since the 1940s (SoE 2011) but much remains to be done. Soil is everywhere, and seems to be taken for granted, even by some farmers; perhaps because many soil degradation processes are chronic, slow and insidious. While Australians expect food production to be sustainable, they also want agricultural land to protect biodiversity and provide clean air and water. There is a very limited appreciation of the connection between these outcomes and sustainable soil management.

There is a need for a better coordinated and more focussed national effort to ensure that the critical issue of sustainable soil management is given sufficient attention. I believe that a national approach to soils is needed, and that this should be driven through the development of a comprehensive National Soils Policy which integrates soil, vegetation and water management to maintain and restore the health of Australia's agricultural lands.

This policy must involve all relevant government portfolios, including agriculture, environment, Indigenous Australians, health, education, defence, Australian Aid, industry and regional development, which have some responsibility for soil or soil related issues. The following sections outline five issues that I think should be considered in developing the National Soils Policy.

1.1 Recognise Australia's soils, water and vegetation as national natural strategic assets

Australia leads the world in our high level recognition and approach to water resource management, through instruments such as the Intergovernmental Agreement on a National Water Initiative 2004 and the Commonwealth Water Act 2007. It was the disastrous effects of the Millennium Drought (1996-2010) that brought governments, agricultural industries and communities together to agree a national approach to water management. While there is more work to be done on water issues, including work to reduce very high evaporation and run off loss, water policy is an example of the national response possible when the public and political importance of a fundamental and finite natural resource is recognised.

The importance of soil and vegetation in the functioning of the water cycle needs greater recognition. Water is scarce most of the time in many Australian landscapes, and this scarcity is likely to be exacerbated by climate change, particularly in southern agricultural regions. Within broad climate zones, interactions between soil type, vegetation, rainfall and

evaporation affect how much water enters the land surface and is stored in the soil, is available for plant growth, evaporates or drains to groundwater and streams. Many of the most difficult land management problems are caused by changes to soil-water regimes. For example, wind and water erosion, soil compaction, loss of soil carbon and smoothing of the land surface resulting from land clearing, reduce the water storage capacity of the soil. For many agricultural systems, building resilience to climate change will mean changing soil and vegetation management practices to improve soil water storage.

Land managed for agriculture is thought to hold about two-thirds of Australia's remnant native vegetation, which is a major biodiversity asset. Much of this land is native pasture. Improving the management of remnant native vegetation, and in some cases adding extra planting, will not only help on-farm water management and increase resilience to dry seasons, but also improve crop pollination and increase the effectiveness of integrated pest management by providing habitat for predator organisms. The benefits to farmers can include increased productivity, less insect damage and reduced costs of pesticides, and higher yields.

A small but increasing proportion of Australia's farmers are trialling and adopting farming approaches that integrate soil, water and vegetation management, and in the process, increasing the natural capital that underpins their farm's productivity and long term sustainability. However, practice change in agriculture is a slow process.

Current international discussions around sustainability and what it means for agriculture may shape how international agricultural markets evolve. Some countries are already using the shift in focus to sustainability to shape policy discussions to their advantage. There is industry recognition that improving sustainability has an intrinsic benefit, and will help meet the changing expectations of stakeholders and customers (for example the Beef Sustainability Framework <http://www.sustainableaustralianbeef.com.au/>).

I believe that our soil, water and vegetation assets are so important, that they should be declared as key national natural strategic assets, to be managed accordingly and in an integrated way. Only by so doing can we ensure that Australian agriculture builds the resilience needed to manage climate change whilst increasing productivity and profitability, and is ready to meet the increasing international demand for sustainably produced food and fibre.

1.2 Acknowledge the role of farmers as stewards of Australia's agricultural land

Around 60 percent of Australia is used for agricultural production with almost 130,000 agricultural business producing most of the food and fibre used by Australians. Farmers have primary responsibility for managing the soil, water and vegetation on their land and hence in effect, they are managing the majority of the country on behalf of 24 million largely urban Australians. The cumulative impact of their daily decisions not only affect the condition of the soil, vegetation and water assets on their farm, but also the air and water quality, and the biodiversity enjoyed by the broader community.

A recent survey (Schirmer et al. 2015) reported that nearly 90 percent of farmers *had undertaken* activities to improve natural resources on their farms, including tree planting, regeneration of native vegetation, feral animal or weed control without assistance; 39 percent reported *currently doing* this and a further 50 percent *had done this at some point in the past*. Many of these on-farm investments, which contribute to improving air and water quality and protecting biodiversity, are largely invisible to the broader community, as are the costs to the farmers involved.

Within urban communities there is little appreciation of the links between the land management practices chosen by farmers, how these affect the condition of their soil and vegetation and the off-farm impacts on air and water quality. Increasing the broad community understanding and appreciation of these linkages and the importance of decisions made by farmers would go some way to providing the social context, and some of the support needed to encourage more farmers to consider how their businesses could benefit from more integrated management of their soil, water and vegetation assets.

1.3 Reconnect urban Australians with their rural roots through the next generation

It is fair to say that the rural/urban divide is increasing, that we have an ageing farming population and that rural communities are declining.

Another aim of the National Soil Policy therefore, should be to build community understanding and support for sustainable soil, water and vegetation management, how these underpin food production and the links between these broader social, environmental and economic outcomes.

Primary and junior high schools in particular provide an ideal location to engage children in behaviours that will not only support their health for life, but also encourage an interest in agriculture and/or science. Capturing the interest and building the knowledge of our youngest citizens would go a long way to reconnecting Australians with their soil through practical hands-on learning at a formative time. The school garden concept has been a successful context for a wide range of learning opportunities, including about soil.

Teaching and learning activities linked to soil are available for students across the entire curricula; children and young people will be crucial to reconnecting Australia's highly urbanised population with the significance of soil, and all that it supports in life. It is recommended that school gardens be established in every primary and junior high school as a national school garden program, implemented through the Australian Curriculum, and with an integrated syllabus which could be developed in collaboration with the Primary Industries Education Foundation of Australia.

1.4 Support research directed at priorities identified through a stocktake of our scientific knowledge of soils and RD&E capacity

The 2015 National Science and Research Agenda established Soil and Water (including vegetation, biodiversity and marine resources) as one of seven National Research Priorities. Development of this priority was informed by a national stocktake of soil science investment and science capability undertaken for 2010-11 (Department of Agriculture, Fisheries and Forestry 2011), and subsequent work by the Soil Research, Development and Extension Strategy Implementation Committee (now known as the Australian Soil Network). The stocktake identified that an estimated \$124 million was spent on soil RD&E in Australia in 2011-12. It is important that future investment decisions be based on up to date information and made collaboratively. I strongly recommend that the Australian Soil Network's 2016-17 stocktake be circulated to research funders, providers and importantly, farmer group representatives, for discussion of opportunities to increase the effectiveness of investment, to ensure that the research done is needed and will benefit farm work through stronger cooperation, collaboration and sharing of information.

1.5 Support regulatory consistency for farmers

In my consultations with farmers, many mentioned that complying with government regulations took up a great deal of their time. They were particularly concerned about competing and often contradictory regulations when dealing with a number of agencies and several levels of government. For example, moving oversized agricultural equipment along public roads can require a number of permits from different agencies; stream remediation in one council area may be appropriate for soil, water, vegetation and biodiversity regeneration, whilst the neighbouring council has different regulations which prohibit such activities. The difficulties associated with navigating the overlap and duplication between state native vegetation regulations and the Commonwealth Environment Protection and Biosecurity Act were also mentioned, along with the time taken up by the need to provide different data for water resource management by state and Australian government agencies. These inconsistencies often involve substantial time consuming application processes, needing to be carried out during business hours, and often at sites substantial distances from the farm, all of which impinges on general farming activities.

Recommendation 1

Agree to a national soils policy with the objective of maintaining and restoring the health of the Australian agricultural landscape through a coordinated and integrated approach involving the portfolios responsible for agriculture, environment, health, education, defence, Australian Aid, Indigenous affairs, regional development and industry.

The policy will recognise Australia's soil, water and vegetation as key national natural strategic assets, better support our 130,000 farmers as stewards of about 60 percent of the Australian continent, and seek to reconnect urban Australians with their rural roots through establishing school gardens in every primary and junior high school through the National Curriculum. The policy will support long term research directed at priorities identified through a stocktake of our scientific knowledge of soils and RD&E capacity, and where possible encourage regulatory consistency for farmers.

2. A permanent role for the National Soil Advocate

The role of the Soil Advocate extends beyond public speaking engagements. It has provided a unique avenue for several thousand farmers to express their views and concerns, and share their knowledge with a person of influence, who is vitally interested in protecting their soils. The role also provides a direct avenue of multi-lateral engagement and discussion between farmers, the soil and water scientific research community, and governments. There has been strong interest in the role internationally, including the USA, the United Nations Food and Agriculture Organisation (FAO), the Club of Madrid and China. At a November 2017 visit to China, I addressed some twenty former Heads of State and Governments from Europe, Asia, Africa and the Pacific on food security issues. The Group included the former Secretary General of the United Nations Ban Ki-Moon. This was followed by a group audience with the Chinese President Xi Jinping who in an address of 1.25 hours emphasised the importance China places on the global imperatives relating to agriculture and climate change.

I will be following up with all these leaders to promote soil advocacy worldwide, emphasising the key role Australia can play in this respect. I have already received informal invitations from Rwanda, Fiji, Nigeria and China to visit their countries.

2.1 The role of the National Soil Advocate in Australia

I was appointed as Australia's first National Soil Advocate by then Prime Minister, the Honourable Julia Gillard MP, on 23 October 2012. The appointment was extended by the then Prime Minister, the Hon Tony Abbott MP, and recently by the Deputy Prime Minister, the Hon Barnaby Joyce MP, to 31 December 2017. I understand that this appointment is the first of its kind in the world. As the Advocate, I raise public awareness of the critical role soil plays in sustainable agricultural production, and in helping to meet global challenges, such as food security and climate change.

The Soil Advocate's role is voluntary. Secretariat support is provided by the Department of Agriculture and Water Resources, which includes assistance with drafting speeches and reports, arranging meetings and speaking engagements, and providing information on Australian government policies. As a retired Governor-General of Australia, I receive support for domestic travel funded by the Department of the Prime Minister and Cabinet.

As the Soil Advocate, I have contributed to the development of the Agricultural Competitiveness and Developing Northern Australia White Papers, and to the Australian Soil Network. I have presented my vision for Australian soil security at numerous domestic and international conferences, in radio interviews and at World Soil Day events, and met with several thousand farmers, organisations, scientists, Ministers and MPs to discuss the importance of healthy soils and ideas for what can be improved. I have travelled to every state and territory in Australia, and consulted widely to inform myself of the issues facing agriculture in each region (**Appendix B**).

2.2 Opportunities for expanding Australia's international influence

Internationally, sustainability issues (particularly in relation to soil) are receiving increasing attention. For example, in 2016 United Nations' member countries adopted the Sustainable Development Goals and in reality, the health of the global soil underpins all 17 of these goals. There are a number which are specifically related to healthy soil, with Goal 15 in particular focusing on the need for sustainable use of land and soils. OECD discussions are beginning to shape what 'sustainability' means for agriculture. As evidenced by the FAO's Voluntary Guidelines for Soil Management (FAO 2017) endorsed by the FAO Council, how soil is managed is a major issue for sustainability. If the emphasis on sustainable agriculture credentials increases internationally, Australia will need to strengthen its position. Our commodities could be vulnerable to reputational damage, non-tariff measures and increasing importer, manufacturer and retailer requirements. This could have significant negative implications for trade access and prices.

The Australian model for a Soil Advocate has been well received internationally. The New Zealand Soil Science Society is currently developing a recommendation to the New Zealand government to establish a National Advocate for Soil Health, and the UN Global Soil Partnership Plenary Assembly has recommended member countries establish a similar soil leadership role. Maintaining the position of the Soil Advocate as a national role could help demonstrate Australia's leadership in championing the importance of good soil management for agricultural resilience and sustainability.

In the long term, having a volunteer National Soil Advocate is unlikely to be viable. There are significant travel, time and administration costs associated with the role. Successors to the role are not guaranteed the level of support which my office lends to the voluntary position. The modest resources needed to sustain the role of the National Soil Advocate will need to be considered and the expenses covered by the Department of Prime Minister and Cabinet for

my travel should be taken into consideration as expenditure already allocated to the role. **Appendix C** outlines a proposed annual budget for the continuing role.

Recommendation 2

Establish a permanent role for the National Soil Advocate as an independent advocate for the importance of soil, its key role in food and water security, and the importance of the agricultural sector. As with other national functions whose managers have been appointed by the Prime Minister, this position is best placed with the Department of Prime Minister and Cabinet. The role has a national focus with a proven potential to contribute to international coordination of good agricultural land management practice.

3. A long term soil, water, vegetation and agricultural knowledge program

Priority 4 of Australia's national soil research, development and extension priorities (Australian Soil Network undated) recognises the need to:

- Develop more effective ways to engage and exchange knowledge with farmers and land managers so that soil related R&D is applied and the potential benefits realised,
- Capture the learnings from farmers and land managers as they test thousands of ideas every year in their day-to-day operations.

There are excellent examples of farmer-led innovation, such as the development of the Harrington seed destructor, which will play an important role in managing weeds in crops and helping to reduce the risk of herbicide resistance. More funding is needed for scientists to work with successful farmers to understand and document the reasons for their success. Extension services will then be able to inform and educate a broad range of stakeholders about regenerative land management practices.

My conversations with farmers across the country indicate that the current extension programs are generally not satisfactory. The process of contracting out or leaving the education process to the private sector has meant there is a dearth of information in many areas, and product placement information only in others. Often the advice given is contradictory to best practice or considered by many farmers to be out of date.

The recent Rural Industries Research and Development Corporation (RIRDC) led project "Consolidating Targeted and Practical Extension for Australian Farmers and Fishers" (RIRDC 2017) assessed current and future extension delivery approaches, and how these approaches could be used. The project also developed an on-line extension Hub (<http://extensionaus.com.au/extension-practice/>) and associated Communities of Practice. Visitors can listen to podcasts, read articles or "ask an expert" technical questions. The findings of this report need to be implemented to enhance coordination and leadership of extension provision across rural RDCs, state and territory governments, industries, private extension providers and universities.

3.1 Fixing the paddock using regenerative farming practices

There are several names used to describe such farming systems including: regenerative farming and holistic farming. Soils for Life (Outcomes Australia 2012) defines regenerative landscape management as: the application of techniques which seek to restore landscape function and deliver outcomes that include sustainable production, an improved natural resource base, healthy nutrient cycling, increased biodiversity and resilience to change. These outcomes benefit all Australians.

The regenerative and similar farming systems adopted depend on a farmer's decision making and local environmental conditions, but all include techniques focused on the integrated management of soil, water, vegetation and biodiversity, and efficiency in the use of natural resources. Table 1 lists some of these techniques.

<ul style="list-style-type: none">• Applying organic composts, fertilisers and bio amendments• Encouraging natural biological cycles and nutrient transfer• Implementing time-controlled planned grazing• Using grazing management and animal impact as farm and ecosystem development tools• Retaining stubble or performing biological stubble breakdown• Constructing interventions in the landscape or waterways (such as leaky weirs) to slow the flow of water	<ul style="list-style-type: none">• Fencing off water ways and implementing water reticulation for stock• Rehydrating wetlands• Investing in revegetation• Pasture cropping• Direct-drill cropping and pasture sowing• Changing crop rotations• Incorporating green manure or under-sowing of legumes• Managing for increasing species diversity• Reducing or ceasing synthetic chemical inputs• Integrating enterprises• Feral animal control
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Table 1 Common regenerative farming techniques (modified from Outcomes Australia 2012)

These agricultural land management techniques have been adopted by a small but rapidly growing number of innovative farmers across Australia and around the world; these efforts need to be better supported and coordinated to increase adoption rates.

3.2 A Program for fixing the paddock

The Soils for Life Report (www.soilsforlife.org.au) describes 21 successful regenerative farming properties which are developing innovative practices to regenerate the soil and build resilience in their land. These practices, which involve integrating soil, water and vegetation management with cropping and livestock management, are delivering good triple-bottom-line returns and hence increasing the farms' profitability, long term sustainability and resilience to climate change. The operations of these farmers are also contributing to the clean air and water and protected biodiversity expected by the broader community from agricultural land activities. The important role that farmers' soil, water and vegetation management practices play in delivering environmental outcomes from agricultural land is now recognised (Campbell 2008, Cork et al. 2015, United Kingdom Department for Environment, Food and Rural Affairs 2015), but is yet to be appreciated by many, including urban Australia.

A long term soil, water, vegetation and agricultural knowledge program is being established by Soils for Life to encourage collaboration between scientists and successful farmers and to inform and educate a broad range of stakeholders about leading regenerative land management practices. This program extends the initial farm based Soils for Life case studies which have proven the concept, to 100 leading-practice agricultural enterprises Australia wide. The program will:

- develop selection criteria for participating farms which use innovation and regenerative management practices leading to an improved quadruple-bottom-line result (financial, productivity, environmental and social benefit) for the farm business
- develop and implement an on-farm measuring and monitoring program (including for water retention, soil moisture levels, soil carbon levels, nutrition levels in food produced, vegetation cover, financial improvements and social benefits) to quantify the impact of adopting regenerative practices on the farm
- establish a targeted and effective farm-based education program with farmer-to-farmer mentoring
- encourage the further development of techniques such as nutrient transfer, cover cropping, stubble retention and stream remediation to also benefit the natural resource base.

Recommendation 3

Establish a long term, permanent soil, water, vegetation and agricultural knowledge program that ensures collaboration between scientists and successful farmers to build knowledge, collate the evidence to support successes and improvements, provide sufficient extension services to share the information and promote the wider use of regenerative farming techniques, which will inform and educate a broad range of stakeholders about leading regenerative land management practices. This will expand the initial 21 Soils for Life case studies which have proven the concept, to include around 100 best practice and innovative farm sites Australia wide.

Recommendation 4

Ask Rural Research and Development Corporations to direct funds to expand the work on extension undertaken through the Extension Hub website, and that the Research and Innovation Committee (which advises the Agriculture Senior Officials Committee) be tasked with deciding how best to implement the strategic actions identified in RIRDC's report on "Consolidating Targeted and Practical Extension for Australian Farmers and Fishers."

3.3 Enhance the role of the National Landcare Program in extending understanding of regenerative practices

The funds available for sustainable agriculture under the National Landcare Program are used by regional organisations, farming systems groups, industry organisations and Landcare groups to promote the adoption of land management practices that improve soil condition and on-farm biodiversity management. The funds are used principally to support field days, field trials and workshops to demonstrate the potential benefits of new practices, and how these can be applied to local agricultural environments. There is increasing interest from many of these groups in practices thought to be more sustainable over the longer term, as evidenced

by the high level of interest and large number of attendees at the 2016 National Biological Farming conference.

I commend the Australian government for providing \$1 billion for the next five years' of the National Landcare Program (from 2018-19) plus the one-off \$100 million for four years from 2016-17. These additional resources for the National Landcare Program could support an increase in regenerative farming extension activities, and I further recommend that the National Landcare Program should continue beyond this five-year timeframe.

I also commend the Australian government for the establishment of the Cooperative Research Centre for High Performance Soils with its 10 year program starting with a clear collaborative approach of science and research working with farmer groups, and focusing on soil to deliver relevant and effective information and tools to improve the agriculture sector.

Recommendation 5

Increase the funds available through the National Landcare Program to encourage more farmers to adopt regenerative landscape management practices.

3.4 Need for plant and soil microbiome research to underpin adoption of regenerative practices

The reasons why the innovative methods developed by the Soils for Life and other farmers are working so well are generally not well understood by science. More research is needed into the microbiological processes in the plant and soil biomes thought to be responsible for the success of various regenerative farming practices. These include those involving application of organic soil amendments, and integrating the management of livestock and crops to improve soil condition. This improved understanding of process is needed to establish how and where regenerative practices can be adapted for use in the range of farming environments encountered across Australia, and to promote adoption. It is vital that information relating to understanding of regenerative farming practices is made available to farmers in a timely manner, both through wide publicity and improved extension services delivery.

Recommendation 6

It is recommended that the Rural Research and Development Corporations be asked to direct a proportion of their funds to improving understanding of the plant and soil microbiome processes underlying the regenerative farming practices being used by highly successful farmers.

4. A nationally consistent approach to soil data and information is needed to support the development of digital agriculture in Australia

Digital agriculture is creating opportunities for the application of big data analytics. On-farm management decisions in the future will increasingly be based on objective data about climate, soil characteristics such as moisture availability and nutrient status, crop and pasture yields, animal health and performance, and a predictive understanding of how these components are interacting and can be manipulated. The biggest benefits from digital

agriculture for Australia are expected to accrue from collecting and sharing large volumes of data from individual farmers and across multiple agencies and businesses. Such data will provide the basis for developing robust new tools to support farmers' management decisions.

The need for finer scale data and better access to soil data has been recognised in a number of reports (Campbell 2008, NCST 2013 and McKenzie 2014). Keogh and Henry (2016) have reinforced the need to improve the soil (and climate) data sets they see as an essential foundation of digital agricultural systems, and recommended that Australian governments should increase funding for soil mapping and weather recording stations.

4.1 The current status of Australia's soil data and information systems

The information from past comparatively modest investments in the collection, collation and management of soil data by Australian and state governments and CSIRO resides in data bases established by each agency. These organisations have different information systems, different data models, access arrangements and attitudes to information connectivity. Custodial, access and licensing arrangements vary considerably. This makes it difficult to access, use and share soil data. These problems are likely to be compounded when other data holdings, including those of private sector organisations (principally those providing soil testing services to farmers) and universities are considered. Additionally, publicly funded research and development organisations have in the course of their research activities, supported the collection of soil data, much of which may not be accessible digitally.

4.2 A new governance model is needed for soil data and information

In my view the first step to improving the soil data and information needed to support the development of digital agriculture in Australia, is for all parties (government and non-government) to work together to develop the data base standards and governance arrangements needed to support a diversity of best practice agricultural business models to achieve the best outcomes for Australian agriculture. This work should include examination of different (including shared) service models, data cooperatives, possibly with public-private investment, and certainly with private sector collaboration.

Developing better information systems for soil related information exchange is a key priority for the Australian Soil Network. The Network has recently established a working group to prepare a business case to secure financial support from stakeholders (including Australian and state governments) for an Australian National Soil Information Facility. I strongly recommend that the Working Group engage with public and private organisations involved in the soil data and information space, to review and recommend options for future business models to deliver cost effective, shared services and benefits for all stakeholders, including farmers and the agricultural advisory community. The outcomes expected are business models for nationally agreed enabling infrastructures that will:

- ensure that all existing digital data holdings can be used
- facilitate collection, collation, management and appropriate integration of data from individuals, researchers and publicly funded research activities which are currently not reaching publicly accessible databases
- support the provision of on-line soil data services, which could range from free information to value added services developed by public or private organisations, and delivered on a subscription basis

- deliver the soil data and information that will support predictive modelling, including the forecasting of the likely state of soil under specified land management systems and climates, and into the future, observational systems for detecting and interpreting soil change with time
- provide the framework and tools to support new soil collection data by public and private organisations, and ensure that this investment is both strategic and cost effective.

The recently announced CRC for High Performance Soils, which involves a collaboration of a wide range of organisations undertaking soil research and implementation of results and products, could also be invited to contribute and play a role in delivering the outcomes needed to improve Australia’s soil data and information.

Recommendation 7

Have Australian government agencies (including relevant portfolio agencies) state and territory governments and the CRC for High Performance Soils agree to contribute funding or in-kind support for an Australian Soil Network endorsed proposal for an Australian National Soil Information Facility.

5. National adoption of the Soil Science Teaching Principles

National and international recognition of the importance of soil and its management has reaffirmed the need for tertiary education that produces soil science graduates that can answer questions like “what can this soil do?” and “is this soil in good condition?” An agile and diverse curriculum is needed to produce work ready soil experts, who can integrate their soil knowledge with other considerations, such as the economic feasibility, availability of resources, the abilities and needs of the end-users requiring good soil science. To address these concerns, Field et al. (2011) published a set of Soil Science Teaching Principles, developed through an Office of Learning and Teaching supported project, that have been recognised by the soil science community nationally and internationally. These include a clear set of learning outcomes involving the capacity to;

- Identify, understand and apply soil science’s unique disciplinary knowledge
- Understand the role, context and relationships of soil science to other disciplines and to society as part of our ecosystems
- Identify problems and design relevant contextual solutions
- Coordinate the function within and between relevant groups and effectively communicate results to practitioners in other disciplines and non-specialists, and
- Manage self for personal development and lifelong learning.

It has been demonstrated that adopting a curriculum where graduates can engage in real-world multidisciplinary soil related problems, including working with industry experts, is effective in supporting graduates to meet the learning outcomes.

Recommendation 8

Task the Soil Education Working Group of the National Soil Research, Development and Extension Strategy Committee (The National Soil Network) with developing

recommendations for the national adoption of the Soil Science Teaching Principles, and conveying these for consideration by the Australian Council of Deans of Agriculture, following endorsement by Soil Science Australia's Certified Practising Soil Scientist accreditation scheme.

Recommendation 9

Through the Deans of Agriculture, stocktake and where appropriate, improve government owned extension service capacity to guarantee timely, accurate and transparent information delivery to farmers Australia wide, including improving the career planning prospects for potential and current agricultural scientists

6. A biennial report to the Australian Government on the global soil, water and food situation

Australia's domestic natural resource management policy decisions and program operations have implications for our international reputation. I believe that the adoption of my recommendations for improving the management outcomes for agricultural land will enhance Australia's international reputation. However, international markets, policy norms and global soil, water and food security issues can change quite quickly, and it is important that Australia is well informed on the potential threats and opportunities associated with these changes.

6.1 Enhancing Australia's reputation in the global food system

The increasing importance of agricultural production and the contribution of food and fibre exports to Australia's prosperity is widely recognised. Australian agriculture also makes an important but modest contribution to global food security. There are bigger opportunities to share what we learn about developing sustainable agriculture in challenging environmental conditions through the provision of tertiary training, and the export of our agricultural research knowledge through research partnerships between Australian institutions and their counterparts in developing countries. We currently enjoy a 'clean' and 'green' image for our exported agricultural products, our agricultural consultants are well regarded internationally and our tertiary education institutions continue to attract students for agricultural training.

However, changing consumer preferences and societal expectations are increasing an international demand for 'sustainably' produced food and fibre commodities. As a result, governments, importers, manufacturers and retailers are increasing sustainability-related requirements. There is limited evidence to support claims of agricultural sustainability for Australia. We need to strengthen our position (through for example, wider adoption of regenerative farming practices and better monitoring of the resulting impacts on soil, water and biodiversity condition outcomes). We also need to be well informed, actively participate in international *fora* to promote Australia's sustainability narrative, influence policy and standard setting and provide regular updates on these issues for governments and industry.

6.2 We need to monitor global soil, water and food security

There is increasing evidence that humanity is driving global environmental change. By 2050 the global population is predicted to be in excess of nine billion. Additional population

pressures, particularly in China, India, Sub-Saharan Africa and the Middle East, are expected to exacerbate food and water shortages, and climate change in these and other regions is likely to result in deteriorating conditions for food production. These factors can threaten social cohesion, and trigger humanitarian and governmental crises with both a regional and global dimension.

For example, in our region, across the South West Pacific, threats to soil function in some countries are serious, and require immediate action to avoid large scale economic costs, social disruption and environmental losses. These threats, combined with other pressures caused by increasing population and climate change, are especially challenging on the atoll islands of the Pacific (McKenzie et al. 2015). More than a third of Australia's coastline is bordered by the Indian Ocean, and its littoral and island states are likely to play an increasingly important role in Australia's future. In this region, instability and conflict can quickly arise from imprecise border delineations, internal conflicts, issues of energy and resource security and changing national interests. A detailed understanding of the evolving nature of these regions is important to Australia. The government should receive a regular report – preferably annually – on the regional and global status of soil, water and food products. Future Directions International, an independent not-for-profit strategic organisation, of which I am the chair, is well qualified to lead the preparation of such a report.

Recommendation 10

Agree to the preparation of an annual alert report to the Australian government on the global soil, water and food situation from an Australian perspective through the auspices of Future Directions International, and in collaboration with the Office of National Assessments and other relevant organisations.

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Appendix A - National Advocate for Soil Health Terms of Reference (2015)

Mission: to provide strong leadership and advocacy on the importance of healthy soil, water and vegetation and the benefits thereof for all Australians.

The focus of this role is on raising public awareness of the importance of improving soil and landscape condition and soil information, and the critical role soil plays in underpinning agricultural productivity, delivering high quality ecosystem services and meeting global challenges such as climate change. Though appointed to this role by the Australian Government, the Advocate for Soil Health will not speak on behalf of the government.

Specified tasks	Implied tasks	Resources required
Advocate that the healthy condition of our soils must be a national priority.	<p>Convince a national audience of the importance of soil health, based on the integrated management of soil, water and vegetation through:</p> <ul style="list-style-type: none"> • One on one meetings with leaders and influencers; • Speaking engagements; • Engaging with schools to educate children; • Papers; • Media engagement and releases; • A webpage (to be managed by the secretariat). 	Secretariat support (including access to the department's media team).
<p>Report to the Australian Government on national priorities for soil and landscape science and management.</p> <p>Deliver an initial report to the Prime Minister, an interim report to the Minister for Agriculture, and a final report to the Prime Minister.</p>	Seek advice from technical experts and practitioners on current soil research needs, including identifying the current deficiencies.	<p>Access to Chief Scientist(s) for advice on coordination of research effort, including international efforts.</p> <p>Access to leaders of research bodies, including universities and research and development corporations.</p> <p>Support from the secretariat in compiling and drafting reports.</p>
Work towards ensuring that existing and new soils research meets the needs of Australia's farmers and other soil managers.	<p>Determine what information, encouragement and help farmers need to build soil health as a priority activity within their business.</p> <p>Engage with the National Implementation Committee for the National Soil Research, Development and Extension</p>	Opportunities to consult with land managers about their needs, and to encourage them to adopt soil health as a priority for their business.

Specified tasks	Implied tasks	Resources required
	Strategy through regular meetings and correspondence.	
Advocate for adequate knowledge and supporting systems to help farmers to actively build healthy soils.	Advocate for resourcing to be linked to Land Management organisations' contribution in delivering positive soil health actions 'on ground'. Ensure that training/education in soil health reflects best practice. Use case studies to communicate proven leading practices to farmers.	Review of current soil health and related fields education, with an emphasis on practical level organisations. Review of existing data on wider adoption trends.
Contribute to the Australian Government white papers on agricultural competitiveness and developing northern Australia.	Liaise with key stakeholders including technical and policy experts to develop relevant input for the development of the white papers.	Regular communications with the white paper taskforces within the Department of Prime Minister and Cabinet.

Appendix B – List of Activities

Since the first report was submitted in June 2013, the Advocate has pursued many hundreds of activities, meetings, speaking engagements and conference presentations. The following provides a brief summary of these activities:

Activity	Individual meetings, conferences and seminars, organisations
Parliamentarians	<p>Multiple meetings with:</p> <ul style="list-style-type: none"> • Previous Prime Minister: Abbott, • Previous Ministers: McFarlane, Truss, • Previous Assistant Ministers: Colbeck, Tudge • Ministers: Joyce, Hunt, Frydenberg, Nash, Tudge, Wyatt, Tehan, Scullion • Assistant Ministers: Hartsuyker, Zesolja • Members of Parliament: Fitzgibbon, Butler, Di Natale, Hanson, • The Coalition Backbench committee, Green MPs, Cross Bench members, • Jurisdictional Parliamentarians: WA Minister for Agriculture, Alannah McTiernan, Tasmanian Premier, Will Hodgeman, ACT Chief Minister, Andrew Barr
Commonwealth and Jurisdictional Departments	<p>Multiple meetings with senior officials from:</p> <ul style="list-style-type: none"> • Prime Minister and Cabinet • Agriculture and Water Resources • Environment • Tasmanian Department of Primary Industry • Western Australian Department of Agriculture • Northern Territory Department of Agriculture • South Australian Department of Primary Industries • NSW Department of Agriculture and Local Land Services • Bureau of Meteorology • ACAIR – Australian Centre for International Agricultural Research
Scientific Organisations	<ul style="list-style-type: none"> • Chief Scientist • CSIRO – CEO, Directors of Divisions, Senior Research Scientists involved in soil science, agriculture, environment, ecology and plants • The Academy of Science – CEO, Deputy CEO and senior members of the organisation • APVMA – Senior scientists and agricultural officers • Australian Soil Network • The Wentworth Group • Australian Rural Leadership • Many retired soil scientists • Geoscience Australia

	<ul style="list-style-type: none"> • Society for Sustainability and Environmental Engineering
Universities and other educational organisations	<p>Chancellors, Vice Chancellors and senior professors, researchers, lecturers and CEOs of institutions.</p> <ul style="list-style-type: none"> • Australian National University • Newcastle • Murdoch • Sydney • Western Sydney • Queensland • Tasmania • Western Australia • Curtin • Charles Darwin • Charles Sturt • La Trobe • Canberra <p>Primary Industries Education Foundation of Australia Nuffield Scholarship Australian Curriculum Assessment and Reporting Authority</p>
Farm Groups and related environmental organisations	<p>Speaking engagements and events with various farm support and extension groups in:</p> <ul style="list-style-type: none"> • Western Australia • South Australia • Victoria • New South Wales • Queensland <p>Meetings, seminars, workshops with CEOs, senior members of organisations and farmers represented by:</p> <ul style="list-style-type: none"> • National Farmers Federation • AORA • Landcare Australia – including State and Territory branches • Australian Landcare Network • Greening Australia • Research Development Councils – MLA, GRDC, Cotton Australia Horticulture Australia • Agricultural Industry groups and organisations • Stephanie Alexander • Gardening Australia Costa Georgiadis • National Botanical Gardens
Conferences	Presented at these conferences as opening key note speaker or plenary speaker:

	<ul style="list-style-type: none"> • Global Food Forum • RSL annual conference • National Soil Conference • World Soil Day • International Year of Soils • Australia Day • Rotary District conferences • Landcare National Conferences and regional workshops or conferences in Victoria and NSW • Landcare and Local Land Services annual conference • Rotary Urban Rural conference • WA farm group conference
International Influence	<ul style="list-style-type: none"> • United Nations Food and Agricultural Organisation Washington US • Global Soil Symposium address • US Deans of Agriculture • Luxemburg Ministry of Agriculture • Rwanda Ministry of Agriculture • China delegation • Discussions with High Commissioner for Fiji re regeneration of their agricultural land • Multiple discussions with Ambassadors from Saudi Arabia, Qatar, United Arab Emirates re regeneration of degraded land and input for agriculture. • The Club of Madrid former world leaders
Media	Multiple interviews for urban and regional radio across the country, substantial op ed pieces for The Australian newspapers over a period of 6 months and other print media copy.
	Recorded videos in lieu of attendance as key note speaker at conferences and dinner meetings of various organisations.
	You Tube presentations on the vital importance of soil, water and vegetation, supported by presentations from Jeff Kennett, Peter Costello, Fiona Simpson, Stephanie Alexander, Costa Georgiadis

Appendix C – Proposed Budget for the continuing role of the National Soil Advocate

1. This report recommends (Recommendation 2) that the position of National Soil Advocate be continued. The current National Soil Advocate, Major General Michael Jeffery, receives funding support because he is a past Governor General. This is provided through the Official Establishments Section of the Ministerial Support Branch in the Department of Prime Minister and Cabinet and includes office accommodation, administrative staff and travel expenses. All past Governor Generals are entitled to this support.

If a future Soil Advocate is not a past Governor General, then resources required to maintain a National Soil Advocate are estimated to be:

Resource	Function	% of FTE	Approx APS equivalent level
National Soil Advocate		0.8	SES Band 1
Personal Assistant	Provide assistance with phone calls, letters, meetings, travel bookings	0.8	APS 4/5
Researcher and writer	Provide up to date and relevant information and advice, written articles, letters, messages and speeches	0.6	EL 1/2

Travel and accommodation budget for attendance at conferences, meetings, seminars, national days and so on, usually to present key note or plenary addresses. Estimate: \$25,000 per year.

Office accommodation: to provide for the staff above. It could be a government department (this report recommends the Department of Prime Minister and Cabinet) or a not-for-profit organisation.