



HEALTHY SOILS FOR SUSTAINABLE FARMS

Program report

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Australian Government
Department of Agriculture,
Fisheries and Forestry



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Land & Water Australia



**Grains
Research &
Development
Corporation**

The Healthy Soils for Sustainable Farms Program has been managed by Land & Water Australia on behalf of the Australian Government Department of Agriculture, Fisheries and Forestry, and in partnership with the Grains Research & Development Corporation.





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Healthy Soils for Sustainable Farms Program Report, 2008. Land & Water Australia, Canberra.

Report compiled by Catherine Viljoen, Phil Price, Siwan Lovett and Lauren O'Connor.

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Executive summary

The Healthy Soils for Sustainable Farms (HSSF) Program was an Australian Government initiative funded through the Department of Agriculture, Fisheries and Forestry (DAFF). The Grains Research & Development Corporation (GRDC) was a major co-funder, and the HSSF Program was managed by Land & Water Australia (LWA).

The HSSF Program operated from 2005 to 2008, and its prime purpose was to get:

'more farmers moving to practices that maintain and restore our soils; which will, in turn, contribute to healthy catchments and sustainable agricultural enterprises'.

This contributed to the Australian Government's National Investment Stream outcomes to achieve:

- improved landholder and industry understanding of the complexity and interactions of natural systems so that management capacity in productive resource based industries is enhanced; and,
- improved productivity of resource-based industries, while maintaining the resource base, including best practice management systems and techniques for resource-based industries.

The HSSF Program had funding of \$6.5 million, and research organisations together with third parties provided a further \$10.3 million in cash and in-kind support for individual projects. Program expenditures are shown below.

Program component	Total expenditure (\$ million)
1. Adoption Projects	4.358
2. Strategic Projects	0.818
3. Communication	0.592
4. Monitoring and evaluation	0.073
5. Program operations	0.667
Total expenditure	6.508



Photo Roger Charlton.



Photos left to right: top LWA, HSSF Program; bottom AUSVEG, BFA.

The HSSF Program brought together industry groups, government agencies, research organisations, grower groups, farm advisors, extension officers, natural resource management (NRM) staff and catchment authorities, to collaborate in a series of projects across major agricultural regions. The projects aimed to encourage farmers, industry and the community to better understand and manage their soil resources, with this effort leading to the development and uptake of best management practices (BMPs) and soil management tools. The HSSF Program investment strategy focused on raising awareness, communicating management principles for healthy soils, providing measurement and assessment tools, demonstrating results, and providing guides and materials for education and training courses. It is conservatively estimated that the HSSF Program had contact with at least 30,000 people, providing general information about healthy soils and their benefits, as well as providing specific information for local commodity-based rural industries and communities. Over 17,000 farmers, advisors, extension and NRM staff were involved in at least one HSSF activity, such as education and training workshops, practical field demonstrations, soil assessment training, seminars and field days. The HSSF Program has developed a large legacy in the form of locally-relevant soil health guides, soil assessment tools and best management practices, new soil health indicators, local or regional soil assessment programs, education and training materials (some registered for National Training Information Service accreditation), and a web-based Soil Health Knowledge Bank that provides a national entry point and links to more detailed knowledge about soil management.



Photos left to right: top LWA, DPI Victoria, QDPIF; bottom DPI Victoria.

... the HSSF Program had contact with 30,000 people, and 17,000 farmers, advisors, extension and NRM staff participated in workshops, field days, and soil assessment training ...

The HSSF Program achieved high participation rates, uncovered significant demand for information about soil health, and successfully delivered a range of products, workshops and forums. This was achieved despite difficult drought conditions. The HSSF Program produced new guides about the key principles of healthy soil management that brought together and collated knowledge that was formerly scattered and difficult to access. The HSSF Program also developed and demonstrated new methods for assessing soil health, including aspects of soil biology, and new soil health indicators. Soil health demonstration sites were established in many agricultural regions and will continue beyond the end of the Program, and its many legacy products will underpin continued education and training in managing for healthy soils.



Growers gain from participating in the HSSF Program

Of the growers involved in HSSF-supported work with the Liebe Group, 100% said they got a lot out of their involvement in the project. All growers also perceived it to be a worthwhile process which gave credible and informative results which they could potentially use to assist with making effective decisions in relation to soil management within their farming enterprises.

One of the growers, Colin Cail (pictured below with wife Ruth), has always had a strong focus on soil health and has supported its importance in agricultural systems. Following involvement in the project, Colin has made more strategic decisions about his liming, deep ripping and fertiliser regimes which are implemented across his farming enterprise, in particular for his lower-performing deep, acidic 'wodjil' sands.

"Being involved in the project has confirmed the need to rectify soil pH, improve organic carbon levels and fertilise appropriately on poor performing wodjil sands," Colin said.

"Although these wodjil soil types are challenging to manage and generally have low yield potentials, it is important to opt for management strategies which focus on improving organic carbon levels and alleviating soil constraints such as low pH (through, for example, stubble retention and liming). These strategies are essential if we are to maintain the soil resource into the future," he said.

Further investment in improving soil health, especially under increasing climate variability, is now required to build on and expand the strong base provided by the HSSF Program.



1. The HSSF Program

The Australian Government established the HSSF Program as a result of an election commitment in 2004 that recognised the importance of healthy soils in underpinning the long-term sustainability of productive agriculture. A healthy soil is defined as one that is productive and easy to manage under the intended land use. Healthy soils have chemical, biological and physical properties that promote the health of plants, animals and humans, and contribute to profitable farming systems and growing regional economies as well as maintaining the environmental condition of our natural resources.



Wheat photo: DPI Victoria. Other photos: CSIRO.

Following European settlement and the introduction of some farming practices now known to be unsuited to Australian conditions, degrading processes, including erosion, structural decline, carbon depletion, nutrient loss, acidification and salinisation have accelerated. These processes threaten the short and long term sustainability of productive agriculture. The HSSF Program was established in response to these threats, and aimed to raise awareness about the need to improve soil health by assisting farmers to adopt good soil management practices.



Photos HSSF Program.

Working with people who manage soil, or who provide advice or planning for soil management, has been the key to the success of the HSSF Program. Activities have focussed on raising awareness, education and training in healthy soil management principles, self-directed soil testing, and adoption and evaluation of improved management practices. The majority of Program investment enabled the synthesis of existing soil health information, and its proactive communication and demonstration to farmers and their advisors through soil health guides, training workshops and events, development of soil assessment and monitoring tools, field days and demonstration sites.

There has been a significant demand for knowledge about soil health and how it affects production, profit and sustainability from farmers who, despite the drought, have been keen to access the workshops, field days and information provided through the Program. Overall, the HSSF has been successful in putting the topic of soil health at the forefront of rural science investment, and in establishing effective collaboration between state departments, rural industries, and farming systems groups through regionally-based projects. Only part of the identified demand could be serviced by the Program, and it is hoped that the products, training courses and field days can continue with a second phase of investment.

HSSF Program objectives

Market surveys undertaken at the commencement of the Program showed that farmers and agronomists working in soil management were interested in the same things. Questions ranged from how to define and measure soil health, to how it affects productivity and environmental condition. Respondents were also interested in understanding more about the interactions and linkages between the physical, chemical and biological features of different soil types, and the benefits versus costs of improving soil management. Those surveyed wanted easier access to information about the relationship between soil health and infiltration, soil fertility, soil erosion, crop rotation and soil structure and compaction. These findings supported the HSSF Program's overarching aim which was to:

“Establish, promote and implement the links between soil health, rainfall management, agricultural production and water catchment management.”



Photos from left: HSSF Program, DPI Victoria, MSMG.

Four HSSF Program objectives were developed to achieve this aim and these are outlined below. The relevant areas of HSSF Program investment are listed in parentheses against each of the objectives.

1. Evaluate agricultural management options based on local-scale healthy soil processes (Strategic and Adoption Projects).
2. Develop efficient systems for monitoring soil from paddock level to the surrounding catchment level (Strategic and Adoption Projects).
3. Develop tools to help producers measure, record, monitor and adaptively manage the health of their soils (Adoption Projects and Knowledge Bank).
4. Provide opportunities for learning about soils and their management (Adoption Projects and Knowledge Bank).

These objectives have been achieved through a combination of research, demonstration and communication projects (see Table 1 for investment details), with outputs and outcomes reflecting the strong, practical end-user focus that has characterised the HSSF Program's investment approach.

HSSF Program outputs

In meeting these objectives, expected outputs from the Program were:

1. development and increased uptake of best management practices and tools for producers in relation to soil management;
2. successful delivery of Adoption Projects to encourage farmers, industry and the community to better understand and manage their soil resources;
3. submission of Healthy Soils Reports from all Adoption Projects;
4. organisation of a regional forum with farmers, scientists, NRM groups and other stakeholders and production of Healthy Soils Symposium Papers; and,
5. production of a Program Evaluation Report.

HSSF Program outcomes

It was anticipated that the HSSF Program objectives and outputs would enable the overarching outcome for the HSSF Program to be accomplished. This outcome is a practical statement about the adoption of new and improved soil management practices to maintain and improve production and economic and environmental sustainability:

“The Healthy Soils for Sustainable Farms Program aims to have more farmers moving to practices that maintain and restore our soils; which will, in turn, contribute to healthy catchments and sustainable agricultural enterprises.”



Photo BFA / SSA

Specific outcomes anticipated from the HSSF Program were:

1. increased understanding and agreed knowledge by farmers about the role of soil health in supporting sustainable farm businesses and healthy catchments through variable circumstances, as evidenced by reports and their acceptance at regional and national symposia;
2. more farmers aware and knowledgeable about soil health issues, as evidenced by the number of farmers involved in Healthy Soils initiatives;
3. more service providers to farmers being aware, knowledgeable and supportive of soil health factors, as evidenced by their use of tools and guidelines generated by the HSSF Program; and,
4. increased adoption by farmers of best management practices for soil health and production outcomes, as evidenced by farm management surveys.

These outcomes contributed to the Australian Government's National Investment Stream (NIS) outcomes that are to achieve:

- improved landholder and industry understanding of the complexity and interactions of natural systems so that management capacity in productive resource based industries is enhanced (principal NIS outcome); and,
- improved productivity of resource-based industries, while maintaining the resource base, including best practice management systems and techniques for resource-based industries (other NIS outcome).

The HSSF Program objectives, outputs and outcomes are reflected in its investment strategy, which focused on raising awareness, communicating management principles, providing measurement and assessment tools, demonstrating results, and providing guides and materials for education and training courses. This emphasis on practical aspects of soil management was delivered through projects that worked with agricultural and horticultural industries, regional catchment authorities, NRM bodies, farmers and farmer groups, advisors (both public and private), government agencies and non-government organisations.

2. HSSF Program partnerships

The cash budget for the HSSF Program included \$5.0 million over three years (2005–2008) provided by DAFF, and \$1.2 million provided by the GRDC; the total, including interest and sundry income, was \$6.5 million. Land & Water Australia managed this investment on behalf of DAFF and in partnership with GRDC. This investment was allocated against five areas of activity, as shown in Table 1 below (all financial data in this report are exclusive of GST).

Table 1: Healthy Soils for Sustainable Farms budget overview

Program component	Total expenditure (\$ million)
1. Adoption Projects	4.358
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Photo: Roger Charlton.

Adoption Projects aimed to collate and interpret existing soils information for particular industries or regions, and to deliver it to as many farmers, advisors, extension and catchment staff as possible. The Strategic Project investments, including the Healthy Soils Knowledge Bank — a key Program legacy, were made to generate new understanding about particular soil management issues. Communication activities raised awareness of the HSSF Program and its projects, provided regular updates about progress and new soils information, and included the very successful National Healthy Soils Symposium. Monitoring and evaluation (M&E) recorded progress by projects in meeting HSSF Program outputs and outcomes and provided the quantitative data for twice-yearly reports to DAFF. Operations supported all aspects of HSSF Program management.

Organisations undertaking the major HSSF projects, and third parties involved in those projects, contributed their own resources (cash and in-kind) to the HSSF Program.



Photo at left Mary Goodacre. Others BFA / SSA.

Organisations undertaking HSSF projects

- Australian Wool Innovation Limited
- AUSVEG Limited
- Cotton Catchment Communities CRC
- Biological Farmers of Australia
- Mid-Loddon Sub-catchment Management Group
- SoilTech Soil and Pasture Consulting
- Department of Primary Industries, New South Wales
- Department of Primary Industries & Fisheries, Queensland
- Department of Primary Industries, Victoria
- Queensland University of Technology
- University of Western Australia

Third parties

- Avon Catchment Council
- Condamine Alliance
- Dairy Australia
- Gwydir Border Rivers Catchment Management Authority
- Namoi Catchment Management Authority
- Queensland Murray Darling Committee Inc.
- Birchip Cropping Group
- Canegrowers
- Mallee Sustainable Farming Inc.
- Southern Farming Systems Limited
- Cotton Research & Development Corporation
- Meat & Livestock Australia
- Department of Agriculture and Food, Western Australia
- Department of Primary Industries, New South Wales
- Department of Primary Industries, Victoria
- Rural Solutions, South Australia



Photo above Cotton Catchment Communities CRC/NSW DPI. Below HSSF Program.

While partnerships of this nature carry high transaction costs, there have been considerable benefits from the Program working with a wide range of organisations and being able to access existing information, networks and knowledge about how different end-users manage soil. Farmer networks and rural R&D corporations have been a key delivery pathway for HSSF Program products, while the HSSF Program has also been able to tap into the growing interest of regional NRM bodies in sustainable agriculture and to provide information and training to their staff. The research providers enabled the Program to access the best available science and present it in ways that are relevant and meaningful for end-users, as well as bringing scientific and technical skills to examine on-ground problems in soil management. The many extension and consultant service staff who participated in the Program provided practical insights into managing healthy soils and ensured that HSSF was firmly grounded in the realities of day-to-day soil management. They were a key target audience because of their direct involvement with farmers and their ability to extend training in soil health.

The 'intelligence' gained from working with these groups, has enabled the HSSF Program to meet end-user needs in practical, relevant and intuitive ways. Representatives from these partner organisations have been closely involved with the HSSF Program from inception through to completion, and this has ensured that their priorities have been met to the greatest extent possible. For all the organisations involved, being able to provide targeted, good quality soil management information for farmers across Australia has been the overriding outcome. The success of the HSSF Program in achieving this outcome is a direct result of the effort that has been made in developing and maintaining strong, enduring partnerships.





Photo AUSVEG.



3. HSSF Program components

A summary is provided below of the activities funded in each of the five components listed in Table 1, with Section 6 of this report providing more detail about the major projects undertaken.

Healthy Soils Adoption Projects

Healthy Soils Adoption Projects were by far the main component of the HSSF Program, and aimed to collate knowledge about best soil management practices, and to provide and demonstrate it to end-users. These projects were developed from an open call for proposals that required applicants to consider four themes when submitting their bids.

1. **Local best management practices.** Documenting best management practices and decision support tools, demonstrating best management and monitoring, conducting participative research or running forums, field days and training programs.
2. **Understanding soil health, productivity and profit.** This theme was concerned with understanding how soil management influences the 'health and condition' of soils, as well as the consequent production and profitability gains that result from using particular management practices.
3. **The consequences for the broader environment.** This theme was focused on assessing the implications of best management for the local environment, for example, the amount and physical and chemical attributes of run-off to the catchment, dust generation, and any greenhouse gas emissions or carbon sequestration. It also included analysis of community values as expressed in local Natural Resource Management Plan environmental targets.
4. **The consequences of variability.** Noting how the above are likely to be affected by our variable climate (drought and floods etc.) and commodity prices, this theme was focused on assessing recommended soil management practices to ensure they are resilient in the face of variability.

The 10 large projects funded under the Adoption component made up the core of the HSSF Program (see Section 6 for details). Working with different industries (cotton, grains, vegetables, meat, sugar, dairy, wool) or regions (southern Western Australia, Victoria and South Australia, northern New South Wales and southern/central Queensland), they addressed the four requirements listed above within the context of local needs, issues, land uses and landscape characteristics. How the four requirements were met is described overleaf.

1. Developing local best management practices

Several projects undertook a market survey of farmers, advisors, extension and NRM staff to identify locally-relevant soil health issues, and the communication and demonstration pathways preferred by those groups; results were used to guide the structure and content of the project. Existing knowledge about healthy soil management was drawn together from multiple sources and collated into a single reference source. This material was then interpreted to match the specific needs and issues of the industry or region. Healthy soil guides were prepared and published. These described the key attributes of healthy soils, how to assess and test for soil health, the benefits of healthy soils for both production and environment, and the crucial principles for management to improve soil health. The principles were then demonstrated and further refined to prepare local best management practices.

A Healthy Soils module for the *Making More From Sheep* publication

Launched in January 2008, *Making More From Sheep* aims to raise awareness among sheep producers (and the wider sheep industry) about the new, 'one-stop-shop' best practice sheep management information package developed jointly by Australian Wool Innovation Limited and Meat & Livestock Australia; and how they can access it. The Manual includes a section funded by the HSSF Program that explains the principles of soil health and the practical steps that sheep producers can take to maintain or improve it. In the three months after the launch, 561 hardcopy manuals were sold, 442 CDs were ordered, there were 6957 website visits, 363 downloads of the complete manual and 68 downloads of the Healthy Soils module with 132 page views of the Healthy Soils module.

Photo courtesy *Making More From Sheep*, Australian Wool Innovation and Meat & Livestock Australia.



Field demonstration on local farms with active participation by grower groups ensured that the principles had practical ground-truthing. Several projects provided workshops on specific local issues, and developed education and training programs to respond to needs identified by participants. Workshops generally included explanation and discussion of soil management principles, followed by a session in the field to show and test their practical application to farm operations. Several projects matched their workshops and training programs to the National Training Information Service learning outcomes to enable formal accreditation, and these programs now form an important part of the HSSF Program's legacy.

Several projects developed and tested new techniques in healthy soil management, for example, the use of locally-available 'biological' materials as sources of soil organic matter and nutrients, or new soil testing methods and test kits. Hands-on demonstrations of how to assess soil health provided skills and confidence for growers and advisors to undertake this task much more regularly, and provided a large set of new soils data which has been integrated into state and national soils databases. A wide range of communication methods were used to reach as large an audience as possible, including published soil health manuals and guides (hard copy and electronic), workshops, field days, local and regional seminars and symposia, newsletters and articles in local media, press releases, public launches and events. Consideration was given to the particular needs of special audiences, for example, people working in the vegetable industry whose primary language is not English. Special DVD versions were made of the industry's *Ute Guide* for this group.

Healthy Soils for Sustainable Vegetable Farms Ute Guide

The *Healthy Soils for Sustainable Vegetable Farms Ute Guide* is a handy reference that can be kept in a farm vehicle, so that if growers observe something that may be a problem with their soil, they can quickly look it up and decide what may need to be done or if outside help is needed.

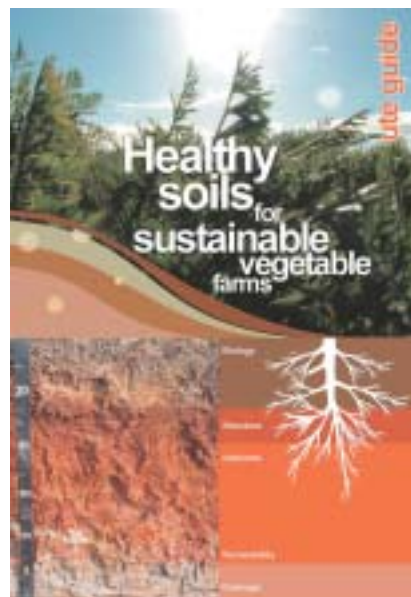
The Guide, launched at the National Vegetable Expo, Werribee in 2007, is a pictorial reference which assists vegetable growers to measure and record the health of their soil, and to put into place management practices which will encourage the sustainability, productivity and profitability of their farms.

AUSVEG's Environmental Manager Helena Whitman believes that the Guide is a valuable resource, as it has been tailored to the specific needs of vegetable growers.

"Historically, there has been little information of specific relevance for vegetable growers. Many growers have a general understanding of their soil, however they are always looking for ways to enhance production and profitability for their businesses, without degrading the sustainability of their soil," Helena said.

In conjunction with the Guide, growers also have access to an instructional CD/DVD. This resource is ideal for time-poor growers, as well as for growers with non-English speaking backgrounds, as the CD/DVD has practical demonstrations and images and verbal descriptions that assist those growers with either literacy or language difficulties.

This HSSF project also provided a series of Soil Interpretation and Management courses run nationally to assist vegetable growers in each state to learn more about their soil profile, to identify and interpret soil structure and chemistry, to restore or improve the health of the soil, and to select the appropriate crop for the soil with the least impacts on the broader environment.



The huge success of this component of the HSSF Program is shown by the fact that over 17,000 farmers, advisors, extension officers and NRM staff have attended at least one HSSF activity. The map and diagram below show where the many workshops were held, and the numbers attending in each state. Brochures, newsletters and displays produced by the Adoption Projects had a distribution of over 30,000 to producers, agronomists, extension officers, farm consultants and NRM staff.

Figure 1: Location of HSSF Program workshops, seminars, field days, demonstration sites, symposia and other events. The sizes of the dots indicate the number of people attending

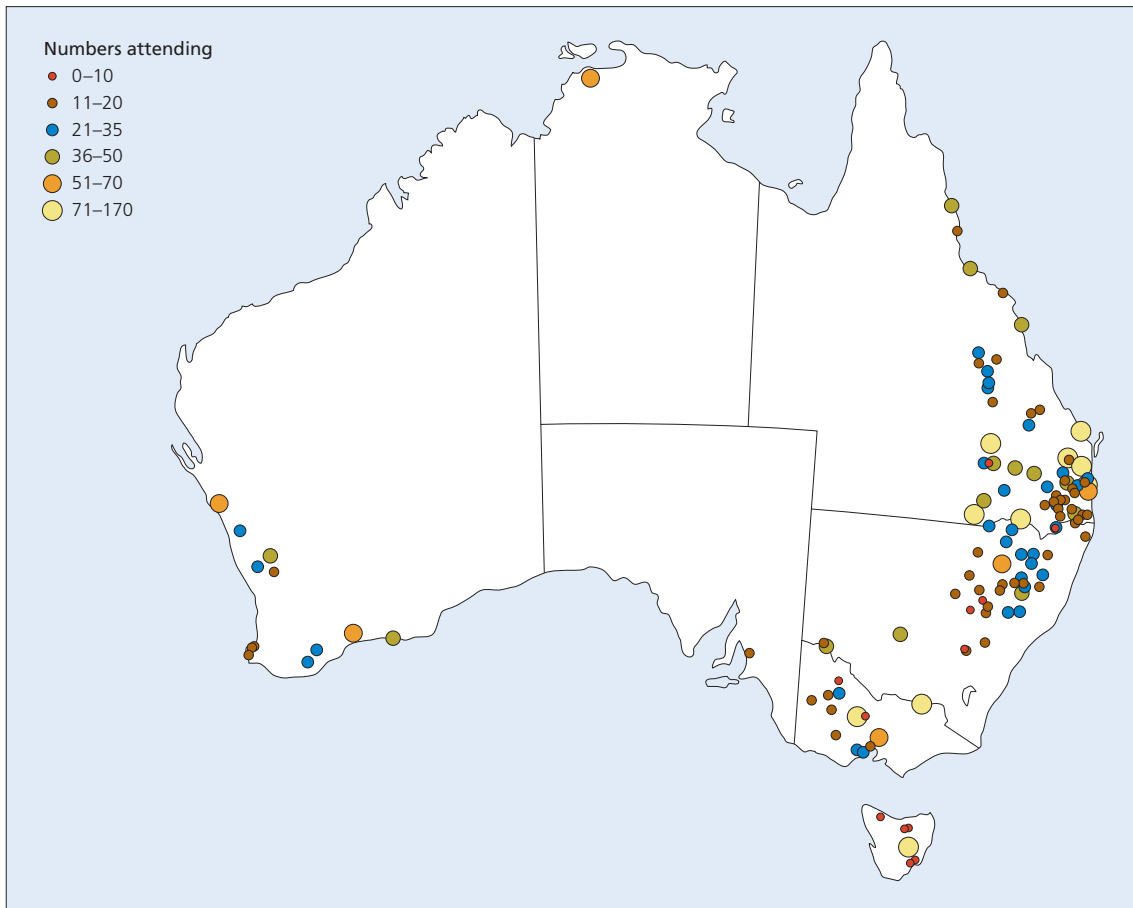
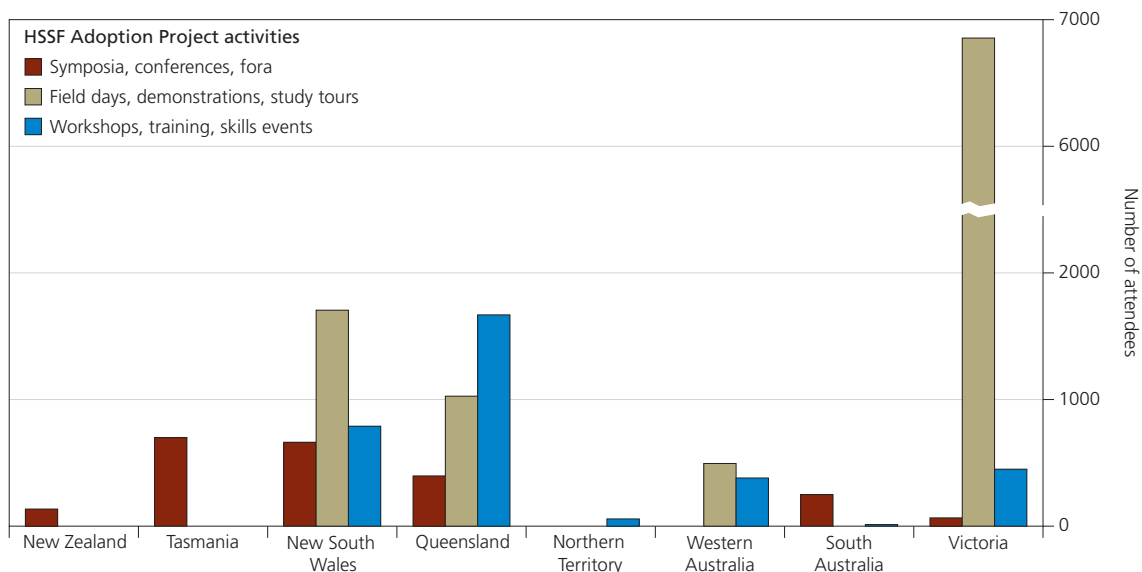


Figure 2: Number of people attending different types of events by state and territory, with one event held in New Zealand



2. Understanding soil health, productivity and profit

All Adoption Projects related changes in soil health to productivity and profit. A key finding from the market surveys was that this was the topic about which farmers and advisors were most interested. In order to go beyond raising awareness and to achieve on-ground practice change, soil managers needed to be confident that resources used to improve soil health would provide a return to their business. HSSF projects worked with local groups to identify soil problems that limited productivity or increased risk, and used the soil health principles to develop and test methods to overcome them. Problems addressed by these projects included declining fertility, loss of soil structure, difficulty and risk in crop or pasture establishment, compaction, acidity, and increasing costs of agricultural inputs in relation to prices received. Soil management methods demonstrated and tested by the projects included retention of crop residues and inclusion of a pasture phase in cropping rotations, other methods to increase soil organic matter, reduced or no-tillage, ripping and amelioration with lime or gypsum, and using low-cost and locally available materials (e.g. manures, rock dust) as a substitute for expensive and energy-intensive artificial inputs.

The regional soil health guides prepared by Adoption Projects, as well as the HSSF Soil Health Knowledge Bank (discussed in detail later) include case studies of farmers who have adopted healthy soil management practices and increased profitability. These case studies are an effective way to encourage others to test the management principles for themselves.

It is too early to assess the overall impact of the HSSF Program on changes in on-ground soil management (although several projects undertook a baseline survey of growers' current practice, so a repeat survey could be used to evaluate this), but the results of workshop evaluations clearly show that participants believe they have gained new knowledge and an understanding of how soil health affects production and profit. Many farmers reported that they intend to change their approach to soil management as a result of the HSSF Program.

Farmer quotes from project AWI 3 (more details page 42)

"The best thing I have done is a test strip for fertiliser, and the Healthy Soils module in *Making More From Sheep* has a tool that shows you how to set up a basic test strip. It's a great tool."

"The Healthy Soils module is very well set up — there are areas you can read through quickly and gain a lot from."



Photo NSW DPI.

Soil health test kit

The soil health kit developed by Queensland University of Technology (QUT) includes a series of simple field-based tests to identify the effects of management practices through interpretation of soil properties. Landholders can assess changes in soil properties to quantitatively benchmark management practices that can best enhance soil health and relate them to economic performance (yield and returns).

The core tests included in the kit are: soil respiration (biological activity), infiltration, bulk density, electrical conductivity, pH, soil mineral nitrogen, aggregate stability, slaking, earthworms, soil physical observations, and water quality.

The approximate wholesale cost of a kit is \$800. Training in the use of the kit was provided via on-farm workshops where both a qualitative soil health scorecard (using landholder observations) and kit were demonstrated and used under field conditions.

Seventy kits were constructed and provided to landholder, industry or catchment groups within the project region (Queensland Sunshine Coast south to Woodburn in New South Wales) and through other HSSF projects to other regions.

A total of 36 soil health workshops were completed by this project, attended by 800 people. Soil health concepts, scorecards and soil health kits were demonstrated in a classroom situation, prior to practical applications in a field setting.

A *Soil Health Assessment Manual* was developed to provide both a detailed description of the methods of the test kit assays, as well as examples of the calculations required. Over 500 manuals were distributed to workshop attendees.



Photo QUT.



Photo DPI Victoria.

3. The consequences for the broader environment

This topic was also included in all Adoption Projects, with the potential for win-wins from improving soil health emphasised. Matching nutrient inputs with crop and pasture needs was a consistent theme, especially with the rapid increase in fertiliser prices. Increasing soil organic matter (SOM) for its ability to both recycle and 'hold' nutrients in the profile with less leaching to below the root zone, and use of biological sources of nutrients, were also common topics. Reducing wind and water erosion to retain valuable soil and nutrients on the paddock and prevent off-site losses was a typical win-win scenario. Other potential environmental effects of improving soil health, such as reduced deep drainage and salinity risk, reduced risk of subsoil acidity, and maintaining soil biodiversity were also included.

Howard Hepburn (left) and Lachlan Ralton
(Mid-Lodden Sub-catchment Management Group [MSMG])

"We aim to reduce expensive and possibly detrimental chemical and artificial fertiliser applications to our farm paddocks through biological farming methods. An increased understanding of the biological processes in our soils will hopefully assist us to enhance and protect our valuable soil ecosystems rather than blindly damaging them. This project will help to increase awareness of the role of biological farming methods in our agricultural system and ultimately lead to a more sustainable enterprise."



The potential to mitigate climate change by reducing greenhouse gas emissions, and by storing carbon in soil, were also covered under this topic. Methods to reduce cultivation, fossil fuel use (e.g. through precision guidance or controlled traffic systems) and nitrous oxide emissions were investigated, and aimed to help agriculture reduce its overall emissions profile. Management to retain plant residues, and other ways to build up soil organic matter (for example, with manure or composts) were also explored. Given the continued depletion of SOM from pre-cultivation levels across Australian soils, there may be opportunities for more win-wins by storing soil carbon, and at the same time improving soil health and productivity.

John (pictured with son Dan) and Kerry Steel
(MSMG)

"Sustainable farming practices and soil health are the corner stones of building a successful farm business. We have been continuously cropping large areas of our land for over 10 years, and soil testing and monitoring inputs has been essential.

"There is much in agriculture we can't control, however healthy soils and sustainable practices are our best opportunity to be successful. The decisions we make regarding sustainable practices and soil health now, will cement our place in profitable agriculture for generations to come."



Photos this page MSMG.

4. The consequences of variability

Growers and advisors were clearly aware of some of the potential consequences of an increasingly variable climate. Projects addressed the issue of soil health as one way of responding to this increased risk. It was recognised by many farmers that improving infiltration and water holding within the profile will be crucial if agriculture is to make maximum use of the rainfall or irrigation water available. Optimal soil structure and fertility are then required to turn that water into useful biomass as crop yield or animal growth. Increasing climatic variability will also encourage growers to hold off applying expensive inputs until the seasonal conditions become clear (i.e. post-emergence application of nutrients to crops), and/or to substitute lower-cost alternatives. The Adoption Projects canvassed and demonstrated these opportunities, with strong interest from project participants.

Leigh Hercus and Kerry Punton (MSMG)

“With future retirement in mind, we are endeavouring to improve our economic and physical environment and make our farming enterprise sustainable. We are experimenting with soil biology, stock management and sowing techniques to leave our land in a better condition than when we started farming.”



Photo MSMG.

Delivering workshops on low input farming approaches to soil health management for landholders in south east Queensland (Biological Farmers of Australia)

Recorded observational and measured data show the results of changed practice, including examples of large increases in production and profit as well as stock health. Surveys showed that following the workshops (that attracted 400 attendees) over 85% of farmers reported they understood the importance of humus and soil organic carbon, more than 75% commented that they gained a better understanding of the role of integrated farming systems in achieving healthy soils, and nearly 90% of farmers who completed the feedback survey were going to implement one activity to improve soil health on their farm over the next two weeks. Examples included the efficient use of effluent and local manures on dairy farms, comprehensive water and soil analysis on marginal soils, crop rotations and improved grazing techniques.



Photo LWA.

Healthy Soils Strategic Projects

Projects in this component aimed to develop new scientific or technical knowledge about particular aspects of healthy soils, or to provide the major information legacy from the HSSF Program. It included the projects 'Accounting for nutrients on Australian dairy farms' and 'Identify farm management practices that promote healthy soils, and investigate the use of a soil health index to monitor changes in soil health'. The development of the HSSF Program Soil Health Knowledge Bank was also funded from within this component. Each of these projects is discussed in the following section.

Accounting for nutrients on Australian dairy farms

This project was set within the context of dairy operations in Australia continuing to intensify and the potential for nutrient surpluses within the dairy landscape increasing. The Australian dairy industry needs a rigorous and standardised approach to nutrient accounting on dairy farms to assist farmers make profitable fertiliser decisions and meet increasing demands for improved environmental standards. The 'Accounting for nutrients' project undertaken by the Department of Primary Industries, Victoria will develop a standardised nutrient accounting framework for the Australian dairy industry that will better quantify nutrient inputs, outputs and within farm nutrient efficiencies, and reduce nutrient accumulation and losses off-farm. This national project includes all dairying states: Victoria, New South Wales, Western Australia, Tasmania, South Australia and Queensland, and will enhance the collaboration between fertiliser companies, dairy industry stakeholders, state and federal government science and policy, and dairy farmers and advisors. The project is still underway.



Photo Jenny O'Sullivan.

Identify farm management practices that promote healthy soils, and investigate the use of a soil health index to monitor changes in soil health

This project aimed to use a large database of geo-referenced and analysed soil samples available in Western Australia to test whether some of the soil parameters measured could be used to develop a soil health index. The initial hypothesis was that soils with a near neutral pH and high organic matter content are more healthy, and that some relatively simple indices based on measured soil characteristics could be used to assess soil health and its trend over time. After potential indices were examined, Western Australian farmers with soils of varying health were interviewed to determine which of their management practices (such as liming, fertiliser use or including pasture in rotation with crops) had been contributors to the formation and maintenance of healthy soils. Soil health indicators varied with rainfall, but some may prove useful for measuring changes in soil health over time at a particular location.

HSSF Program Soil Health Knowledge Bank

The web address for the HSSF Program is: www.healthysoils.gov.au

The web address for the HSSF Soil Health Knowledge Bank is: www.soilhealthknowledge.com.au



An important output from the HSSF Program is the HSSF Soil Health Knowledge Bank. This project has consolidated current knowledge and experience in managing healthy soils into one, easy to access website, with a range of supporting documentation, workshop material and activities. Development of the Soil Health Knowledge Bank ensures that all regions and industries have equal access to the best possible knowledge and assistance. It also provides clear and consistent messages about the attributes of healthy soils, and the management practices farmers need to use to sustain biological functioning, maintain environmental quality, and promote plant and animal health. The six 'characteristics' of healthy soils, and the ten 'habits' of healthy soil farmers are key messages developed through the HSSF Program.



The six 'CHARACTERISTICS' of healthy soils

1. The level of soil organic matter is maintained
 - *Functionality maintained* (substrate, role in soil structure, ground cover)
 - *Net carbon sequestration*
 - *SOM level matching land use and soil texture*
2. Soil fertility is optimised
 - *Nutrient additions at least match removals and losses*
 - *Fertility is adequate for land use*
 - *Nutrient storage capacity is maintained*
 - *Minimise nutrient loss off-site*
3. Optimised water entry, storage and supply
 - *Water infiltration, permeability and storage maximised to meet land use needs*
 - *Drainage is minimised where there is risk of dryland salinity or acidification*
 - *No constraints to water use* (supply function)
4. Enhanced soil biological function
 - *Resilient and diverse biological community* (self-regulating)
 - *Biota undertake key functions, such as nutrient recycling*
 - *Optimal biological functioning* (efficient, beneficial, dynamic)
 - *Absence of disease expression*
5. Supports productive land uses
 - *Supports plant growth/land use requirements*
 - *Maintains resource condition and ecosystem services*
6. Enhances environmental and community health and well-being
 - *Healthy soils = healthy food = healthy people*
 - *Profitable whilst conserving soil resource and reducing environmental impact*
 - *Fit for purpose*

Soil health refers to the condition of the soil and its potential to sustain biological functioning, maintain environmental quality, and promote plant and animal health.

The **resistance** of a soil refers to its capacity to retain function during stress or disturbance, whilst its **resilience** refers to how quickly it recovers after stress or disturbance.



Photo DPI Victoria.

The ten 'HABITS' of healthy soils farmers

1. Maintain organic matter and ground cover

- *Retain organic matter and maximise ground cover*
- *Incorporate rotations and farming systems to support plant diversity*
- *Maintain and enhance native and riparian vegetation extent and condition*
- *Manage grazing (stocking rates; grazing interval) to maintain ground cover*
- *Optimise cropping frequency, perennial and pasture rotations, for multiple benefits*
- *Minimise soil disturbance*

2. Balance (targeted) application of inputs to maintain soil fertility

- *Apply nutrient budgeting and nutrient replacement with targeted inputs of macro and micro nutrients*
- *Use appropriate ameliorants addressing the soil condition (e.g. gypsum, compost)*
- *Time application of inputs to reduce risk of losses and off-site impacts*
- *Manage rotations to assist in maintaining soil fertility*

3. Maintain healthy plant growth

- *Integrate disease and pest management and use a mix of control methods*
- *Optimise agronomic management*
- *Measure and manage for increased water use efficiency*

4. Manage for soil structural stability

- *Smart tillage i.e. fit for system/purpose/intent and timed to match soil condition*
- *Minimise area of soil affected by traffic through use of controlled or 'low impact' traffic systems*
- *Implement minimum or zero tillage farming systems (including pasture cropping) for carbon sequestration, reduced greenhouse gas emissions, optimal water infiltration, reduced soil erosion, energy efficiency, and to enhance soil biology*
- *Prevent soil structural loss*
- *Implement appropriate grazing management systems to maintain soil condition*

5. Monitor and evaluate soil constraints

- *Identify specific soil constraints (e.g. acidity, compaction)*
- *Monitor for extent and severity (strategic soil testing, observation)*
- *Determine potential costs versus benefits of amelioration*
- *Manage and monitor for change (continuous improvement)*

6. Understand soil limitations — fit for purpose

- *Understand soil type and limitations related to potential land uses*
- *Match enterprise to land use capability*



Photo LWA.

7. Learn for continuous improvement

- *Seek diverse and reputable sources of information*
- *Use on-farm testing (what/how are you sampling?, replicated test strips, sampling strategy, analyses) and observation*
- *Adopt, adapt and innovate*

8. Value the balance between production, and ecological and environmental services

- *Acknowledge key interactions between physical, chemical and biological soil properties*
- *Investigate farming strategies that minimise environmental footprints (i.e. reduce energy use, greenhouse gas emissions)*
- *Recognise the value of biodiversity and manage it within the landscape*

9. Invest in profitable strategies to enhance soil health

- *Recognise the value of your soil health resource*
- *Gradational change can result in improved soil condition*

10. Manage for climatic variability

- *Manage for changing rainfall patterns and climatic extremes*
- *Use increased resilience of soils and land use systems to buffer climate variability*

These six 'characteristics' of healthy soil and ten 'habits' of healthy soils farmers provide the foundation upon which the Soil Health Knowledge Bank has been developed. The resources provided through the Soil Health Knowledge Bank all aim to explain the 'characteristics' of healthy soil and support farmers in getting into the 'habit' of managing their soils to maximise 'health'.

Project forums, workshops sessions and discussions have been used to identify key messages for healthy soils, as well as to provide consistency in resource information and delivery. It was decided that web-based delivery was the most appropriate mechanism to build and deliver the Soil Health Knowledge Bank. Three 'hooks' were developed as ways to enter the Soil Health Knowledge Bank resources.

Hook 1: I want to solve a soil health problem

This is diagnostic and supports both a technically informed approach (i.e. soil testing and record keeping), and a problem solving approach (i.e. visual indicators).

Hook 2: I want to do better

This is a positive approach based on agreed healthy soils messages, as well as providing access to what other farmers are doing.

Hook 3: I want to increase yield and profitability

The production approach is based on working against benchmarks for yield.

These 'hooks' provide people with a number of different entry points: (1) technical soil information and visual keys; (2) a positive approach on continuing improvement in soil condition, information on how other farmers are approaching soil health; and (3) a production focus working against benchmarks. Once entering the website through one of the 'hooks', users are able to access soil health information organised in a series of modules. The topics for these modules were identified by end-users consulted as part of the Soil Health Knowledge Bank development process. The leaders of the HSSF projects, as well as a Senior Editorial Panel, were involved in developing and reviewing the content of, and in sourcing material for, the Soil Health Knowledge Bank.

Figure 3: Different components of the Soil Health Knowledge Bank

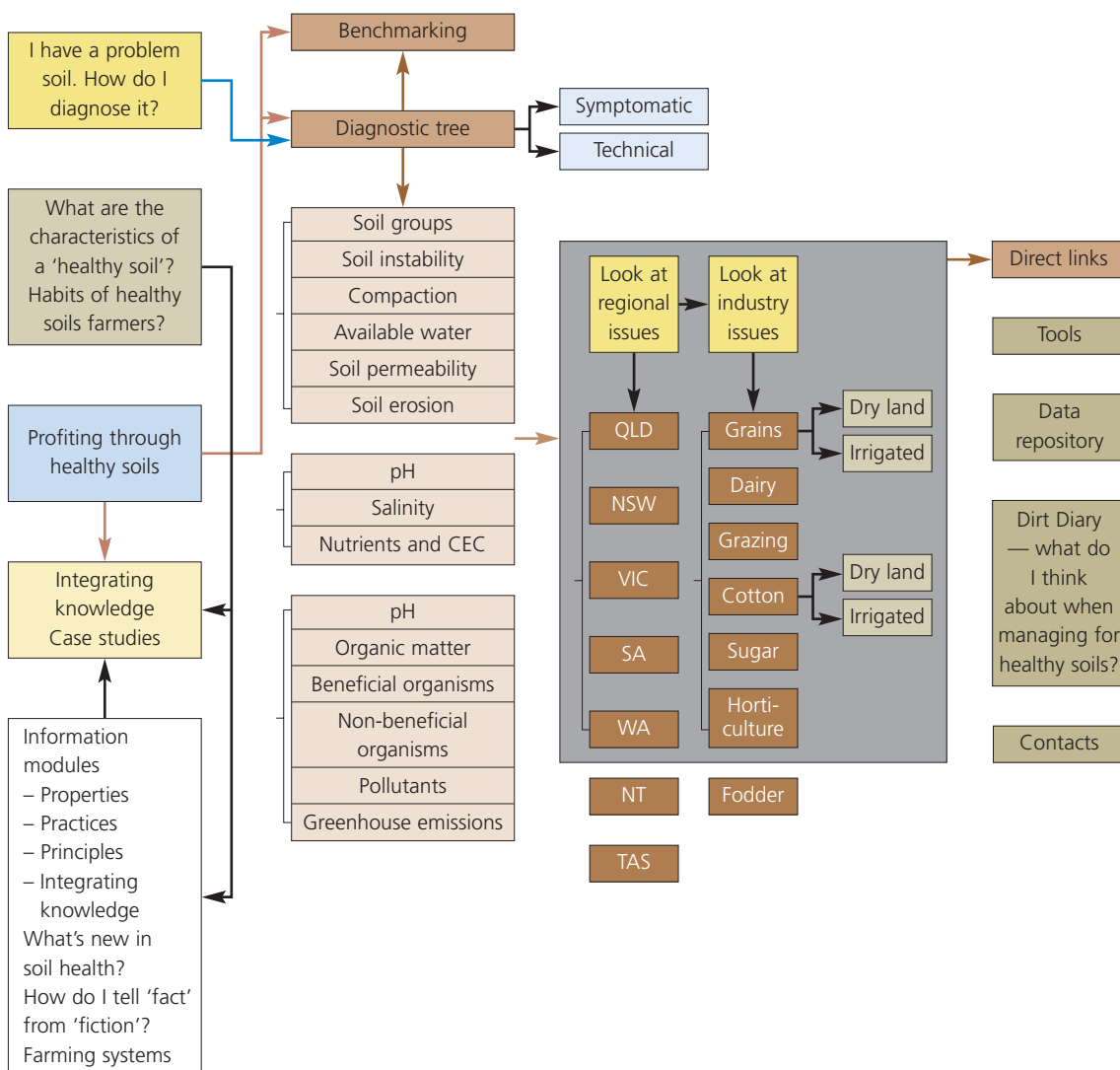


Photo this page and opposite BFA / SSA.



In addition to the information modules, the Soil Health Knowledge Bank provides:

- access to HSSF Program 'endorsed' information (on both a regional and industry basis);
- case studies of 'real life' farmers who have applied some of the approaches discussed in the Soil Health Knowledge Bank;
- a diagnostic tool to identify soil constraints and direct users to the relevant module(s) for more detailed information;
- diagnostic tools for water use efficiency;
- a tool to calculate potential carbon inputs required to shift soil organic carbon status;
- regional 'Dirt diaries';
- links to benchmark 'www.soilquality.org.au' and other sites; and,
- material covering new science, alternate farming practices and supporting material for technical modules is under continuing development.

The Soil Health Knowledge Bank is designed to be a dynamic website that is updated as new information, research and practical experiences arise. It is an important HSSF Program legacy, and one that would benefit from ongoing investment so that its potential in supporting and facilitating people accessing healthy soils information is fully realised.

Communications

This component included developing a HSSF Program brand, having a coordinated approach to HSSF Program booklets and information sheets, developing protocols for information release, providing templates for presentations, booklets and field day publications; and preparing and releasing two web-based newsletters, the E-NEWS and Profiler, on alternate weeks to all those interested in soil health news.

HSSF E-NEWS and Profiler

National communication activity included circulation of two newsletters, the E-NEWS (48 editions) and the Profiler (38 editions) by e-mail to subscribers from mid-May 2006 until June 2008. Both newsletters played an important role in building the strong sense of community that developed within and around the HSSF Program. The E-NEWS enabled HSSF participants to share information about project activities, forthcoming workshops, field days and soils related conferences. The Profiler featured short articles about latest research findings in soil science, sourced internationally. The audience for these newsletters increased through self-nomination from 50 to over 375 during their 18-month life. Considerable positive feedback about content, relevance and usefulness was received, and the newsletters were clearly filling a gap in the soils information marketplace.



A very successful National Healthy Soils Symposium was held in July 2007. This brought together 262 people, including 103 farmers, to examine and discuss all aspects of managing healthy soils within Australian agriculture and horticulture and included international perspectives. Presented papers covered technical aspects of soil physics, chemistry and biology, the principles of healthy soil management and soil assessment, and examples of how growers had put those principles into practice. It maintained the Program's focus on making soil health pay, and included updates about how different industries are working to assist their members to improve soil health. The Symposium received excellent feedback from attendees and good press coverage including a story on ABC breakfast radio and on WIN TV. The full proceedings of the Symposium are available at http://www.healthysoils.gov.au/Healthy_Soils_Symposium/index.aspx

Delegate responses at the National Healthy Soils Symposium included this from Chris Reichstein, a farmer from Esperance, Western Australia: "This has been really good. We've had totally different perspectives on soil health — showing us a very similar end result. What I've heard today has reinforced stuff I've been thinking. The other great thing about this is just the opportunity to meet so many different people — other farmers and scientists from all over."

'Down and Dirty' at the Symposium

The HSSF Healthy Soils Symposium featured a very popular innovative interactive session 'Down and Dirty'. Participants toured a series of 12 work stations, each specialising in a topical soil health subject. Soil science experts were on hand to give demonstrations, answer questions and help the audience gain more insight into a range of soil health topics. Some of the subjects covered included:

- Impact of earthworms and termites on soil health.
- Response of soil microbes to rainfall, illustrated via infrared gas analyser.
- The interactions between pH and roots in the soil.
- Your soil under the microscope (bring your own sample).
- Understanding the contribution of *mycorrhiza*.
- Soil cores and a decision tree to identify subsoil constraints.
- The invaluable contribution of dung beetles.



Photo LWA.

'Down and Dirty' was particularly enjoyed by farmers in the audience; many revisited the work stations during conference breaks to get further information. Feedback in event evaluation sheets was extremely favourable, for example...

Merna Curnow, Laanecoorie, Victoria: "The Down and Dirty session was so good that my husband and I had to make sure we did six different ones each and then compare notes! I was particularly interested in the *Ute Guide*. This style of information has enormous application for all forms of farming. We need this in grains."



Photo GRDC.

Monitoring and evaluation

A monitoring and evaluation (M&E) framework and guide were developed for the HSSF Program to:

- provide a framework which demonstrated how planned outcomes contributed to the HSSF Program objectives;
- improve the quality of projects by incorporating use of a monitoring and evaluation template to collect output and outcome data from each project from its set-up phase onwards; and,
- allow the HSSF Program and its projects to report and evaluate achievements through reporting by outcomes.

All projects and HSSF Program components were required to collect M&E data throughout their life, and the data reported was used in conjunction with further information in project progress reports to complete the twice-yearly National Investment Stream reports provided to DAFF.

Although M&E data is valuable in providing numbers and some information about project activities, it does not reflect the full extent of project achievements, many of which are qualitative. To fill this gap, summaries of results, outcomes and an overall evaluation is provided for each project in Section 6 of this report.

A major challenge for the Program's M&E activity was its short time frame (three years), as this limited the ability of projects to demonstrate long term impacts through on-ground change and increasing adoption of healthy soils management. For most projects, long-term impacts will not be able to be measured for at least three to five years, well beyond the completion of the first phase of the HSSF Program. If further work on healthy soils is funded, the M&E template put into place will be able to be used to its full potential, capturing useful data and information for all HSSF Program participants.

The M&E framework assisted the HSSF Program and projects in project design and articulating outcomes that could demonstrate progress towards its objectives. During implementation, the function of the M&E framework was to demonstrate progress and inform management and investors if there is a need for adaptation. In the early phases, input-output reporting is the most feasible and this needs to be progressively supplemented with outcome reporting. In the final completion phase the emphasis needs to shift to reporting impact (outcomes) and making recommendations. The HSSF Program benefited from establishing an M&E framework in the set-up phase, and the success of the M&E activities led to the recommendation that their early introduction should be a part of all large NRM programs. This approach aligns with the recommendations of the Australian National Audit Office review of Natural Heritage Trust 2 and the Caring for our Country MERI framework.



Photo AUSVEG.

HSSF mid-term review

As part of the overall M&E activities, an independent mid-term review was conducted in early 2007 to provide a brief assessment of how the HSSF Program had been performing since its inception in 2005. This review found that the HSSF Program was meeting its milestones as specified in its Operating Plan, and was on track to address the stated objectives. There was a consistent view from project leaders and management committee members that the HSSF Program had successfully put soils 'back on the agenda', and that it was stimulating a renewed focus on the sustainable management of soils, particularly for the organisations and stakeholders involved in the HSSF Program.

A major strength of the HSSF Program was found to be the new partnerships that had been formed between farmer groups, industry bodies and governments at all levels. These relationships, and the collaborative approach taken to developing solutions to soil problems, were considered likely to provide benefits to all those directly involved in the HSSF Program. The review also emphasised that there was now an opportunity for the HSSF Program to extend this legacy of knowledge and experience beyond the projects to a wider audience. This laid the foundation for the Soil Health Knowledge Bank project.

Program operations

This component provided support for all aspects of Program management. A HSSF Program Management Committee was established with an independent chair and representatives of DAFF, GRDC, and LWA; it determined strategy and approved investments. An Expert Panel was also established, to review and assess Adoption Project proposals, with membership drawn from people with expertise in cropping and pasture systems, soils and soil biology, fertilisers and nutrients, and natural resource management and Landcare. LWA had responsibility for oversight of Program development and implementation, ensuring contractual responsibilities to DAFF and GRDC were met, and that all aspects of investment management and reporting were completed. A HSSF Program National Coordinator was responsible for implementing the HSSF investment strategy and for overseeing day-to-day operations.

Networking and coordination between groups and project leaders, who had not necessarily worked together before, was considered an important element of the HSSF Program to enable the sharing of understanding and ideas, as well as optimising the value of investments through collaboration. Project leaders met twice each year to give presentations on their projects and to share ideas and information. This process also enabled peer review of methods and results. By the end of the HSSF Program the meetings had resulted in a substantial shared knowledge and understanding of soil health, as well as the development of strong working relationships between all those involved.

A workshop sponsored by HSSF was held in October 2006 to canvass potential ways to involve the large agribusiness groups — Elders, Landmark, CSBP Limited, Incitec-Pivot and others. This led to an understanding of their interest in soil health information, and to awareness of the HSSF Program and the range of products that would become available.



Photo AUSVEG.

4. HSSF Program achievements

The HSSF Program has achieved high participation rates, uncovered significant demand for information about soil health, and delivered a range of products, workshops and forums successfully. This has been achieved despite difficult drought conditions. Key successes include:

- A substantial rise in awareness about the importance of soil health among farmers, advisors, extension and NRM staff, catchment and industry bodies and governments at all levels. More than 30,000 people have received information about the HSSF Program and its results. The HSSF Program has also placed soil science and soil management back on the agenda for rural industries.
- Production of new information about key principles of soil management, and collation of existing knowledge that was formerly scattered and difficult to access.
- Development and demonstration of new methods for assessing soil health, including aspects of soil biology, and of soil health indicators.
- Development and effective demonstration and delivery of methods to achieve soil health principles, tailored to the specific needs (uncovered by prior market survey) of different industries and regions.
- Establishment of soil health demonstration sites in many agricultural regions that will continue beyond the end of the HSSF Program.
- Development and delivery of education and training materials that enable learning about both the principles and practice of soil health management. These are now widely available for use in further training programs, and several have been linked to the National Training Information Service for eventual accreditation of learning outcomes achieved.
- Development of a new resource through the establishment of the Soil Health Knowledge Bank that will be available to a wide range of users, including for regional and local training programs.
- Education and training of over 17,000 farmers, advisors and technical staff attending at least one course, workshop, symposium or field day as part of HSSF-funded projects.
- Ongoing demand from farmers and advisors for training in soil health. The HSSF Program has been unable to service all of this demand and so it remains unmet.
- Program funding of \$5.0 million (DAFF) and \$1.2 million (GRDC) leveraged further project investment from industry, research providers and third party participants in excess of \$10.3 million.

- Convening a National HSSF Symposium that received excellent feedback from attendees (262 people); 40% of those attending were farmers.
- Embedding M&E into project reporting from the beginning of the HSSF Program, rather than adding it later. This has helped to retain project focus on achieving outputs and outcomes.
- Developing good collaboration between industries, governments and their agencies, catchment bodies, farmer groups and extension staff. Strong links between projects, including sharing of skills and products, were developed both within regions (e.g. Queensland and northern New South Wales), across regions (e.g. Queensland with Victoria) and with some CMAs (e.g. Queensland projects and South East Queensland Catchments).
- Establishing a legacy of HSSF Program knowledge, resources and capacity in all those involved, upon which a second phase of investment could build and achieve even greater results.

Table 2: Summary of HSSF Program achievements and outputs

Output or outcome	Number
Farmers, advisors, extension and NRM staff, industry and agency personnel, and other people aware of the Program	30,000*
Farmers, advisors, extension and NRM staff, industry and agency personnel attending at least one Program activity	17,000
Major, new region- or industry-specific Soil Health Management or Assessment Guides and workshop resource materials developed	14
Number of guides or equivalent distributed	13,000
Fact sheets, case studies and articles written	103
Number of fact sheets, case studies, etc. distributed	12,630
Education and training workshops and specialist seminars held	187
Number of participants in workshops and seminars	4,700
Number of soil health demonstration sites established or renewed	30
Sites assessed for soil health, and data provided to state/national databases	2,500
Field days held	102
Field day attendees	12,300
Number of project brochures, newsletters, articles in industry journals, displays, press releases and other media events organised by projects	120
Soil health websites established or enhanced to store and provide Program tools and information	7

*It is estimated that at least a further 20,000 people were made aware of the Program through media articles, shared newsletters and other communications.

The HSSF Program's overarching aim was to:

“Establish, promote and implement the links between soil health, rainfall management, agricultural production and water catchment management.”

This aim has been largely achieved for those industries and regions where HSSF Program investments were made. The links between soil health, rainfall management (and water use efficiency) and agricultural production have been at the core of HSSF projects, and the principles of how to optimise these links and to achieve them in practice, have been addressed through project outputs and in education and training activities.

The links between soil health and water catchment management have been less easy to define, and as the HSSF Program investments focused on Adoption Projects, it has not been possible to make substantial progress in filling the gaps in scientific knowledge about these links. This further strengthens the case for a second phase of investment. The table below summarises achievement of HSSF Program intended outputs and outcomes.

Table 3: HSSF Program outputs

Program outputs	How outputs have been achieved
Development and increased uptake of best management practices (BMPs) and tools for producers in relation to soil management.	Ten Adoption Projects provided clear BMPs for particular industries, regions, and soil management topics, and these have been delivered through fact sheets, soil health manuals, demonstration sites, workshops and regional symposia, and through education and training programs.
Successful delivery of Adoption Projects to encourage farmers, industry and the community to better understand and manage their soil resources.	Adoption Projects have been delivered successfully, with over 17,000 farmers, advisors, extension, agency and NRM staff attending at least one HSSF activity. Evaluations show that participants believe they have gained new knowledge, an ability to assess soil health themselves, and many have indicated an intention to improve soil management practices.
Healthy Soils Reports from all Adoption Projects.	Adoption Projects have prepared and published regional and industry-based soil health manuals, assessment methods and kits, BMPs, results from demonstration sites, and other forms of reporting about healthy soils.
Undertaking a Regional Forum with farmers, scientists, NRM groups and other stakeholders and facilitating development of Healthy Soils Symposium Papers.	A very successful National Healthy Soils Symposium was held with 262 attendees including 103 farmers in July 2007. Evaluations of the benefits from those who attended were very positive.
Program Evaluation Report.	A mid-term evaluation of the Program, and periodic M&E assessments of each project, were completed, together with a final report to DAFF and this Program Report.

Table 4: Summary of HSSF Program outcomes

Program outcomes	How outcomes have been achieved
Increased understanding and agreed knowledge by farmers about the role of soil health in supporting sustainable farm businesses and healthy catchments through variable circumstances, as evidenced by reports and their acceptance at regional and national symposia.	Evaluations undertaken at the conclusion of adoption project workshops and seminars, including some undertaken independently, show increased understanding and knowledge by farmers about the role of soil health in supporting sustainable farm businesses and healthy catchments. For example, evaluations undertaken for project QPI 64 showed that participating farmers and agronomists had gained a greater awareness that soil health and their own soil health problems have chemical, physical and biological components. Participants reported changed management activities (e.g. assessing their soils) and 50% of respondents nominated practice changes that they intended to make following their involvement with the project.
More farmers aware and knowledgeable about soil health issues, as evidenced by the number of farmers involved in Healthy Soils initiatives.	Over 17,000 farmers, advisors, extension, agency and NRM staff attended at least one HSSF activity, and awareness raising materials and events have involved more than 30,000 people in total. Evaluations show that participants believe they have gained new awareness and knowledge about the importance of soil health to their business, about how to assess soil health themselves, and how to improve soil management practices.
More service providers to farmers being aware, knowledgeable and supportive of soil health factors, as evidenced by their use of tools and guidelines generated by the Program.	Adoption Projects have prepared and published regional and industry-based soil health manuals, assessment methods and kits, BMPs, results from demonstration sites, and other forms of reports about healthy soils. These are widely available, and although there is no firm quantitative data about their use by service providers, several industry and farmer groups as well as training organisations have sought them from HSSF projects.
Increased adoption by farmers of best management practices for soil health and production outcomes, as evidenced by farm management surveys.	Several projects have provided anecdotal evidence of likely increased adoption of improved or best management practices for soil health, and in some cases this has already been undertaken by individual growers or grower groups, for example at new demonstration sites supported by catchment bodies. It is too early to expect measurable changes in adoption, but some HSSF projects completed a baseline survey of current practice, and these will provide a basis for quantitative re-survey in the future to measure adoption rates.

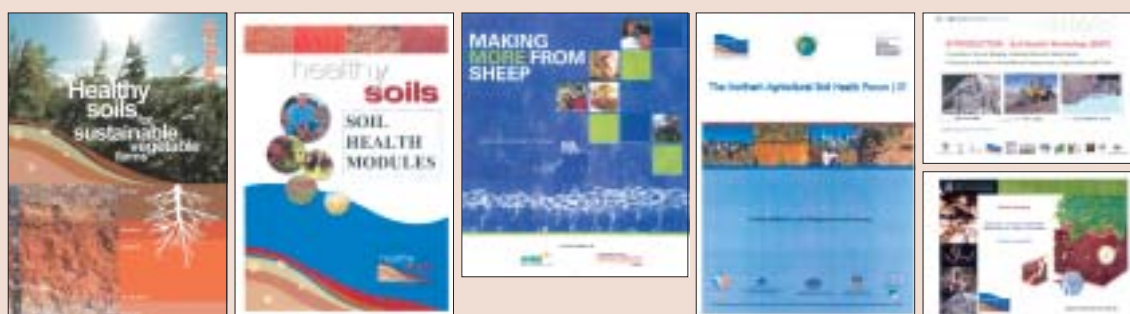
Note: Tables 3 and 4 list outputs and outcomes as per the Program Agreement.

In summary, the HSSF Program achieved high participation rates, uncovered significant demand for information about soil health and delivered successfully a range of products, workshops and forums to raise awareness and promote practice change. This has been achieved despite difficult drought conditions. Evaluations show the Program was timely and addressed a strong need within many sectors of the agricultural community for information about management of soil health, its importance and vital contribution towards the future sustainability and productivity of Australian agriculture.

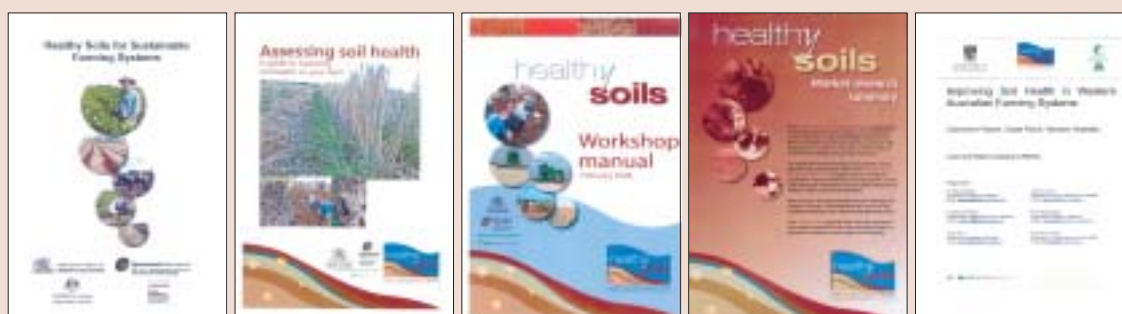
The table on the following pages lists the outputs from various projects.

Table 5: HSSF project outputs

Project	Project products (hard copy and electronic)
<p>Healthy soils for sustainable vegetable farms: Ute Guide and Soil Health Interpretation Courses for Vegetable Growers, AUSVEG (AVG 1)</p>	<ul style="list-style-type: none"> ■ Ute Guide: Healthy soils for sustainable vegetable farms ■ DVD of Ute Guide, with focus on LOTE growers ■ Five media articles ■ Soil Awareness Day workshop handouts
<p>A “Healthy Soils” module for More Sheep & Wool from Pastures, Australian Wool Innovation Limited and Meat & Livestock Australia (AWI 3)</p>	<ul style="list-style-type: none"> ■ Healthy Soils module in Making More From Sheep training package
<p>Delivering workshops on low input farming approaches to soil health management, Biological Farmers Australia (BFA 2)</p>	<ul style="list-style-type: none"> ■ Soil Health Management Guide ■ Eight newspaper / industry magazine articles ■ Two sets of workshop notes ■ Soil Health card ■ BFA website enhanced to include new information on soil health
<p>Accelerating adoption of integrated soil management practices in irrigated cotton and grain, Cotton CRC (COC 4)</p>	<ul style="list-style-type: none"> ■ Benchmark survey of current farmer practices related to soil health ■ Twelve case studies on key topics for healthy soils ■ Three Regional Symposia proceedings ■ New page of healthy soils information on Cotton CRC website ■ Soil Health Guide covering soil biology, soil pits, soil nutrition and measuring soil health ■ Two conference papers ■ Five industry magazine / journal publications ■ Three newspaper / newsletter articles ■ Three sets of education and training workshop notes
<p>Managing Landscapes — matching soils, climate and enterprises, NSW Department of Primary Industries (DAN 26)</p>	<ul style="list-style-type: none"> ■ Two decision-support tools (a relative fertiliser cost calculator, and a Phosphorus Buffering Index card for use when calculating P requirement from soil tests) ■ LANDSCAN manual, customised for northern New South Wales producers, including soil biology information ■ Read Your Soils manual (for facilitators) ■ Sixteen Paddock Diaries (one for each set of workshops) to assist farmers in collecting and recording soils data ■ Soil monoliths for education and training workshops ■ A simple soil health card



Project	Project products (hard copy and electronic)
<p>Sustainable farming practices in the mid-Loddon sub-catchment, Mid-Loddon Sub-catchment Management Group (MID 1)</p>	<ul style="list-style-type: none"> ■ Soil and crop sample reports from six sites ■ One DVD — ‘There’s a party in the leaf litter’ aimed at school children ■ Twenty two newsletters and articles ■ Four newspaper / magazine articles ■ Three fact sheets ■ One journal paper ■ One soil assessment report
<p>Sustainable soil health management workshops for northern broadacre cropping industries, Queensland Department of Primary Industries & Fisheries (QPI 64)</p>	<ul style="list-style-type: none"> ■ National Market Research report and summary ■ Soil Health Assessment Guide ■ Healthy Soil Technical Manual ■ Queensland Healthy Soils workshop manual ■ NSW Healthy Soils workshop manual ■ ‘Fit for Farming’ agronomist training notes ■ Balancing water and nutrient supply booklet ■ Demonstration sites results booklet
<p>Defining and promoting soil health for sustainable productions systems, Queensland University of Technology (UQT 3)</p>	<ul style="list-style-type: none"> ■ Soil health scorecard (based on farmers’ observations) ■ Field-based soil health test kit ■ Soil Health Assessment Training Manual ■ Review of soil organic carbon dynamics — report based on detailed laboratory analyses of 15 sites with differing land use and management
<p>Improving soil health in Western Australian farming systems, University of Western Australia (UWA 54)</p>	<ul style="list-style-type: none"> ■ Eight Catchment-level Soil Quality benchmark reports ■ Three decision-support tools (on soilquality.org.au) ■ Twenty fact sheets about different aspects of soil health ■ Nine farmer case studies ■ One DVD — materials from the Murray Catchment Management Authority soil health workshops ■ soilquality.org.au website upgraded ■ Fourteen trade press articles published ■ Six workshop PowerPoint presentations
<p>Soil Health — Leaving a legacy for south eastern Australia, Department of Primary Industries, Victoria (VPI 9)</p>	<ul style="list-style-type: none"> ■ Market needs analysis report ■ Five media articles ■ Detailed resource materials for soil health education and training workshops ■ Three soil health training modules, registered with NTIS ■ Two websites enhanced, all soil health materials available from the Victoria Online site





5. Opportunities for the future

The HSSF Program achieved high participation rates, uncovered significant demand for information about soil health and successfully delivered a range of products, workshops and forums. It also highlighted several aspects of soil management where more needs to be done to maintain Australia's soil assets, their productive use for regional economies and the environmental services they provide. These include:

- How best to manage soils for resilient agricultural production under climate change and increased climate variability.
- Managing agricultural soils to minimise greenhouse gas emissions and optimise carbon sequestration — part of getting Australian agriculture ready for its eventual inclusion in emissions trading (national and international).
- Managing soils to maintain ecosystem services and conserve their biodiversity.
- Building the Soil Health Knowledge Bank further to incorporate new information from ongoing research and development (for example, into subsoil constraints, use of precision agriculture technologies).
- Linking on-farm soil management with catchment-scale targets for water quality, salinity or sustainable agriculture, as well as with environmental management systems in different rural industries.
- Expanding the use of HSSF products in education and training programs (including those of CMAs and NRM Boards, and rural industries) to build community capacity — there is evidence of large, unmet demand for this from the current HSSF Program.
- Continuing to support those people and organisations who have been involved in the HSSF Program so that they can maximise investment and continue working to improve soil management economic and environmental outcomes.

It is hoped that the Australian Government will continue to provide leadership in this topic through its role in national coordination and collaboration with state agencies, rural groups, catchment authorities and boards, research providers, farmer groups and non-government organisations. This will ensure consistent messages and standards are maintained, as well as leveraging the Government's funding.

A five year program has been proposed to build on the work begun in the HSSF Program, with funding of \$0.5 million in the initial scoping and development year (2008–2009), rising to \$2 million per annum in subsequent years as the full suite of projects is funded.

This is now being discussed by LWA with other rural R&D corporations, state agencies and organisations, industry groups and catchment bodies, with the intention that a joint proposal be developed for submission to the Caring for our Country initiative. It has been recommended to DAFF that the Department:

- consider providing seed funds to enable this scoping and collaboration study to be completed quickly and a joint proposal prepared; and
- provide its views about future priorities in healthy soils management R,D&E, particularly as they relate to sustainable agriculture under a more variable climate.



Photo BFA / SSA.

For information on the HSSF Program go to www.healthysoils.gov.au

also visit the HSSF Soil Health Knowledge Bank at www.soilhealthknowledge.com.au

6. Summaries of HSSF Program projects

Healthy soils for sustainable vegetable farms (AVG 1)

Project data [title, contractor(s), timeline]

- Healthy soils for sustainable vegetable farms: *Ute Guide* and Soil Health Interpretation Courses for Vegetable Growers.
- AUSVEG Limited. Collaborators were NSW Farmers' Association, Arris Pty Ltd, and McKenzie Soil Management Pty Ltd.
- 15 March 2006 to 1 August 2008. The HSSF Program provided funding of \$350,000; total funding for the project was \$662,000 in cash and in-kind.

Summary

This project aimed to collate information about healthy soils and their management, and to make this information widely available within and beyond the vegetable industry in forms that could be accessed easily by growers and advisors. An industry review identified there was a need for a resource that contained the latest information with respect to soil and land management. It also took into account that many people in the industry have a non-English or LOTE (Language Other Than English) background, and a need to train people in using healthy soil guides and other information products.

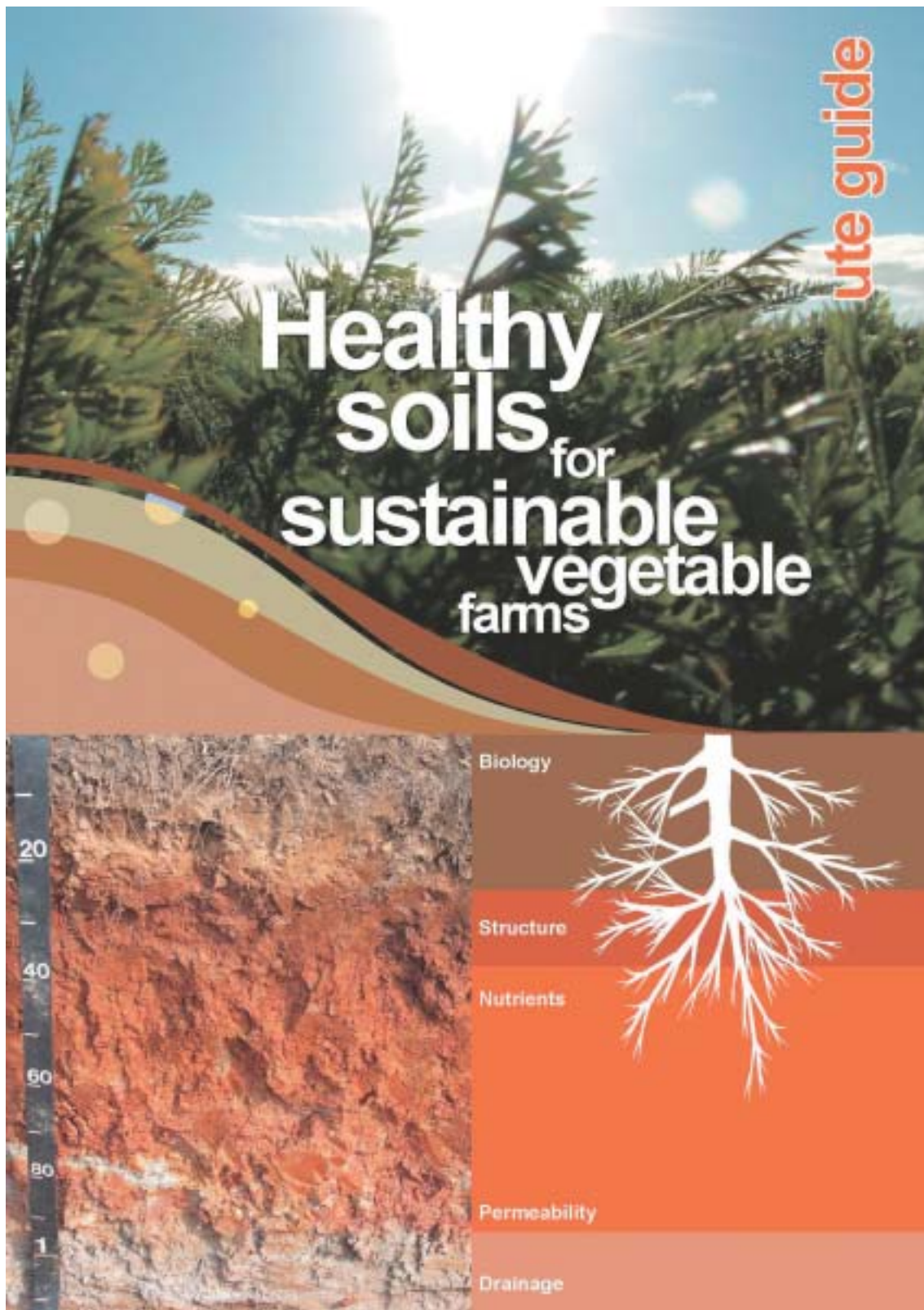
Project description

- Project objectives were: development, publication, promotion and dissemination of a soil identification and interpretation reference that can be carried around in the ute or tractor; development of a CD/DVD based on the *Ute Guide* which will be especially beneficial for LOTE growers and for listening to whilst in the tractor or ute; development of a Soil Interpretation and Management Course in line with the Australian National Training Authority: Certificate of Amenity Horticulture RTF03; identification and appointment of appropriate instructors and/or educational facilities for delivery of the course material to growers and agricultural students; and long-term management of healthy soil information through EnviroVeg.

- A thorough national and international search was conducted of all relevant soil information. Once identified this information was collated, rewritten in a vegetable production context, and then peer-reviewed. Where needed, diagrams and photos were sourced or created. The design and layout of the *Ute Guide* was also reviewed by a grower panel to ensure that it met the requirements of the target audience.
- The information contained in the *Ute Guide* was used as the basis for developing the Soil Awareness Day Courses and the presentations and written materials created for the workshops. Six Soil Awareness Days were held — Werribee (Victoria), Dareton (New South Wales), Virginia (South Australia), Darwin (Northern Territory), Stanthorpe (Queensland) and Camden (New South Wales). These provided an opportunity to assess industry response to the *Ute Guide* and information about on-farm testing methods to be used in the training resources. Through the *Ute Guide* and Soil Awareness Days, the industry was provided with the latest information that is specifically designed for the vegetable industry in a format that is readily 'useable', thereby promoting the successful adoption of good agricultural practice with respect to soil and land management. These have also been provided to a range of training organisations including agricultural colleges, state agencies and CMAs.
- The DVD will initially be sent out to the growers that have indicated interest in attending the Soil Awareness Day workshops but for whom the project was unable to meet the demand. It will then be advertised in various industry publications and the Industry Development Officers will target LOTE growers.
- More detailed training material is being developed by in line with the Australian National Training Authority (ANTA): Certificate of Amenity Horticulture RTF03 (Level IV or higher). This aspect of the project will be completed for distribution by end of June 2008.



Photo AUSVEG.



Project results

- The primary product is the *Healthy soils for sustainable vegetable farms* book, produced in the form of a *Ute Guide*. Over 9500 copies have now been distributed, including class sets to eight agricultural colleges. The response to the production and distribution of the *Ute Guide* has been overwhelming with positive feedback coming from a wide range of sectors including the farming, education, extension and science communities.

- A one-day course including in-field demonstration of various methods of soil testing was developed. The Soil Awareness Day consisted of a classroom session based on the *Ute Guide* information, followed by demonstrations of various testing applications around, and in, a soil pit. Six Awareness Days were held in five states, covering a very broad range of soil conditions and crops. In total there were close to 200 participants. The presentation and handout material developed through this project is being used for delivery by other trainers in Victoria, Tasmania, Northern Territory and Western Australia. The project did not have sufficient resources to cater to the high level of interest from growers.
- The project also produced a DVD demonstrating the on-farm soil assessments that were covered in the Soil Awareness Days. The DVD will be a useful tool for the LOTE growers, growers that have not been able to attend the workshops, as well as others with literacy issues. It will also assist those growers who have attended workshops by boosting confidence in their ability to undertake the tests and then use that information in soil and land management on their farm.
- A training manual that will be linked to Australian National Training Authority: Certificate of Amenity Horticulture RTF03 (Level IV or higher) has also been developed and will be made available to education and training organisations for delivery. All project materials are widely available for continued use in training, and the project has demonstrated a large ongoing demand from growers and advisors for practical information and training in healthy soil management.



Photos this page and opposite AUSVEG.





Communications

- Project products have been publicised widely within and beyond the vegetable industry. The *Ute Guide* was launched by the then Minister for Agriculture, Fisheries and Forestry at the Werribee Field Days in May 2007 (5000 attendees), and has been publicised in industry journals with readerships around 10,000. Products have also been promoted at industry conferences (total attendees around 2200). Soil Awareness Days were attended by 200 people including vegetable growers, advisors, agency and CMA staff and industry personnel.
- The *Ute Guide* and other training materials have been provided upon request to other industries and education and training organisations.

Project outcomes

- Through the *Ute Guide* and other healthy soil awareness and training materials, the vegetable industry has been provided with the information, skills and confidence to conduct soil tests on-farm and to understand what the tests indicated. Anecdotal evidence shows that growers have been able to make better soil management decisions using these or after attending a Soil Health Awareness Day. This has also provided growers with the 'right questions' to ask their advisors or to confidently question information or solutions being offered to them.
- This will lead to savings on-farm from growers conducting their own tests and by better matching inputs such as fertiliser to crop needs; the latter will also provide environmental benefits. An unintended outcome has been the interest shown by other industries and education and training organisations in using the project products.

Evaluation

This has been a well-managed and very effective project that has achieved its objectives and provided valuable new information throughout the vegetable industry, including to members whose usual language is not English. There is further demand for healthy soils training within this industry that could not be met by this project.

A Healthy Soils module for the *Making More From Sheep* publication (AWI 3)

Project data [title, contractor(s), timeline]

- A Healthy Soils module for the *Making More From Sheep* publication.
- Australian Wool Innovation Limited.
- 15 June to 1 October 2006. The HSSF Program provided funding of \$80,000. Total funding was \$1.8 million in cash for the development and publication of the *Making More From Sheep* manual (hard copy, CD and web versions), and delivery of producer workshops.

Summary

This project aimed to prepare a written module of practical advice about how sheep producers can improve soil management and soil health on their property. This has been incorporated into the *Making More From Sheep* publication prepared jointly by Australian Wool Innovation Limited (AWI) and Meat & Livestock Australia (MLA). The publication has been distributed widely to sheep producers across Australia following its launch in January 2008.

Project description

A draft Healthy Soils module was written using existing information interpreted into the context of the sheep industry. It was developed by a team of nine people, and technically refereed by a further nine people, including leading sheep producers, technical experts and R&D corporation representatives. The Healthy Soils module was thoroughly road tested before being finalised.

Project results

- The *Making More From Sheep* publication is a best practice package of information, management tools and learning opportunities to achieve profitable and sustainable sheep production. It consists of 11 modules: Plan for success; Market focused wool production; Market focused lamb and sheepmeat production; Capable and confident producers; Protect your farm's natural assets; Healthy soils; Grow more pasture; Turn pasture into product; Gain from genetics; Wean more lambs; and Healthy and contented sheep.
- Key aspects of soil management covered in the Healthy Soils module include: managing according to soil capability; maintaining ground cover to protect soil and keep the soil 'bugs' healthy; testing soils for key indicators of soil health; and implementing solutions for problem soils.

- Launched in January 2008, *Making More From Sheep* aims to raise awareness among sheep producers (and the wider sheep industry) about the new, 'one-stop-shop' best practice sheep management information package developed jointly by AWI and MLA; and how they can access it. In the three months after the launch, 561 hardcopy manuals were sold, 442 CDs were ordered, there were 6957 website visits, 363 downloads of the complete manual and 68 downloads of the Healthy Soils module with 132 page views of the Healthy Soils module.

Communications

Activities to support uptake of the publication and practice change on farm include the activities of the National Making More From Sheep Coordinator; communication activities using the website, media promotion and a trial of webcasting; the nomination of producer advocates; support from agribusiness groups Elders and Landmark; and planned module-based workshops across Australia over the next two years.

Project outcomes

Sheep producers now have available collated information about the importance of soil health and its effects on both pasture and sheep productivity and environmental condition. The importance of soil constraints and how to manage them or live with them is explained, as well as practical steps that sheep producers can take to improve soil health on their property.

Evaluation

This project has successfully collated a wide range of soils information and interpreted it within the context of the sheep industry. This information has been disseminated widely and is available in a number of formats (including free on the website www.makingmorefromsheep.com.au) for use in education and training activities at an industry, region or local level, and for incorporation into other extension programs.

Photo Mary Goodacre.



Delivering workshops on low input farming approaches to soil health management for landholders in south east Queensland (BFA 2)

Project data [title, contractor(s), timeline]

- Delivering workshops on low input farming approaches to soil health management for landholders in south east Queensland.
- Biological Farmers of Australia (BFA). Soil Systems Australia (SSA) was a major collaborator.
- 1 May 2006 to 1 September 2008. The HSSF Program provided funding of \$30,000; total funding for the project was \$52,500 in cash and in-kind.

Summary

This project considered that the current system of conventional agriculture cannot readily accommodate prolonged extremes in climate or rising input prices without causing severe stress on land managers, the resource that they utilise and the community that agriculture is embedded in. Producers have identified that during these times yields have levelled off or dropped, but variable costs have increased. Farmers now want practical solutions to resolving the consequent financial and emotional stress. The project's series of workshops aimed to help land managers change their operating paradigm by emphasising that farming is concerned with the soil, not only what grows on it, and that using the cultural practices and ecosystem services associated with improved soil health is cost effective. The workshops gave land resource managers and the community an understanding of how low input farming systems can address soil health issues whilst maintaining profitability.

Project description

- Project objectives were: to deliver 20 workshops to regional stakeholders and land resource managers on best management practice utilising organic soil management strategies for optimum soil health, production and catchment outcomes; to build capacity of the participants to access knowledge streams in fundamental ecological principles in relation to soil environmental parameters and agro-ecology practices that yield viable farms and resilient and stable catchment environments; and ensure that the information provided will be beneficial to all sectors of land resource managers to reduce energy use, increase carbon sequestration using the soil as a sink and lessen the amelioration cost of downside externalities from production systems within the catchment area of the regional bodies involved.
- The project delivered 20 soil health workshops, initially focusing on south east Queensland catchments and the Burnett Mary Regional Group. Workshops were later expanded to northern Queensland, central Queensland, south west Queensland and northern New South Wales. The project also prepared a Soil Health Management Guide based on approaches discussed in the workshop material, and conducted evaluations of the workshops by participants.

Project results

- Attendance at the workshops was around 400 in total. The workshops covered a wide spectrum of land managers including peri-urban, horticultural, grazing, cropping, dairying, cane and mixed farming. The farms that have been engaged by this project have ranged from 0.1 hectares to 8000 hectares in size.
- Following the first two workshops held in 2006, a decision was made to expand on the information provided. Feedback from growers indicated a need to provide further technical information on soil health, especially to link together the practical aspects of systems management with the three cornerstones of soil health (soil physics, chemistry and biology). Soil Systems Australia was engaged to help achieve this. Workshops were generally held on-farm, and included initial presentation and discussion of key principles of soil health and how these can be achieved in practice, followed by field inspection and discussion of how the farming system can be changed to improve both production and soil health.

Communications

Articles in farm journals and press releases, as well as e-mail newsletters and the BFA website, have been used to publicise the project, the workshops, and project results. The project team has been involved in joint activities with other HSSF projects, and with industry, agency and regional NRM groups. This has included work on improving soil health, on utilising local wastes and low-quality resources, and on combating extreme variations in climate and rising input costs for agriculture.

Photo: BFA / SSA.



Project outcomes

- Despite extreme drought conditions and in an environment of increasing farm input costs, up to 10% of each participating farming group adopted major practice changes following the workshops. In many cases this involved seeking local sources of materials that could be used instead of or blended with existing fertilisers to help reduce on-farm variable costs. Practices adopted included the use of raw manures in a sheet composting program, the addition of minerals in accordance with soil tests, and some added biological inputs to augment soil processes. Machinery changes were made to manage these alternative materials.
- The use of direct drilling of fodder crops into native pastures during the dormant phase was also trialled. It is regarded as a poly-culture practice and utilises multiple species to increase biomass and feed production and give greater resilience to fluctuation in climate. This practice is thought to also increase the diversity of root exudates thus aiding nutrient recycling processes.
- Recorded observational and measured data show the results of changed practice, including examples of large increases in production and profit as well as stock health. Surveys showed that following the workshops over 85% of farmers reported they understood the importance of humus and soil organic carbon, more than 75% commented that they gained a better understanding of the role of integrated farming systems in achieving healthy soils and nearly 90% of farmers who completed the feedback survey were going to implement one activity to improve soil health on their farm over the next two weeks. Examples included the efficient use of effluent and local manures on dairy farms, comprehensive water and soil analysis on marginal soils, crop rotations and improved grazing techniques.
- Another major change has been an increase in optimism in farming and a passion to re-engage with agriculture as evident when interviewing participants following a workshop. As an unintended outcome, four producers have established production demonstration sites to showcase low energy input farming systems or practices as part of a parallel study funded by south east Queensland catchments to further extend information from this project.

Evaluation

The project engaged with over 400 farmers, advisors and extension staff and provided information about how improvements to soil health within agricultural production systems can be achieved in practice using alternative inputs with lower cost and lower embedded energy.

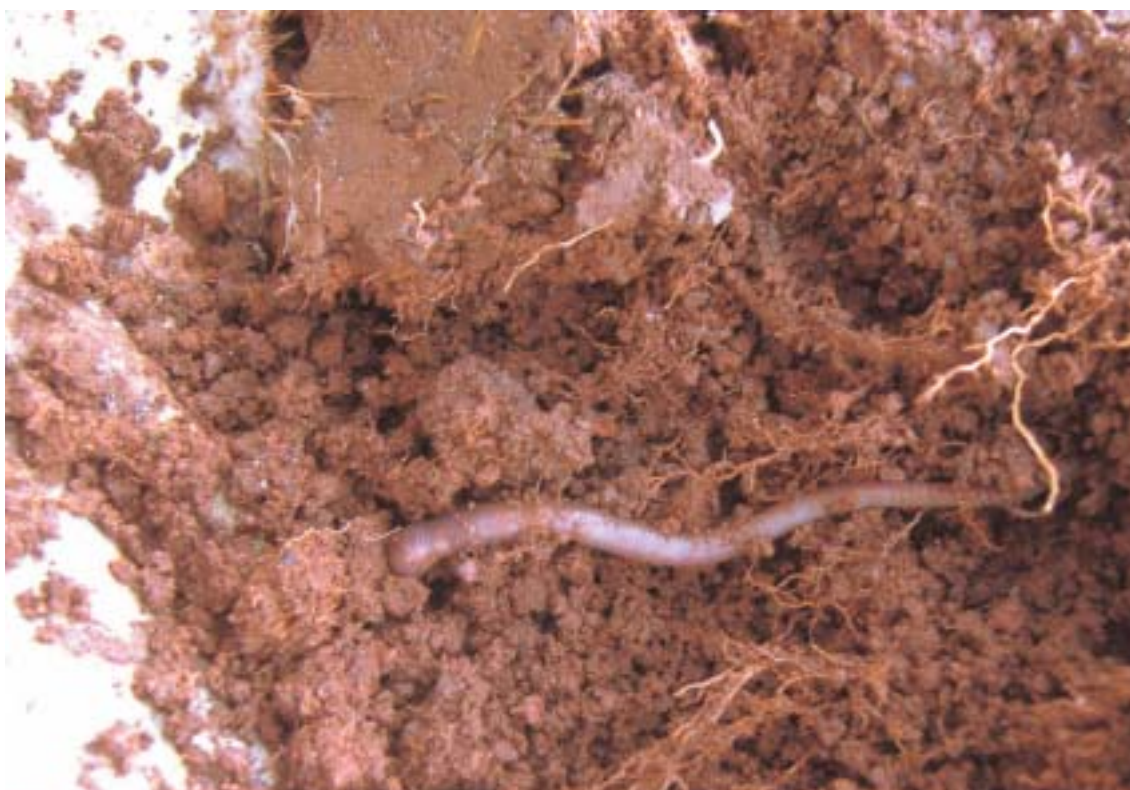


Photo NSW DPI.

Accelerating adoption of integrated soil management practices in irrigated cotton and grain (COC 4)

Project data [title, contractor(s), timeline]

- Accelerating adoption of integrated soil management practices in irrigated cotton and grain.
- Cotton Catchment Communities CRC. Main collaborator was NSW Department of Primary Industries, together with the Cotton R&D Corporation, CSIRO, Queensland Department of Primary Industries & Fisheries and some regional catchment bodies.
- 15 June 2006 to 1 September 2008. The HSSF Program provided funding of \$270,000; total funding for the project was \$1,210,000 in cash and in-kind.

Summary

The goal of this project was to rejuvenate soils extension and emphasise the importance of soil health in the irrigated cotton and grains systems throughout the cotton growing region spread from Griffith in southern New South Wales to Emerald in central Queensland. It used market research to determine the extension needs for healthy soils information and a benchmark survey of soil management practices. Existing information was collated and reshaped into an extension program consisting of training workshops, field days, regional soil forums, published case studies and on-farm demonstration sites. Relevant regional information was targeted at agribusiness, consultants, irrigated cotton and grain growers, government agency staff and regional natural resource management bodies.

Twelve case studies of healthy soil management were published. A soils web page was rejuvenated on the Cotton Catchment Communities CRC website. Three regional healthy soil forums were held in Goondiwindi, Narrabri and Hillston. Fifteen training workshops on soil nutrition, soil pits, understanding soil testing and property planning were delivered to agribusiness, consultants and farmers. Of respondents 75% thought the information in the workshops would increase their profitability, 88% thought it would increase their sustainability and 100% thought the workshops proposed useful indicators to assess soil health.

Project description

- Project objectives were to: develop, collate and reshape an extension program that provides a good foundation of soil health principles and management to increase the knowledge of growers; target farm advisors and agribusiness to increase knowledge of soil health; develop and implement locally relevant, integrated soil management strategies that increase the capacity and motivation to adopt good soil management practices; improve access to existing soil health information through the provision of a range of tools, advisory services, resources and extension activities, and; assist growers and advisors develop and implement on-farm monitoring systems that also encompass catchment outcomes.

- This project focussed on collating existing soil extension information for irrigated cotton and grains, targeting relevant soil health issues to specific locations and extending this information through a number of workshops, forums, case studies and other information transfer. This was done through employment of a soil extension specialist, and identifying specific soil health issues in the cotton and irrigated grains industry by undertaking a benchmark survey and holding focus groups in key catchments.
- Training workshops, forums and farm field days were held about these priority issues, case studies were published on relevant healthy soils topics to promote technology transfer, 12 growers and consultants were supported to attend the HSSF National Healthy Soils Symposium, and there was continuous communication with cotton and grain communities, urban communities and wider industry through industry publications, local newsletters and newspapers.
- Six field sites were established to test and demonstrate methods for managing sodic soils and the use of organic amendments; these sites will continue for two further years.

Project results

- The market research on grower needs for soil health information and a benchmark survey on farmer practices related to soil health in 2005 were completed and published.
- Eight soil health focus groups were held across the industry in New South Wales at Narrabri, Moree, Hillston, Hay and Mungindi and in Queensland at Goondiwindi, St George and Dalby with telephone interviews conducted in the Emerald district. Three healthy soils regional symposia were held at Narrabri, Goondiwindi and Hillston with 100 participants in total.



- Twelve case studies have been written on key topics related to healthy soils, and are available at the Cotton CRC website; they will be made available to the Healthy Soils Knowledge Bank. The field sites were established at Warren and Hillston (management of sodic soils), and at Hillston, Trangie, Dalby and Mungindi (use of organic amendments).
- Fifteen training workshops were held, based around the topics of soil biology (Warren), soil pits (Mungindi, Goondiwindi, Dirranbandi, Saint George, Mullaley, Emerald, Theodore and Carol), understanding soil testing (Moree, Dalby, Emerald and Theodore), the Cotton BMP Land and Water Module (Moree) and Cotton CRC soil database (Tamworth).
- A comprehensive guide was compiled and published on soil health topics covering soil biology, soil pits, soil nutrition and measuring soil health.

Communications

The project and its products have been publicised widely within the cotton and grains industries, government agencies, and regional catchment bodies and communities. A large range of communication publications on HSSF project topics and HSSF promotion has been produced in industry magazines and newsletters. These include *The Australian Cotton Grower*, *Spotlight* magazine, *Cotton Outlook*, *Cottontails* (the Cotton CRC regional newsletters), *CCA* (Cotton Consultants Australia) newsletter, *Lower Namoi Cotton News*, *The Land*, *The Australian Landcare Magazine* and *Agriculture Today*.

Photos this page, opposite and overleaf Cotton Catchment Communities CRC/NSW DPI.



Project outcomes

- The project has provided a streamlined, consistent and coordinated approach to soil extension throughout the irrigated cotton and grain growing areas in north eastern Australia. The majority of participants at project forums, training workshops and field days reported they gained new knowledge about the sustainability and profitability of soil management practices on farm, and about the principles of soil testing. The market research has improved the knowledge of R&D managers and extension providers about local soil health issues, and this will enable them to ensure well targeted R,D&E. Project extension materials will be incorporated in the cotton industry BMP Manual.
- Many growers reported an intention to change their soil management practices; the benchmark survey will enable better tracking of project outcomes over time.

Evaluation

This project has provided an effective mechanism for both extending information and instigating on-ground change to improve the health of soils for irrigated cotton and grains. The benchmark and market surveys provided a sound base for the collation and extension work. The project has delivered a consistent message across a wide area, been very efficient in collating existing soil information (rather than producing a range of similar extension publications from scratch) and given soil health the highest profile it has had on irrigated cotton and grain soils in more than a decade.



Managing Landscapes — matching soils, climate and enterprises (DAN 26)

Project data [title, contractor(s), timeline]

- Managing Landscapes — matching soils, climate and enterprises.
- NSW Department of Primary Industries.
- 20 June 2006 to 1 September 2008. The HSSF Program provided funding of \$300,000; total funding for the project was \$707,000 in cash and in-kind.

Summary

This project aimed to assist farmers in northern New South Wales to understand and assess the health of soils on their property and to make decisions about improved land use and management. It had a particular focus on the use of tropical, perennial pasture grasses to improve productivity while at the same time maintaining ground cover, reducing soil erosion and improving soil health. The LANDSCAN™ manual was customised for northern New South Wales and a series of six soil health workshops was provided to groups of farmers in the region to raise awareness and understanding of soil health principles and indicators. Demonstration sites were established with each group of farmers to investigate locally-relevant issues related to the successful establishment and management of perennial, tropical grass pastures. A soil health manual was prepared in collaboration with other HSSF projects, as well as a soil health card incorporating local benchmarks and targets for ongoing monitoring of soil health by project participants.

Project description

- Project objectives were to: present LANDSCAN™ workshops to 30 groups of 12–15 farmers, using the LANDSCAN™ manual customised for northern New South Wales, including more information on soil biology; establish at least one demonstration site, using the most suitable perennial grass species, with each group attending the workshops; using research links and on-farm research demonstrations, develop locally-based best management practices for each group of workshop participants; and produce soil health guides incorporating benchmarks and targets for ongoing monitoring of soils by workshop participants.

- The LANDSCAN™ manual was revised to include information on soil biology and to focus on soil issues relevant to the project area in northern New South Wales. The set of six workshop sessions was used to enable participants to understand and recognise the limitations of climate, landscapes and suitability of soils in relation to enterprises, farming activity and land use. As part of the workshops, farmers took representative soil samples and recorded their locations using GPS and were trained to recognise different soil structures and textures, and to interpret soil test results. At the completion of the six workshops, farmers were able to develop and understand local soil health benchmarks and to identify and implement appropriate management practices relating to soils on their farms.
- Perennial tropical grass species are currently not widely sown by producers in northern New South Wales because of their generally poor establishment and perceived problems in matching their seasonal production and quality characteristics to livestock production systems. However, these species offer significant benefits over existing temperate improved pasture species, due to a longer growing season and greater biomass production in the sub-tropical north as well as maintenance of year-round soil cover. Increased adoption of tropical perennial grasses will impact significantly on soil health by reducing erosion, increasing soil organic matter and biota and improving the landscape water balance. Demonstration sites showing different aspects of the use of tropical perennial grass pastures allowed participants to gain experience in pasture establishment including understanding machinery modifications and establishment techniques, and to evaluate BMPs developed by research and adapt them for their own farms and locality.



Photo NSW DPI.

Project results

- The LANDSCAN™ workshop manual and other training materials were reviewed and additional information included for northern New South Wales. This included additional information on soil biology, with presentation notes and simple practical procedures for farmers to monitor the activities of soil biota 'on farm'.
- Sixteen LANDSCAN™ workshops series (each series comprising six sessions) were commenced; some have been completed, others are ongoing and some new series are starting. So far a total of 252 farmers have been or are involved, representing 70% of the intended project target audience, a good outcome given the drought years experienced. "LANDSCAN DOWNS" was an interactive workshop exercise, initiated by the project team to enable participants to use new skills and knowledge to solve management and resource issues using limited funds for a simulated typical regional farm. This was a very popular exercise with the groups and increased their understanding of soil test interpretation and the need for ground cover and soil organic matter to be maximised under the northern New South Wales climate.
- Eleven tropical grass demonstration areas were established with a further 10 planned. A series of BMPs developed from other research for the establishment and management of tropical grasses were tested at the demonstration areas to show the adaptations that could be used locally. New South Wales DPI advisors in northern New South Wales have a strong pasture network that will help to ensure that these results are communicated across the region.
- A local soil health card incorporating benchmarks and targets for ongoing monitoring by participants was drafted and should be completed by the end of June 2008. The soil tests from the workshop groups have been entered into an excel spreadsheet to upload into the New South Wales Soil And Land Information System (SALIS) by a cooperating team in the Department of Environment and Climate Change.
- A 'Read Your Soil' manual and resources for farmer workshop facilitators was distributed to New South Wales DPI agronomists and horticulturalists. A fertiliser cost calculator to enable quick comparison of the cost of nutrients in various fertilisers, as well as a PBI (Phosphate Buffer Index) card ready reckoner for use when interpreting soil tests for application of phosphorous to pasture, were also produced and distributed.

Communications

- As well as direct communication to farmers and consultants/advisors through the workshops and demonstration sites, the Tropical Pasture Week held in April 2008 was an initiative of the project, running field days over six days and 13 sites; 273 producers attended the week, while field days in 2006 and 2007 on the tropical research site at Tamworth attracted 200 farmers.
- Six further Paddock Plant field days were used to signpost the availability of the LANDSCAN™ workshops, and also assisted land managers in identifying vegetation and plants as indicator species of soil health and land management. Timely press releases on radio, at field days and in local press highlighted outcomes from the tropical grass research.

- A number of additional delivery resources were developed by the project team to aid in development of knowledge and skills by farmers. These included: Growth tubes to show the impact of root development by various pasture species; Geological collections; Plant collections; Soil identification charts; Living tropical grass specimens; Calico strip tests for measuring activity levels of soil biota; Fill in charts to assist farmers calculate their nutrient needs estimated from soil nutrient test reports; and extra publications on soil health issues and soil management related topics.

Project outcomes

- As a result of the LANDSCAN™ workshops each group showed increased awareness and skills in: soil biology knowledge integrated with management and implications for soil health; using vegetation as indicators of soil type and other soil health and fertility indicators; soil properties and assessment and interpretation of soil tests; and matching landscape and soil resources to land use and management. Following involvement in the demonstration sites, growers and advisors are more aware of and able to apply with confidence the key BMPs required to ensure successful establishment and ongoing management of tropical perennial pastures; this will lead to improvements in soil health.
- It is estimated that 20,000 to 50,000 hectares of tropical grass pastures were sown during 2008 in northern New South Wales largely as a result of this project, and that by 2010 a further 200,000 to 250,000 hectares will be sown.

Evaluation

This project has successfully used education to help achieve on-ground change by linking training and field demonstration directly into practical outcomes. It also developed and provided training in a soil health monitoring system that has the potential to be implemented by farmers on a wider scale. The project gave soil biology a much higher profile in the region and this topic may be incorporated into other extension programs.



Photo NSW DPI

Accounting for nutrients on Australian dairy farms [A4N] (DRD 4800)

Project data [title, contractor(s), timeline]

- Accounting for nutrients on Australian dairy farms [A4N].
- Department of Primary Industries, Victoria. This is a national project with collaborators including Dairy Australia and its regional groups, state agriculture agencies and fertiliser companies and organisations.
- 14 January to 1 September 2008 for the HSSF contribution. The project itself commenced in 2006 and will be completed in 2010. The HSSF Program provided funding of \$100,000; total funding for the project is \$2.98 million in cash and \$4.7 million in-kind.

Summary

Dairy operations in Australia continue to intensify and the potential for nutrient surpluses within the dairy landscape are increasing. The Australian dairy industry needs a rigorous and standardised approach to nutrient accounting on dairy farms to assist farmers make profitable fertiliser decisions and meet increasing demands for improved environmental standards. The 'Accounting for nutrients' project will develop a standardised nutrient accounting framework for the Australian dairy industry that will better quantify nutrient inputs, outputs and within farm nutrient efficiencies, and reduce nutrient accumulation and losses off-farm. This national project includes all dairying states: Victoria, New South Wales, Western Australia, Tasmania, South Australia and Queensland, and will enhance the collaboration between fertiliser companies, dairy industry stakeholders, state and federal government science and policy, and dairy farmers and advisors.

Project description

- Long term objectives are: more efficient use of nutrients on farm and reduced nutrient losses off-farm; greater collaboration between fertiliser companies and dairy industry stakeholders to promote scientifically sound information about nutrient use efficiency; and an Australian dairy industry that is able to meet community expectations for nutrient management through self-regulation.
- The project aims to improve understanding of nutrient requirements, nutrient flows and potential losses at a paddock and farm scale, and to develop, refine and validate a nutrient auditing framework for nitrogen, phosphorus, potassium, sulphur, calcium and magnesium. It will improve the knowledge and practices of the fertiliser industry, private and government agricultural consultants, dairy industry field officers, and farmers relating to nutrient management within dairy farming systems.

- The primary method employed by the project is the measuring and monitoring of nutrient imports, exports and within-farm nutrient flows on a broad range of dairy farming operations across Australia. Forty four dairy farms have been selected for the study, following a statistical analysis of their location, climate, soils, production systems and management to ensure this sample is representative of the national industry. Quarterly farm visits will be made to all participating farms by the project's 'on-farm' teams. There are 14 regional teams nationally, who are responsible for liaising with farmers, organising visits, ensuring that they are familiar with the sampling requirements, and collecting information and samples from which nutrient budgets will be constructed.
- Detailed data will be collected from a range of sources including farm records (i.e. stock numbers, animal age and live weight, milk production, fertiliser inputs, imported forage), direct measurements (i.e. pasture, feed, manure, effluent, milk, soil, irrigation water, and where necessary model estimates (biological nitrogen fixation, atmospheric deposition, volatilisation, leaching and runoff).
- For each of the input and output factors, components will be sampled and laboratory analysis undertaken where possible. The variability around the nutrient concentration and amount of each component will be determined and results compared against estimated 'book' values and expected variability, derived from published information. Where this is not possible, these coefficients will be obtained from literature.



Photo Jenny O'Sullivan.

- The various input and output factors on each individual farm will be prioritised from most to least important, and their impact on the overall nutrient budget will be determined. From this analysis, it will become evident which factors would benefit from more accurate measurement and analysis.
- A selection of four to five organic farms will be compared with four to five conventional farms in similar geographical and climatic zones. Additional soil analyses will allow a comparison of these farming systems. Areas within farms that are markedly different (e.g. high versus low productivity areas, effluent treated versus non-treated areas, night paddocks, shelter areas, feed out areas and bush blocks) will be the focus for soil samples. In these areas, testing for labile carbon (as an indicator of soil biological health) will be undertaken.
- A detailed 'on-farm' experimental protocol document was developed to provide a comprehensive set of instructions for collecting data from the participating dairy farms. For each different nutrient pool, there is a description of the issues associated with collecting data, the methods for collecting data and a summary table of the data requirements. As well, customised diaries were provided to all farmers at the commencement of monitoring to allow them to record farm activities. Standard questionnaires have been developed and will be used by the on-farm team members during the quarterly farm visits and interviews. Detail about sample handling, storage and shipping, are all outlined in the project documentation. All of the data collected in this project will be centrally managed and stored on a national relational database.

Project results

As this project has only just commenced its main data collection phase it is too early to report results or findings.

Communications

The communication plan identifies as the primary audience 'next users', people who interact and communicate with dairy farmers. This includes dairy and fertiliser companies and other agribusiness, agency and CMA extension officers, and policy and program managers. The needs of this group are being defined and products and capacity building targeted to meet those needs. Some project outputs may be used directly by leading dairy farmers and advisors.

Project outcomes

It is too early to report on outcomes.

Evaluation

As this project has only just commenced its main data collection phase it is too early to report on evaluation, other than that the approach being taken is national in extent, comprehensive, and very thorough in its scientific basis and communications planning.

Sustainable farming practices in the mid-Loddon sub-catchment (MID 1)

Project data [title, contractor(s), timeline]

- Sustainable farming practices in the mid-Loddon sub-catchment.
- Mid-Loddon Sub-catchment Management Group (MSMG). Technical support has been provided by the Department of Primary Industries, Victoria.
- 15 April 2006 to 31 December 2008. The HSSF Program provided funding of \$69,300; total funding for the project was \$297,000 in cash and in-kind.

Summary

This project aimed to involve the mid-Loddon sub-catchment landholders in a community-based participative research project with the benefit of ongoing scientific support and monitoring. The main focus was a three-year trial of biological farming methods, which aimed to increase soil health and productivity by less paddock cultivation, retaining stubble (no burning), adding natural biological inputs and lowering the use of chemicals and artificial fertilisers. The project supported six growers on a variety of soil types and landscape positions in the sub-catchment to commence field trials of biological farming in a crop or pasture paddock, with treatments on a commercial scale. Knowledge transfer was implemented through newsletters, fact sheets and meetings, with community field days and site tours held each year to enable the wider community to be involved in ongoing site assessment and to learn more about the local soils and their management, productive capability and resulting regional impacts.



Photo MSMG.



Photo MSM/G.

Project description

- Project objectives were to: assist sub-catchment landholders to develop more efficient, economic agricultural production methods and also be aware of the broader environmental benefits gained from healthy soils in the catchment; create healthy soils by balancing soil chemistry, physics and biology; prove that improved biological activity can alleviate common soil problems such as acidity, salinity, compaction, and wind erosion, poor water retention and crop disease; develop farming systems and management practices that increase resilience of agriculture in the face of climate variability and climate change; increase the group's current knowledge transfer capability through a partnership established with the Bendigo Regional Institute of TAFE (BRIT); build on established strong partnership links with agencies and educational institutions; and establish appropriate monitoring and evaluation procedures to assess outcomes.
- The project supported six local farmers to undertake field trials of biological farming methods in a crop or pasture paddock with treatments on a commercial scale. Soils were tested to establish their physical/chemical and biological (soil food web) status. Field measurements were of a standard suitable for inclusion in the DPI Victoria and ASRIS soils databases.
- Each site included a 15 hectare area where a range of biological inputs and treatments were applied, with the balance of the paddock managed under current/conventional inputs and methods, and a 200 x 400 metre control area pegged on the dividing line between them. Soil samples from both treated and control areas were gathered and tested before the project began and each following year by DPI Victoria. Crop and pasture measurements were also completed each year.

- Biological farming treatments included a commercially produced compost with the addition of a variety of limes, minerals and molasses which was spread on all 'biological' sites in 2006 at 62.5 kg per ha. In following years the group made its own compost from chicken manure using a fermentation method, with resulting composts being of varying quality and spread at 2 m³/ha. The seed sown on the biological sites was treated with a biological seed dressing and sown with a Nutrismart/MAP 70/30 mix fertiliser at 80 kg per ha. In 2007, whilst waiting for spring rains a foliar spray was added to the biological sites which included Worm juice, VRM Cal booster, sea minerals and seaweed. Where weed control chemicals were used on the biological sites, Potassium Fulvate was added as a buffering agent.
- The website hub established with BRIT was not activated as it was found that the participating farmers' access to the internet was so unsatisfactory that the project had to resort to other means of communication, such as newsletters (posted), faxes and (the most successful method) group meetings held at least once or twice a month. Similar and additional methods of communication were used to present information to the wider community and to special sections of it.

Project results

- A wide range of data has been collected from the trial plots including standard and Albrecht soil measurements and soil food web analyses, crop establishment numbers, crop and pasture biomass, and crop yield/protein and harvest index. Earthworm samples were collected from conventional and biologically-treated areas on two trial sites for nuclear magnetic resonance metabolic testing to study earthworms' response to different environments and detect any presymptomatic indicators of stress and disease. Results showed that the land treatment appeared to have a significant effect on the worm's metabolism.
- Although there are some differences suggested between the treated and control areas, no definite conclusions can be drawn yet. A consistent increase in soil organic carbon on the biological sites was measured, perhaps reflecting the compost additions. It was observed that this increase was reflected in a greater moisture holding capability of the 'biological' soil even with the drought conditions. Higher earthworm numbers on the biological treatment areas were also observed.



Photo MSMG.

- The project has also provided many education and training events for local farmers, including workshops and seminars on local soil types, links between soil and animal health, use of foliar sprays for crops and pastures, using chemicals and application equipment, soil condition and weed control, integrated pest management, use of GPS and yield monitoring, and making and using compost and its effects on soil. A course in recognising soil types and soil testing methods was provided to local school teachers and students.

Communications

Communications products include a DVD of a children's digitally animated soil health story (150 copies produced with associated posters), monthly project newsletters and 22 soil health articles (circulation of 300), a regional *News & Views* magazine and a fact sheet about compost production (80 produced), as well as press releases.

Project outcomes

- The group members now have a greater awareness of the benefits of healthy soils producing healthier pastures and healthier stock. The farmers have become much more interested and observant of their soil conditions and any changes occurring through different management actions. Even though the dry conditions continued, the project has provided farmers with the knowledge that they can make changes to their current management and become more sustainable to buffer against future droughts.
- Because of the project providing an increased understanding of their soils and how best to manage them, some farmers have upgraded their agricultural machinery and others will follow if the seasons improve. The project participants and also many of the wider farming community are now increasing their paddock soil organic content through the use of manures/compost, retaining stubble and installing protective shelterbelts. The number of actively participating farmers is steadily increasing through attendance at workshops, field days, discussion and social events, and group members have requested a continuation of the current trials with an extension into Lucerne trials and planning for soil health at the whole-farm scale.
- Other outcomes include the involvement and education of local school children about local soils and soil health, and the development of a strong and active partnership between the farmers and DPI Victoria scientists.

Evaluation

This project has successfully used new information together with education and training activities and on-farm trials to help achieve on-ground change. Local farmers have become more aware of the importance of soil health and ways in which it might be improved. The project has highlighted that changes in one aspect of farming (in this case management to improve soil health) may require a re-think of the whole farm enterprise.

Sustainable soil health management workshops for northern broadacre cropping industries (QPI 64)

Project data [title, contractor(s), timeline]

- Sustainable soil health management workshops for northern broadacre cropping industries.
- Queensland Department of Primary Industries & Fisheries, NSW Department of Primary Industries, Nutrient Management Systems P/L.
- 15 June 2006 to 1 December 2008. The HSSF Program provided funding of \$703,000; total funding for the project was \$2,012,000 in cash and in-kind.

Summary

This project was developed to assist farmers and advisors in the sugar, grains and cotton industries of Queensland and northern New South Wales. It enabled participants to learn the principles of soil health, to develop the knowledge and skills to assess soil health on their own farms, and to select and implement practices that can improve their soils for the future. A range of interactive workshops and field activities was developed and is being used across the region including: introductory workshops to understand and assess soil health; specialised workshops to balance soil water and nutrients during the prolonged drought, and to understand soil organic carbon and carbon sequestration; and specific technical training for commercial advisors.

Project description

- Project objectives were: to develop and deliver 'Sustainable soil management' workshops to around 500 grain, sugar and dryland cotton producers and their advisors in Queensland and northern New South Wales; to develop and deliver extension publications and activities relating to soil health throughout the Queensland and northern New South Wales grain, dryland cotton and sugar industries; to develop and validate tools and processes to quantify the soil health status of cropping soils; to facilitate the conduct of on-farm research to validate and demonstrate locally relevant best soil management practices; and to compile a database to benchmark the current soil health status of Queensland and northern New South Wales cropping soils.
- The project has used an interactive workshop approach which recognised that to make informed decisions and be able to implement practices that will improve their soil health, land managers and their advisors must recognise the need for change, possess a knowledge of their current soil condition and the fundamental soil health processes that will determine the most appropriate management practices for their individual situation, and develop the skills to select and implement improved management practices. An initial market survey of the project audiences showed that while soil health issues were broadly similar across the regions and industries, there were also specific local topics that would need to be accommodated in the different workshops in order to make them fully relevant to and able to engage with the participants.

- Workshops were redesigned to take account of the survey results. The general workshop structure was developed to: (1) help people understand the basic principles of soil health that applied across all industries and regions; (2) use team members' local experience to apply this understanding to the issues of concern in their region/industry; and (3) support further local research with established networks as required to further investigate issues or test the outcomes of their decisions. It was also clear that a series of two or three shorter 'hands-on' workshops over a year was required rather than a single two-day workshop as first envisaged.

Project results

- The first step was a review and synthesis of existing knowledge about soil health relevant to the project. A Soil Health Technical Manual was compiled to support facilitators of the workshops and the in-field activities. Other general information products were also prepared for workshop participants and the wider community. The project subsequently developed a series of workshop manuals, results booklets, soil health assessment tools and press releases to support general inquires about soil health.
- In addition to general field days and talks at activities organised by others, the project developed a series of different workshop and field activities in response to the market research, the ongoing drought and the established institutional networks of team members. Each activity focused on the 10 functions of a healthy soil, and the soil properties, processes and practices that supply these functions for profitable and sustainable crop production.
- These activities included: a general 'Introduction to soil health for dryland grain/cotton in Queensland' workshop; use of soil pits to demonstrate soil profiles and properties; farmers bringing their own soil to a workshop and using the Queensland University of Technology soil health test kit and other hands-on activities to understand and assess their own soils; specialised workshops for dryland grain/cotton in Queensland (e.g. on balancing nitrogen and water, and on the importance of soil organic matter), a three-day workshop series for dryland grain/cotton in New South Wales, a workshop on 'Satellite imagery and on-farm research for cane producers', and use of the Soil Health Assessment Guide for technical workshops for advisors.
- Seven sets of materials were developed (Queensland Healthy Soils workshop manual; New South Wales Healthy Soils for Sustainable Farms workshop manual; Fit for Farming agronomist training notes; Balancing Water and Nutrient Supply factsheet; Results booklet — soil characterisations; Assessing Soil Health — a guide to assessing soil health on your farm; Healthy Soils technical manual).

Photo NSW DPI.



- To date, 48 workshops have been conducted with over 650 farmers, advisors and R,D&E staff, who manage over 1.5 million hectares in total. Participants overwhelmingly believe that they now have better knowledge and skills to improve the health of their soils. Furthermore, over 270 farmers and agronomists have assessed soil health on their farms, with more than 400 assessments expected to be included in the project's 'benchmarking database'. They estimate an average of 32% of their land has significant soil health problems. While few major changes in practice were anticipated within the current funding term of the project, 50% of evaluation respondents reported an intention to change their soil management practice.

Communications

Communication is the key activity of this project and as well as the workshops the project team also undertook many talks at field day/activities organised by others, prepared summary articles (e.g. 'Soil Health Q&A' in Farming Systems newsletters posted to farmers and agronomists) and sent out direct mail and flyers to raise awareness and promote project activities.

Project outcomes

- Evaluations confirm that the 650 participants in project activities overwhelmingly believe they now have better knowledge and skills to improve the health of their soils. For example, the great majority agreed that their participation had increased their knowledge of how soil properties and processes affect soil health, proposed useful indicators to assess soil health, improved their ability to assess the health of their soil, improved their ability to identify soil health priorities, and to implement changes on their farm.
- Evaluations also showed that participating farmers and agronomists had gained a greater awareness that soil health and their own soil health problems have chemical, physical and biological components. Anecdotal evidence from farmers and agronomists also confirms their growing recognition of soil health as more than simply soil biology. Few major changes in practice were anticipated within the current funding term. Fertiliser rates were commonly changed to meet seasonal conditions. However, participants also reported changed management activities (e.g. assessing their soils) and 50% of respondents nominated practice changes that they intended to make following their involvement with the project.
- The strong cooperation developed with other HSSF projects (across both geographic and organisational boundaries) and opportunity to coordinate work with CMAs and other NRM bodies were welcome if unintended outcomes.

Evaluation

The project has exceeded expectations and engaged well over 500 farmers and agronomists despite the widespread drought conditions that prevailed throughout much of the project. This successful engagement can be attributed to the project's initial market research and the commitment to refine methods to meet potential participants' needs. Consequently, the workshops were based on helping participants understand basic principles of soil health and using their own farm data to apply these principles to their own local situations. The project successfully developed materials that have helped many farmers and agronomists to understand soil health and will improve their soils. However, there is considerable potential to continue this work in grains, cotton, sugar and other industries in response to the unmet demand.

Identify farm management practices that promote healthy soils and investigate the use of a soil health index to monitor changes in soil health (SOT 4775)

Project data [title, contractor(s), timeline]

- Identify farm management practices that promote healthy soils and investigate the use of a soil health index to monitor changes in soil health.
- SoilTech Soil and Pasture Consulting.
- 15 October 2007 to 1 August 2008. The HSSF Program provided funding of \$45,000; total funding for the project was \$90,000 in cash and in-kind.

Summary

This project aimed to use a large database of geo-referenced and analysed soil samples available in Western Australia to test whether some of the soil parameters measured could be used to develop a soil health index. The initial hypothesis was that soils with a near neutral pH and high organic matter content are more healthy, and that some relatively simple indices based on measured soil characteristics could be used to assess soil health and its trend over time. Once one or more indices were established, Western Australian farmers with soils of varying health would be interviewed to determine which of their management practices (such as liming, fertiliser use or including pasture in rotation with crops) had been contributors to the formation and maintenance of healthy soils. Communications materials showing the project findings with reputable case studies would be published to promote management practices for healthy soils.

Project description

- Project objectives were to: examine a database of more than 85,000 geo-located soil sampling sites across the agricultural region of Western Australia (available to Precision SoilTech, Soil and Plant Consulting); identify Western Australian farmers that have developed management practices that create and/or sustain healthy soils; determine the effect of correlations between a range of soil health indices (SHI) on soil health, part of testing the hypothesis that soils with near neutral pH and high organic matter content are 'more' healthy; interview farmers that have 'created' the soils with varying SHI to determine the key management practices that have contributed to the formation and maintenance of healthy soils; identify what effect the practices identified have had on productivity and profitability of individual farmer's properties; and develop promotional material in the form of case studies of reputable growers to outline their experiences and methods, in order to promote their practices to other growers.
- A desktop analysis of the soil test data was undertaken to identify parameters that could form a soil health index. A range of data was examined for consistency, possible relationships between measures, and for relationships to climatic or other variables not related directly to soil health.



Photo DPI Victoria.

- Farmer interviews were conducted in four regions, selected within the southern Western Australian agricultural region so as to adequately sample its climate and soil variability. Data was collected about the farmers' management practices and their perceived effects on productivity and profitability as well as on soil health indices.

Project results

- Interrogation of the database was undertaken using Excel, statistical program Genstat and GIS program Geomedia, with a focus on data for pH and soil organic carbon. No clear correlation or change over time could be observed on a statewide basis probably due to the variability of the data set. Data about soil nutrients nitrogen, phosphorus, potassium and sulphur in the database was also very variable and meant they were unlikely to be suited to use in a soil health index.
- Further work focused on organic carbon and pH as these factors are less volatile and may therefore give a better reflection of the effects of farm management. However, they can also be more closely correlated with other factors such as rainfall and soil type, so some type of normalisation for these factors may be required.
- Transects were established both across and along rainfall isohyets within the southern Western Australian agricultural region, and four regions identified that also included transition areas from pastoral regions to primarily cropping regions. The regions were located in the Northern, Eastern, South Eastern and Upper Great Southern agricultural zones. The GIS program, Geomedia, was used to first select the geo-located sampling points within transects. With the new subset database farmers were selected with above average soil quality on the basis of their soil tests for a particular rainfall isohyet. Approximately 10 farmers were then interviewed across each region.
- Interview responses are being analysed to determine whether there are relationships between management practices, soil health indicators, and perceived productivity and profitability.

Communications

Communication activities await completion of the interview data and correlation with soil test indices.

Project outcomes

The analysis of the soils database showed that many of the parameters measured in standard soil tests are unlikely to provide the basis for a useful soil health index, due to their large variability. Expressing indicators as percent of potential in an effort to account for both soil type and environmental factors was investigated with pH and organic carbon. Further improvement of the model is still required, however it is a potentially useful approach to soil health assessment. In addition the development of a rotation index was also investigated for its use in indicating sustainability and diversity of rotations.

Evaluation

This project provided an excellent opportunity to use a large, existing soils database to test whether standard test information can be used to produce an index of soil health, and whether health can be linked to management practices and profitability. However, this approach has significant challenges to overcome, as the test data did not include some key aspects of soil health and the relationships between management, soil health and productivity may be diffuse, variable and difficult to detect amongst a large amount of natural and induced variability.

Photo HSSF Program.



Defining and promoting soil health for sustainable production systems (UQT 3)

Project data [title, contractor(s), timeline]

- Defining and promoting soil health for sustainable production systems.
- Queensland University of Technology. Collaboration with several HSSF projects and industry and catchment groups.
- 15 March 2006 to 1 August 2008. The HSSF Program provided funding of \$237,000; total funding for the project was \$561,000 in cash and in-kind.

Summary

This participatory project involved education and training of soil health concepts through existing industry networks of land holders and natural resource management groups from the Sunshine Coast region of Queensland to northern New South Wales. It combined farmer, advisor and researcher knowledge in the development and implementation of qualitative soil health scorecards and a quantitative 'hands-on' soil health test kit. These combined the power of proven laboratory-based tests with simple field-based observations and tests to demonstrate soil health concepts and the strategies which will improve soil health, that is, the soils ability to function at optimum levels for sustainable production. Scorecards and soil health manuals were delivered through a series of soil health workshops, many developed jointly with other HSSF Program projects. The kits were demonstrated at workshops, and also distributed to a wide range of landholder, industry and catchment groups. Comprehensive laboratory assessments for 15 agricultural sites were undertaken to develop benchmark soil health information, and the amount of CO₂ evolved as a proportion of total soil organic carbon was found to be a suitable index of soil health for soils containing 30% or more clay.

Project description

- Project objectives were: the education of soil health concepts and the development of locally adapted qualitative soil health 'scorecards' for self-assessment at the field level; the implementation of a quantitative soil health test 'kit' for direct on-farm assessments; and the development and implementation of a laboratory-based soil health/quality 'index' based on field and laboratory assessments.

- A soil health scorecard was developed for on-site assessment by growers, land managers and advisors of a soil's ability to sustain productivity in the long-term, predominately by using visual observations such as erosion, ground cover, waterlogging, crop appearance, or soil colour. The scorecards were designed specifically for each industry and eco-region, with a varying number of indicators selected through local workshops, and then checked by field-testing. The completed cards were marketed and distributed widely and served as a communication and learning tool for educators at all levels. Whilst the scorecard was primarily a tool for self assessment, the data within the completed cards were geo-referenced by project staff to allow comparisons in space and time as a function of region, soil, climatic, crop and management differences.
- The soil health kit includes a series of simple field-based tests to identify the effects of management practices through interpretation of soil properties. Land holders can assess changes in soil properties (on a subset of the same fields used in the scorecard approach) to quantitatively benchmark management practices that can best enhance soil health and relate them to economic performance (yield and returns). The core tests are: soil respiration (biological activity), infiltration, bulk density, electrical conductivity, pH, soil mineral nitrogen, aggregate stability, slaking, earthworms, soil physical observations, and water quality. The approximate wholesale cost of a kit is \$800. Training in the use of the kit was provided through on-farm workshops where both the scorecard and kit were demonstrated and used under field conditions. Seventy kits were constructed and provided to landholder, industry or catchment groups.
- Laboratory-based soil health assessments were performed on selected soil samples with a known history collected during the project's training activities. They were designed to underpin the potential development of rapid field tests, and to contribute to knowledge about soil organic carbon dynamics and its relationship to soil health. They also provided data to test models of soil carbon that align with the National Carbon Accounting System (NCAS) as results could be advantageous for landholders in identifying management strategies which accumulate soil carbon and reduce atmospheric carbon dioxide concentrations.

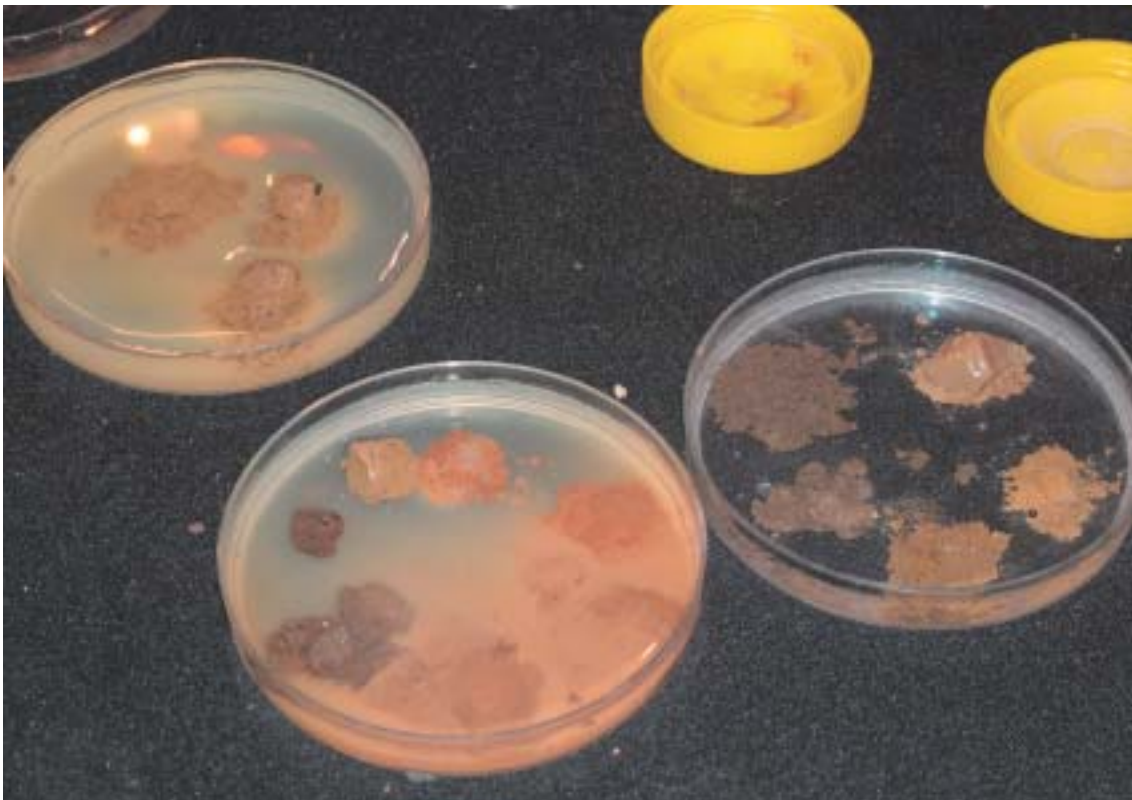


Photo LWA

Project results

- A total of 36 soil health workshops were completed, attended by 800 people. Ten of these workshops were jointly developed with the HSSF QDPIF dry land cropping project. Soil health concepts, scorecards and soil health kits were demonstrated in a classroom situation, prior to practical field applications in a field setting. The project was also invited to present its innovative use of soil health scorecards and test kits to two large conferences (Sunshine Coast Environment Council and New Zealand Foundation for Agricultural Research).
- A standardised soil health scorecard was produced, and accepted by the majority of the workshop groups, with some minor changes needed for specific modifications made for the extensive grazing industry. Over 1000 A5-size scorecards were distributed and made available at workshops, forums and conferences.
- Seventy soil health test kits were constructed and distributed to a wide range of landholders and advisory groups; 15 of these were funded and used by other HSSF projects. Each kit also contained a laminated summary of the test methods and calculation and interpretation sheets for ease of use in the field. A soil health manual was developed to provide both a detailed methodology of the test kit assays as well as the calculations required. Over 500 manuals were distributed to workshop attendees.
- Comprehensive laboratory assessments for 15 agricultural sites (and one native forest benchmark site) were completed and results reported. These included four specific chemical fractionation procedures (three for determining active carbon fractions and one for resistant carbon), long-term aerobic soil incubations and CO₂ assay, soil microbial biomass carbon and mid infrared analysis to determine total organic carbon, particulate and charcoal fractions, and soil texture, EC and pH. The amount of CO₂ evolved as a proportion of total soil organic carbon was found to be a suitable index of soil health as it aligned itself with a key sustainable management practice of crop residue retention, reduced cultivation, and high carbon inputs (e.g. the inclusion of pastures).

Communications

A range of methods was used to raise awareness of the project and to organise participants for workshop groups in the coastal region stretching from Bundaberg in Queensland, south to Woodburn in New South Wales.

Project outcomes

- The highly participatory nature of the project played a role in developing a truly collaborative and cooperative national approach to soil health assessment and the use of simple tools for educating land holders and advisors. The user-friendly scorecards and soil health test kits, which have now been successfully used within and beyond the project region, enabled landholders to quickly gain a greater understanding of what constitutes soil health and why it is important for both production and environmental condition.

- The direct exposure of over 800 landholders and advisors showed the value of the project's information on soil health concepts and the scorecard and kit to aid in the teaching of soil health concepts. The landholder and advisory community enthusiastically embraced the use of the practical, hands-on aspects of this project, with qualitative scorecards and quantitative soil health test kits clearly identified as suitable enabling technologies for educating soil health concepts, especially the underpinning role of soil carbon in sustainable agriculture and adapting to climate change. The training of skilled professionals was identified as a critical ingredient in continued development of soil health programs which empower land holders in sustainable management of soils for increased productivity and profitability.
- The comprehensive laboratory assessment of 15 agricultural soils and one native forest soil provided new information on the impacts of agricultural management on soil health indicators in intensively managed agricultural systems, together with the development of a new soil health indicator for clay-based soils.

Evaluation

Independent evaluation showed that 90% of workshop participants rated the project's soil health scorecard as a useful and user-friendly monitoring tool for use on their own properties. The project has successfully developed and demonstrated an effective method for education and training in soil health that could be adapted for continued use in its region and elsewhere.



Photo LWA.

Improving soil health in Western Australian farming systems (UWA 54)

Project data [title, contractor(s), timeline]

- Improving soil health in Western Australian farming systems.
- The University of Western Australia on behalf of Agricultural Research Western Australia (ARWA). Major collaborators included the Department of Agriculture and Food Western Australia, the Avon Catchment Council, Australian Soil Monitoring Services, Planfarm, Precision Soil Tech, The Grower Group Alliance and farmer groups.
- 30 May 2006 to 1 November 2008. The HSSF Program provided funding of \$940,000; total funding for the project was \$1,724,000 in cash and in-kind.

Summary

This project aimed to establish a series of benchmarked sites to identify and highlight the nature and extent of soil biological, chemical and physical constraints within the cropping areas of southern Western Australia, and to establish through collaboration with grower groups demonstration sites that addressed issues relevant to best practice for the future production and sustainability of the soil resource. The project provided soil health workshops (tailored to specific issues for a region) to grower groups and agribusiness, and increased the awareness of a larger number of growers through delivery of general soil health information at regional field days. Farmer participation in soil collection was used to further engage the audience, and an innovative website (www.soilquality.org.au) used to provide education and training materials and to deliver soil analyses and regional comparisons to farmers. Much of the results and products of the project can be extended to the wider community of landholders beyond the cropping industry and Western Australia, as is currently being done with the Murray Catchment Management Authority in New South Wales.

Project description

- Project objectives were: to develop a state-wide (by agricultural region) soil health monitoring program (in association with the Avon Catchment Council and South Coast NRM soil health projects) that can be used to identify primary soil biological, chemical and physical health issues and increase awareness of their influence on a regional basis; to develop management strategies to overcome these constraints, delivering this information to growers and agribusiness through a series of workshops and demonstration trial sites; to undertake soil monitoring, evaluation and extension in collaboration with regionally located Department of Agriculture and Food staff (nodes in Geraldton, Esperance, Albany), whilst the establishment of extension networks and information dissemination will be achieved in collaboration with staff from the Grower Group Alliance, Local Farmer Group Network and agribusiness.

- A mix of regional workshops, presentation of general information at agricultural field days, and demonstration sites was used to help raise awareness about soil health among farmers, advisors and extension staff.
- The comprehensive soil monitoring program was conducted in collaboration with regional Department of Agriculture and Food staff and grower groups. A total of eight initial Western Australian catchment groups were engaged in soil health workshops and associated soil quality benchmarking, and two additional groups in Western Australia and one group in New South Wales (the Murray Catchment Management Authority) adopted the soil health program of activities. Soils were analysed for a range of biological, chemical and physical parameters, to a depth of at least 30 centimetres or deeper where growers paid the additional costs.
- Individual growers have been provided with their unique paddock ID code so that they can access their paddock specific soil health reports from the www.soilquality.org.au website as well as seeing how their results compare with regional data. Computer training sessions using regional teleconference centres were used to assist grower access to, and use of, the website which also includes economic calculators for primary management options. Expert panels of leading agribusiness, extension and scientists were used to assess the project and website and to define critical values for soil quality indicators in the Western Australian wheat belt.

Project results

- Nearly 500 people attended the 22 workshops provided by the project, including the initial and final soil health workshops conducted with Western Australian grower groups, and specialised workshops for the Western Australian dairy industry on specific aspects of soil health.
- An initial 200 paddock data sets was later expanded with a further 80 paddock sets from two southern Western Australian catchments. The number of soil assessment sites was increased from the initial 320 to 570 and then (with additional external funds) to over 1000. Farmers were provided access to the results from their own paddock sites and were able to compare these with regional range and average values for each measured soil parameter. Fact sheets available from the website, as well as specific advice from workshops and public and private advisors, provided information about possible responses to the soil test results. Economic analyses of management practices that enhance soil health were developed and made available to farmers and advisors as interactive calculators on the soil quality website.



Photo LWA.

- A survey about attendees' initial knowledge of soil health was completed during workshop sessions, and a re-survey at the end of the project will provide an evaluation of what increases in knowledge and skills those participating in the project have gained. The workshop audience was around 83% farmers, 11% agribusiness, 4% extension staff and 2% researchers. Few respondents reported that they had a 'high' level of knowledge about soil health, but it was noticeable that individuals believed they had a greater understanding of soil physics and chemistry compared to soil biology. Three quarters of those surveyed cited low soil organic matter as a primary constraint to production.
- The project distributed to growers, agribusiness and natural resource managers 3000 copies of a glossy 8-page brochure that highlights the key facilities available on the website. The site includes 25 fact sheets that relate to the soil quality indicators and calculators. This website currently receives 100–200 visitors per week, with over 50,000 page views since it was established. This website won the 2007 Western Australian web awards "Not for Profit" category for best design.

Communications

As well as the workshops the project team also gave many talks at field day/activities organised by others in both Western Australia and the eastern states, prepared summary articles for farm journals, achieved broad press coverage in rural newspapers newsletters and sent out direct mail and flyers to raise awareness and promote project activities. In addition the project findings were a key feature of the annual Western Australian Soil Health Forum which attracts over 100 people mainly from the agribusiness and extension sectors.

Project outcomes

- Around 250 farmers and other participants have been involved directly in the soil health workshops and monitoring program, and have gained new information and skills. About 160 have access to the data recorded for their own paddock sites and are able to determine what changes in land use and soil management could be used to increase production and soil health. A much larger number have become more aware of soil health issues and how they affect both production and long-term sustainability of the farm enterprise.
- The website has become an effective way of promoting soil health and of providing information, education and training materials to a wide audience. The website is structured to enable comparison of soil health attributes through time thus encouraging longer-term monitoring concepts. It is at present focused largely on data and information from Western Australia, but could be expanded to become a major national hub of soil health knowledge.

Evaluation

The project engaged with over 500 farmers, advisors and extension staff at different levels of information about soil health and soil management. It has developed a highly successful program for on-farm assessment of soil condition and trend over time, enabling landholders to know whether problems exist and what can be done about them. The workshops enabled participants to understand the basic principles of soil health and to use their own farm data to apply these principles to their own situations. The soilquality.org.au website has been enhanced to the stage where it could become a major national hub of soil health data and knowledge.

Soil Health — leaving a legacy for south eastern Australia for the Healthy Soils for Sustainable Farms Program (VPI 9)

Project data [title, contractor(s), timeline]

- Soil Health — leaving a legacy for south eastern Australia for the Healthy Soils for Sustainable Farms Program.
- Department of Primary Industries, Victoria. Partners were Birchip Cropping Group (BCG), Mallee Sustainable Farming Inc. (MSF), Nutrient Management Systems, Rural Solutions South Australia, and Southern Farming Systems Ltd (SFS).
- 15 June 2006 to 1 October 2008. The HSSF Program provided funding of \$1,070,000; total funding for the project was \$2,279,000 in cash and in-kind.

Summary

This project, led by DPI Victoria, was a catalyst to provide a collaborative and unified approach to addressing soil health issues across south eastern Australia through a partnership including state agencies (Victoria and South Australia), agribusiness/knowledge brokers (Nutrient Management Systems) and farmer networks (BCG, SFS, MSF). The development of industry and landscape-specific information products through this project has assisted in identifying farming systems and/or practices in south eastern Australia that could be adopted to achieve improved soil health outcomes. The project has collated and packaged current soil health knowledge at a landscape scale focussed on the cropping industry, at a level relevant to agribusiness and state government advisors as well as leading farmers. The project has used local demonstration sites where appropriate to promote soil health management practices at a local scale. Interactive workshops have been developed and conducted to deliver prepared information about assessment of soil health for farmers and for advisors in both the private and public sectors. It has left a legacy of enhanced knowledge and capacity around soil health for the future. The soil health information and module material will be made available through the DPI sponsored website — Victorian Resources Online: <http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/vrohome>

Project description

- Project objectives were: to provide a consolidated source of information on soil health issues in south eastern Australia, rather than the current ad hoc approach to this issue; to provide an approach that is adaptable to industry or landscape needs, for answering the question 'how do I know if my soil health is improving?'; and to maximise project 'legacy' by ensuring information is transferred to farmers through farmer groups and agribusiness, using appropriate and relevant training and capacity building approaches.

- The project had three main components: knowledge integration and access, demonstration sites (paired if possible), and training and capacity building for farmers and advisors. It built on the existing soils knowledge generated by researchers and farmers, promoted applied learning locally with the use of demonstration sites, and left a legacy with farmers and advisors through the training and capacity building activities. The key role that private and public sector advisors play in delivering information to farmers was recognised through engagement with these groups. The focus areas for delivery of these components were the Mallee wheat-sheep zone of north west Victoria, and South Australia; the Wimmera wheat-sheep zone of western Victoria; and the high rainfall wheat-sheep zone of south west Victoria, south east South Australia and Tasmania.

Project results

- A Market Needs Analysis survey was undertaken at the start of the project, and showed a general lack of understanding of soil health (which was often equated to soil biology). Respondents identified a wide range of soil health issues, including declining organic matter (raised in all regions), erosion, compaction, and declining soil fertility. Assessment of soil health was considered to be inadequate, and those surveyed were keen to know more about farming practices that could improve soil health. The survey also identified the preferred learning styles of respondents, and this knowledge was used in preparing and delivering the project's education and training materials and workshops in the form of theory/workshop sessions balanced with field and practical, hands-on activity with easy to use supporting material.
- Soil health knowledge has been collated into a set of nine modules, together with fact sheets and technical notes as part of the information package. These include substantial technical information and are aimed at farm advisors and agency/group staff. This information can then be used selectively according to local needs, customised as required, and used as the basis for local training activities. It also provides a framework for the Victorian Government Healthy Soils project and will be available through the Victorian Resources Online website.
- The modules were also mapped to the competency standards of the National Training Information Service. While most farmers do not seek accredited training, this may change in future and the accreditation will be valuable for agribusiness advisors and for more formal delivery such as the Environmental Management Action Plan project (EMApp) conducted in the Mallee and northern Wimmera, and when TAFE and other educational institutions are intending to use the modules and materials.
- Three pilot delivery workshops were held and some changes made to the training materials as a result. Workshops will be progressively delivered by DPI Victoria and project collaborators, continuing after the completion date of the project. So far around 100 agency staff and advisors as well as about 450 farmers have attended soil health field days or training workshops.
- It was proposed that paired demonstration sites would be used to demonstrate local soil management practices and their impact on soil health. As the benefits of soil interventions often take longer than the project duration to be realised no new sites were established, but instead the project took advantage of existing demonstration sites. By providing additional soil information for these sites and linking them to workshop topics, the project was able to combine the principles of soil health knowledge with on-ground demonstration of practical ways to achieve them. Detailed fact sheets were prepared for the 21 sites and will assist future assessment of changes in soil health.

Communications

The project has been focussed on the delivery of the best soil health information and science, mainly through the use of modules and field days, to farmers and advisors. Other events, articles and newsletters and radio interviews have been used to publicise both the project and its outputs. All of the notes, slides, work sheets and practical/technical notes have been provided as colour handouts for each module and are freely available on the Soil Health Project Forum website. All participants are able to access this information.

Project outcomes

- Awareness of soil physical, chemical and biological properties has significantly increased through training events and improved access to soil health information. Evaluation conducted at recent field days and workshops provided evidence from participants that the workshop increased their awareness of soil health, and also how to address poor health issues of their soils. Enthusiasm by participants to attend future training events, particularly around the topics of soil biology and organic matter, are testimony to the increased awareness of soil health and healthy soils issues.
- Effective delivery of training material in workshops and field days has encouraged farmers and advisors to make changes to current land and soil management practices through increased recognition and understanding of the importance of soil health. Evidence of this has been gathered through event evaluation where key learnings reported by participants included: 'farming practices to enhance and protect soil health', 'aware[ness] of how important soil conservation is and how to look after soil structure', and 'investigate the soils on our farm more, and thus improve soil quality/productivity'.

Evaluation

The project has successfully collated a large amount of knowledge about healthy soils and their management in the form of a series of modules suitable as the basis for education and training activities. This material is readily available and is a major legacy of the project. Delivery of the material through workshops and field days has commenced and is progressing well. Field sites have been used to demonstrate practical aspects of health soils management, and the baseline data will enable further assessment of effects in the future.



Photo BFA / SSA.

Abbreviations and acronyms

ACIAR	Australian Centre for International Agricultural Research
ANAO	Australian National Audit Office
ANTA	Australian National Training Authority
ARWA	Agricultural Research Western Australia
ASRIS	Australian Soil Resource Information System
AWI	Australian Wool Innovation Limited
BCG	Birchip Cropping Group (a grower group)
BFA	Biological Farmers of Australia
BMP	best management practice
BRIT	Bendigo Regional Institute of TAFE
CMA	Catchment Management Authority
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Australian Government Department of Agriculture, Fisheries and Forestry
EC	electrical conductivity (a measure of salinity)
GIS	Geographic Information System
GPS	Global Positioning System
GRDC	Grains Research & Development Corporation
HSSF	Healthy Soils for Sustainable Farms
LOTE	Language Other Than English
LWA	Land & Water Australia
M&E	monitoring and evaluation
MERI	monitoring, evaluation, reporting and improvement
MLA	Meat & Livestock Australia
MSF	Mallee Sustainable Farming (a grower group)
MSMG	Mid-Lodden Sub-catchment Management Group
NCAS	National Carbon Accounting System
NIS	National Investment Stream
NRM	natural resource management
NSW DPI	Department of Primary Industries, New South Wales
NTIS	National Training Information Service
QDPIF	Department of Primary Industries & Fisheries, Queensland
R&D	research and development
R,D&E	research, development and extension
SFS	Southern Farming Systems (a grower group)
SOM	soil organic matter
SSA	Soil Systems Australia
TAFE	Technical and Further Education
UWA	University of Western Australia
UQT	Queensland University of Technology

Photo opposite DPI Victoria.



