Pasture cropping the way to health

WINONA

Farm Facts

20km north of Gulgong, NSW Central Highlands

Enterprise: Sheep. Crops. Native Grass Seed. Kelpie Dogs.
Merino sheep, rams and wool; grain crops

Property Size: 840 hectares

Average Annual Rainfall: 650 mm

Elevation: 460-580 m

Motivation for Change

- Loss after major bushfire necessitating establishment of a low-input agricultural system

Innovations

- Developing and implementing 'pasture cropping'
- Time-controlled rotational grazing
- 'Vertical Stacking' of enterprises – cropping, native grass seed, sheep wool and meat
- Innovations commenced: Time controlled grazing 1989/Pasture cropping 1993

Key Results

- Annual input costs reduced by over $120,000
- Soil carbon increased by 203% in 10 years
- Delivering three production lines from each paddock
- Improved wool quality

Contact Colin Seis: colin@winona.net.au

Colin Seis faced adversity and then struck 'gold' in developing a new way to look after the land and his bottom line - building tonnes of soil along the way.

The management of Winona from 1930 to 1980 turned out to be an ecological disaster. Loss of land to salinity, declining soil quality, dead and dying trees, insect attack, fungal and animal diseases, plus the high cost of fertilisers, herbicides and other inputs showed the suffering of an unhealthy system. In 1979 a devastating bushfire left no choice but to change the way things were done.

In developing 'Pasture Cropping' Colin Seis found a way to work his pastures, crops and sheep together and healed his land. Now, Winona produces similar volumes of wool and grain to that achieved under previous management methods, but annual costs have decreased by over $120,000 and the condition of the land is improving, not degrading.

By applying regenerative forms of cropping and grazing, Colin has achieved a 203% increase in soil carbon in just ten years. The vast majority of the soil carbon is highly stable (non-labile), meaning it is significantly less subject to degradation, and carbon is being built and measured to a depth of 500mm

In addition to being able to pass on a productive and sustainable farm to the next generation, Colin feels a well-deserved sense of achievement at having developed an innovative farming method that is being adopted by thousands of other farmers in similar climates and soil landscapes all over the world.

Pasture Cropping

Pasture cropping is a technique developed by Colin Seis and Daryl Cluff in 1993 which involves sowing crops into living perennial pastures and growing them symbiotically. In a mixed farm enterprise it seeks to combine cropping and grazing into one land management method where each one benefits the other.

In 1993, the original concept of sowing crops into a dormant stand of summer growing native grass, red grass (*Bothriochloa macra*), was thought of as an inexpensive way of sowing oats for stock feed. While this certainly turned out to be true, many side benefits were also identified. The grazing crops performed so well that it was obvious that good grain yields could also be achieved. The initial concept was only touching the surface of a land management technique that is proving to be revolutionary.

Conventional cropping methods require that all vegetation be killed prior to sowing and while the crop is growing. With pasture cropping, there is no need to kill competing ground cover vegetation for cultivation, and adequate productivity can still be achieved. Groundcover is maintained at all times so that erosion by wind and water is avoided, soil structure is not destroyed by cultivation and chemical input requirements are only a fraction of those used in traditional crop production methods. 'No till' cropping, in contrast, also minimises soil disturbance, often with direct drilling of seed, however it is not performed in combination with a perennial pasture, but more usually into the stubble of previous crops.

Sowing a crop using the pasture cropping method also stimulates perennial grass seedlings to grow in numbers and diversity. This then produces more stock feed after the crop is harvested and totally eliminates the need to re-sow pastures.

Economically, this technique provides good potential for profit as input costs are a fraction of conventional cropping methods. The added benefit in a mixed farm situation is that up to six months extra grazing is achieved with pasture cropping as no grazing time is lost due to traditional ground preparation and weed control requirements.

There is growing evidence, scientific and anecdotal, to support pasture cropping's contribution to improvements in soil health, improved water use efficiency and general improvement in ecosystem function. By retaining perennial native grass in grazing and cropping systems and having full ground cover all of the time, large increase in plant biomass can be achieved when compared to conventional methods. When combined with plant root functions, this biomass can dramatically increase soil carbon levels and improve nutrient cycling within the soil.

This technique has been trialled, practiced or adopted across Australia and in other countries where regions share similar climate and soil landscapes. Colin reports, "There are now over 2000 farmers "pasture cropping" cereal crops into summer (C4) and winter (C3) perennial native grass in NSW, South Australia, Victoria Queensland, West Australia and Tasmania as well as other areas around the world".

Pasture cropping is also being used to restore native grasslands in many areas of Australia.

Pasture Cropping: emerging grain seedlings in dormant perennial pasture, the growing crop and harvesting

How It All Began

The Seis family has farmed at Winona since the 1860s. Colin's great grandfather initially selected a small allotment to which other allotments were added over the years to eventually form the current 840 hectares. Colin took over management of the Winona from his father in the 1970s, and now, Colin's son Nick performs much of the day-to-day management.

Ranging from valley floors and gentle slopes rising to granite outcrops on hilltops and ridges, the predominant soils on Winona are well-drained coarse and fine sands derived from granite. There are yellow sodic (high sodium) soils along drainage lines and euchrozems (deep red clay loams) that developed on an area of basalt at the southern end of the property.

When the Seis family selected the first allotment in 1860, survey reports described the area as woodland, suggesting that the land cover was grassland with scattered trees. It is likely that there were over 100 native grass, forb and herb species, with the grassland dominated by kangaroo grass (*Themeda australis*). While little tree clearing was probably required to develop the land for farming, the change in management soon led to widespread tree regeneration. Title deeds dated 1906 record the presence of stringybark saplings. Colin's father recalled considerable ring-barking occurring when he was a boy in the 1920s, indeed, one paddock is still referred to today by the name of the man employed at the time to ring-bark trees. Colin's father also recalled that there were sparsely scattered large trees within the saplings. The large trees were retained and some remain today.

From the 1930s to 1980, the farm was used for wheat, oats, wool and sheep production. Pastures of introduced grasses, mostly annual species (sub clover, rye grass, small areas of lucerne), were established. Set or continuous stock grazing practices were used. Crops were sown every three to five years, depending on soil moisture, by ploughing and working the soil up to five times. Crop yields during this period were good, with yields of over three tonnes a hectare being achieved.

Declining Health

Associated with these management practices the soils were showing excesses of aluminium, iron and sodium. Soil carbon levels were around 1% in the 0-10cm range with observed inefficient nutrient cycling. To sustain agricultural productivity it was necessary to apply high rates fertiliser to correct phosphorus, molybdenum and calcium deficiencies.

"Inappropriate grazing techniques have done major damage to Australia's grasslands and rangelands over the last 200 years. Animals can be beneficial, if they are grazed well."

Top: Grazing on Winona 1938
Below: Grazing on Winona 2009

Colin recalls, "While superphosphate was cheap and subsidised by government during the 1950s and 1960s this high input method was very productive, but at great ecological cost such as declining soil health, soil carbon loss, soil structure decline, saline areas and dysfunctional landscape".

He notes, "As superphosphate became more expensive and the government subsidy removed this high input system could no longer be afforded. The high cost of fertilising pasture and farm inputs was around $121,000 annually - in 2011 dollars, including wages".

Chemical inputs were high. Constant drenching was practiced to remedy worms in sheep. Coccidiosis and pulpy kidney in lambs were also common and sheath rot and scours were an ongoing concern caused by high nitrate levels in the pasture. Insect attack on crops and fungal disease were common in crops and pastures and were controlled by using insecticide and fungicide.

Over these years, mature trees were dead or dying and perennial grass species were declining in numbers in the intensively managed lower slopes. Annual weeds such as Paterson's curse (*Echium plantagineum)*, capeweed (*Arctotheca calendula*), Bathurst burr (*Xanthium spinosum*) and saffron thistle (*Carthamus lanatus*), were invading, symptomatic of the poorly structured, bare soil. Introduced birds such as sparrows and starlings were commonplace and there was a lack of native birds.

Ultimately the management practices destroyed the native grassland and led to serious salinity problems. The lack of perennial vegetation allowed groundwater levels to rise, bringing salt to the surface in lower lying parts of the farm. The resulting in high soil salinity degraded the soil structure and restricted plant growth, leading to major gully erosion.

No Choice

In 1979 a major bushfire resulted in the loss of over 3000 sheep and most of the farm infrastructure - house, sheds and fencing. The lack of income prevented re-establishing the previous high input cost cropping method. So, after the fire, Colin started looking for a low input agricultural system. He set about understanding the ecological function of the landscape he had inherited and had managed using practices learned from his father. Faced with the challenge of matching inputs to outputs, Colin began exploring alternatives to the traditional farming system and the likely impacts on his farm's economics.

He realised that native grassland did not require high levels of phosphorus and started to develop methods that would stimulate seedling recruitment of native grass species. He sought to restore Winona to native grassland that did not require inputs like superphosphate and would function in an ecologically sound manner. Colin summarises, "If you get out of the way and let nature fix it, it works better and is much easier".

Colin notes that tradition was arguably the greatest impediment to change. In spite of requesting assistance from scientific and research organisations, they were not interested in developing a pasture cropping management system. Representatives of these organisations told Colin that it was impossible to grow crops in this manner.

"...get out of the way and let nature fix it..."

Instead, over a period of 20 years Colin developed the pasture cropping technique by trial and error on Winona. He has spent much of his time perfecting this technique and can now grow many different types of winter and summer growing crops, without destroying the perennial pasture base.

Pasture Cropping on Winona

Colin originally started time control grazing in 1989 to better manage pastures, but it was not until he and Daryl Cluff developed pasture cropping in 1993 that Colin saw dramatic improvement in the regeneration of native perennial pasture species.

Colin now sows commercial crops into the dominant pasture by direct drilling to minimise soil disturbance. Sheep are used to prepare paddocks to pasture crop and crops are sown, usually with no herbicide and 70% less fertiliser than conventional methods. Only relatively small amounts of liquid organic fertiliser are added at the time of sowing, using the same machine, so that tractor costs and soil compaction are minimised.

Livestock are an intrinsic part of Colin's pasture cropping system on Winona. Before sowing, when perennial pasture species are dormant, short term time-control grazing with a large mob of sheep (100-150 a hectare) is used to graze and trample perennial pasture down to a height of

Native pastures on Winona are grazed by sheep and, when dormant, direct drilled with crops

Single trees are being planted in paddocks to restore original vegetation cover

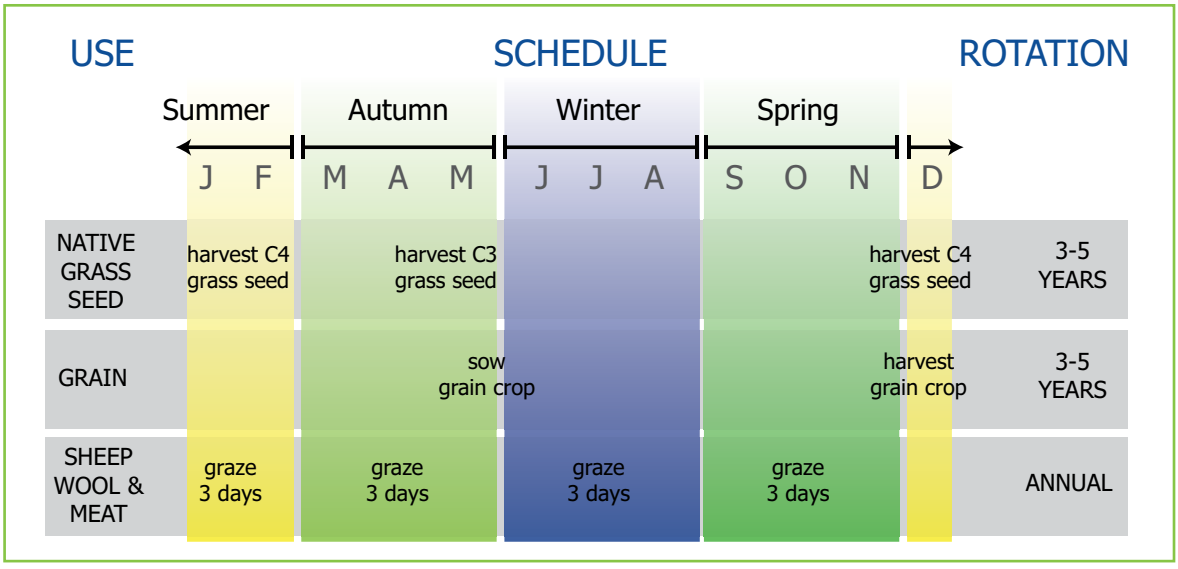
around 100mm. This practice prepares the paddock for cropping by reducing the starting biomass and physically breaking down weeds, creating a litter and mulch layer and adding nutrients from manure and urine.

Sheep can lightly graze the growing grain crop after it has become established but before it begins to develop seed. Once the crop is harvested sheep are reintroduced for a short period to take advantage of the native pasture that has been re-growing while the crop was maturing. Grazing tolerant native grass species such as red grass (*Bothriochloa macra*) and spear grass (*Austrostipa spp*) are gradually being replaced by more productive species such as warrego summer-grass (*Paspalidium spp*) and wallaby grass (*Austrodanthonia spp*). Significant areas of winter active species such as common wheat grass (*Elymus scaber*) and weeping grass (*Microlaena stipoides*) are returning.

Pasture cropping enables integration of sheep and crop production, optimising production of both while minimising chemical inputs and machinery use and improving soil structure and fertility.

Sheep are managed in two main mobs of 2000 head and rotated around 75 paddocks in a time-control grazing technique. Introducing time-control grazing necessitated a denser pattern of fencing to increase the number of paddocks from 10 to 75. A central laneway provides an efficient way to move sheep around the property. Over 70 small dams supply stock water as there are no creeks

VERTICAL STACKING OF ENTERPRISES ON WINONA



Vertical stacking enables three uses of the native grassland in each paddock - native seed harvesting, grain cropping (oats and wheat) and grazing sheep for wool and meat. The three land uses are rotated seasonally, annually and every 3-5 years, depending of the prevailing seasonal conditions such as soil moisture, rainfall and temperature.

Native grass seed is harvested in summer (C4 species) and autumn (C3 species). Grain crops are direct drilled into the winter dormant native pasture at the end of autumn and harvested in summer. Sheep graze each paddock once each season, approximately 3 days every 90 days, the highest frequency of the land use rotations.

or rivers on Winona. These dams have high water levels and are maintained mainly through lateral underground flow. The combination of the soil type and maintaining a complete groundcover ensures that all rainfall infiltrates.

Colin recognises that trees provide stock shelter and that it is essential to replace the old paddock trees that are nearing the end of their life span. He has planted over 2000 single paddock trees, aiming to restore the original 1860s cover, estimated to be about two trees a hectare. As they establish, the single trees are protected from stock with guards. In addition, around 15,000 local native trees and shrubs have been planted in belts to form wildlife corridors and to link areas of remnant native vegetation.

Colin is deservedly proud of the technique he developed, noting its strengths, "With pasture cropping it is now possible to produce an annual crop like wheat and a perennial grain crop for human consumption off the same area within a twelve month period. Added to this is the grazing value of sheep meat and wool as well as native grass seed and carbon sequestration".

"I believe that this technique of using 'vertical stacking' of enterprises on the same area over the same time period has potential for addressing world food shortages into the future."

SOIL CARBON LEVELS ON WINONA

Increase in soil microbial numbers and species diversity has resulted in better nutrient cycling and greater potential for increasing soil carbon. Soil tests conducted in September 2010 revealed the following carbon levels at the various depths:

Depth	*Soil Carbon Level*
0-10 cm	*2.65%*
10-20 cm	*1.35%*
20-30 cm	*1.18%*
30-40 cm	*0.53%*
40-50 cm	*0.26%*

Health Restored, Benefits Accrued

Extensive soil testing on Winona has shown that eliminating all cultivation other than the direct drilling for pasture cropping, together with rotational grazing, has enabled dramatic improvements in soil condition. Soil carbon has increased by 203% to 90 tonnes a hectare over a ten-year period. This equates to storage of around 170 tonnes of CO_2 (equivalent) a hectare.

Seventy-eight per cent of newly sequestered carbon is in the humic fraction of the soil[1]. This is non-labile, therefore much more stable and significantly less subject to degradation.

All soil nutrients have increased by an average of 172% in available and total amounts, except for aluminium, iron and sodium, which have decreased. Compared to regular cropping, pasture cropping soils show an increase in actinomycete (bacteria which have a role in decomposition of organic materials) and fungal abundance consistent with less disturbance and/or with greater perennial basal cover and litter cover. These impressive results have been validated through a paired site analysis by Sydney University and CSIRO/Department of Primary Industries[2].

Soil from a conventionally grazed and cropped paddock (right) and from a time-controlled grazed and pasture cropped paddock (left) which contains significantly more microbial life, soil carbon and subsequently greater water holding capacity

Colin notes that his landscape has developed a real resilience, with relatively stable production regardless of rainfall. "Over the last ten years, we have experienced five years of above average rainfall and five years below. A new rainfall pattern has emerged that sees 70% of our rain falling in the summer months, whereas before it was closer to 50%. In the poorer years, no 'drought' feeding has been required, due to the resilience in the pastures from the improving soil conditions."

Many biodiversity improvements are apparent since the changes to management of Winona. Vegetation changes are being monitored on six 100 metre long survey lines (transects). Winona was once dominated by annual weeds and the transect counts from 1999 showed 60% weeds and 10% native perennial species in the pasture. Transects now show 80% perennial native species and 5% weeds. Winona is now a diverse, functioning native grassland with over 50 native species.

As Colin points out, this change was created, not with herbicides, but with groundcover. "Providing the conditions for perennial pasture species to thrive will steadily suppress the weeds. Using herbicides can help is some circumstances but can also kill desirable species, such as the perennial pasture species."

Tree health has improved and the remaining naturally established trees are regenerating.

Monitored bird numbers and diversity includes around 100 species. Sparrows and starlings that were common prior to 1990s are no longer observed on Winona. Few marsupial species were observed prior to 1990s and now marsupial diversity has also increased, including grey kangaroos, swamp and red necked wallabies and wallaroos.

A large increase of spiders in pastures has delivered a more stable balance to the insect populations and provided biological control of problem insects like red leg earth mite.

Whilst crop production on Winona has remained about the same, averaging two tonnes a hectare but producing up to four tonnes a hectare, the cost of growing the crops has reduced significantly; in the order of $120,000 a year.

Additionally, Winona now produces and sells about one tonne of native grass seed annually to farmers and for landscape rehabilitation. Colin is also investigating the economics of harvesting and marketing of two native grass seeds for human food consumption.

Healthy soils are clearly apparent under the diverse native vegetation cover on Winona

Pasture cropping enables extra grazing of up to six months on Winona's mixed farm enterprise. No longer having to re-sow pastures saves $100 - $150 a hectare per year

Wool and sheep production has also remained about the same, however wool tensile strength has improved by 60% and vegetable matter such as burr and seed in the wool has declined by around 70% making both the wool and sheep more valuable.

Colin says that being able to measure and monitor on his farm has been very important, "Carbon and soil nutrients, plant and ground cover transects as well as sheep and crop monitoring has been very beneficial in observing the positive change forward".

Education is also seen essential to bringing positive change. Colin states, "We require more farmer educators. Farmers should empower themselves with knowledge." Colin devotes a lot of his own time running courses, workshops and providing training on pasture cropping across the country, encouraging experimentation with or adoption of this innovative technique.

Overall, the development and implementation of pasture cropping has restored the landscape health on Winona. Re-establishing native grasslands through methods working with nature, ensuring ground cover at all times, rather than trying to control it through use of herbicides and fertilisers has delivered its rewards to Colin Seis.

In his words, "As we farm closer to how nature had it originally designed, the easier the workload becomes and the more profitable it can be."

[1] Jones, C.E. (2011). *Carbon that counts*. New England and North West Landcare Adventure, Guyra, NSW,

[2] Ampt, P. and Doornbos, S. (2010) *Communities in Landscape Project: Benchmark Study of Innovators, Gulgong, Central West Catchment NSW,* http://cil.landcarensw.org.au/pra/reports

This case study is an excerpt from the Soils for Life report:

Innovations for Regenerative Landscape Management:
Case studies of regenerative land management in practice

REPORT SUMMARY

The Need for Change

Despite good practices of many of our land managers and farmers linked to some good science, the realities of an increasingly arid and degraded landscape will impact significantly not only on the productivity and viability of agricultural enterprises, but also on the health of our environment and the wellbeing of every Australian.

Landscape degradation is an issue of national and global concern. Landscape management practices including, but not limited to agriculture, forestry and fire have caused significant damage and in the process have altered the earth's natural biosystem. Consequently the precious resources of soil and water necessary to sustain life are being lost at unsustainable rates.

Unprecedented global challenges are arising in the face of this massive degradation of the landscape.

Soil erosion due to traditional agriculture is occurring at a rate between 10 and 100 times faster than the soil's natural formation process (pedogenesis)[1,2]. Healthy soils are necessary to provide sufficient amounts of food with quality nutrition and fibre to meet global requirements.

Three billion people globally already have inadequate water and sanitation. It is assessed that 80% more water will need to be accessed by 2050 to feed the potential global population of more than nine billion[3]. Unless all limited soil and fresh water resources are understood and wisely managed, we are at risk of escalating social disruption and regional instability.

Even with its significant land area, Australia is not immune to the consequences of landscape degradation and increasing future needs. The realities of an increasingly arid and degraded landscape are already being experienced across the country. These include:

- increasing acidification, particularly in the south-east;
- declining soil health, caused by the loss of soil organic carbon (SOC);
- erosion;
- severe salinity;
- diminishing river flows;
- high evaporation and runoff rates;
- decreasing availability of groundwater; and
- reduced resilience to impacts of extreme and variable weather events such as drought, flood and fire.

The current state of the Australian natural landscape is further challenged by stresses from our changing climate, unsustainable management practices (such as reliance on high energy inputs), increased mining activity and urban expansion.

The national and global challenges being faced are interrelated and can be best met through a comprehensive coordinated approach focused on improved regenerative environmental management practices.

Landscape Regeneration for our Future

The key process drivers for landscape regeneration are **soil**, **water** and **vegetation**. Together in a natural system, supported by a constant flow of solar energy, these provide a regenerative cycle.

By restoring natural systems through improving landscape management practices, we can maximise water use efficiency, improve soil health, nutrient cycling and biodiversity of vegetation. A properly structured soil, with good levels of SOC, allows greater infiltration and retention of rainfall. Every gram of carbon in the soil can retain up to eight grams of water.

Currently, approximately 50% of rainfall on the Australian landscape is lost to evaporation due to poor soil structure and insufficient groundcover. By improving soil structure – particularly carbon – through increasing organic matter in the soil, we will be able to better capture and retain any rain that falls, making it available to plants for longer.

Through revegetation, groundcover is improved, and subsequently so is the quality of the soil, enhancing water infiltration. In turn, improved soil health and efficiency in water use contributes directly to the ability to support a biodiversity of vegetation and species.

If properly supported, this regenerative cycle can continue to sustain and improve the natural resource base and therefore landscape resilience and productivity.

Restoring these natural cycles and becoming more efficient in the use of natural resources is fundamental to the provision of sufficient food, fibre and water for a growing population. Business as usual is neither viable nor sustainable. Effective practical policies and actions are needed now.

Landscape Regeneration in Action

Innovative farmers are using high performance regenerative landscape management methods and fighting the trend of continued degradation of the landscape with its heavy reliance on external inputs. They are demonstrating sustainable, regenerative practices on their land. With relevant policies and incentives these practices could be extended successfully and quickly to involve a significant number of Australia's 135,000 farmers. Whilst there are always opportunities to learn more, enough is already known to take action now.

Soils for Life has documented some of these regenerative practices in 19 case studies across a range of locations and land-use types. Experiences shared by the 17 innovative farmers and two community organisations in the Soils for Life case studies demonstrate successful action being taken to restore the landscape. Due to the interrelated nature of soil, water and vegetation, benefits can be experienced across all process drivers regardless of the particular area of focus.

The Soils for Life case studies describe a range of techniques being used to obtain positive, regenerative outcomes, including:

- Applying organic composts, fertilisers and bio-amendments;
- Encouraging natural biological cycles and nutrient transfer;
- Implementing time-controlled planned grazing;
- Using grazing management and animal impact as farm and ecosystem development tools;
- Retaining stubble or performing biological stubble breakdown;
- Constructing interventions in the landscape or waterways to slow or capture the flow of water;
- Fencing off water ways and implementing water reticulation for stock;
- Investing in revegetation;
- Pasture cropping;
- Direct-drill cropping and pasture sowing;
- Changing crop rotations;
- Incorporating green manure or under-sowing of legumes;
- Managing for increasing species diversity;
- Controlling weeds through increased competition by desirable species;
- Reducing or ceasing synthetic chemical inputs; and
- Integrating enterprises.

PRINCIPLES FOR REGENERATIVE LANDSCAPE MANAGEMENT

Our case studies show that many different techniques can be applied to regenerate the landscape. Farmers and land managers commonly tailor a variety of methods to their own landscape and personal preferences. There is no single solution to landscape regeneration.

The following principles consistently emerge as underlying their regenerative practices – regardless of location or enterprise. These can be applied by other landholders as a basis for their own regeneration journey.

- Improve the structure of soil, through enhancing organic matter content
- Use and conserve rain where it falls
- Manage holistically
- Care about the land as a resource
- Commit to education and constant learning
- Search out communities of interest for help and advice
- Work on best land and extend from there
- Strive for maximum groundcover, for the majority of the time
- Manage times of plenty for times of shortage
- Reduce reliance on off-farm inputs
- Observe, measure and respond

Notes:

1 United Nations Environment Program, 2012, UNEP Year Book 2012: Emerging issues in our global environment, http://www.unep.org/yearbook/2012

2 Pimentel, D., 2006, 'Soil erosion: A food and environmental threat.' Environment Development and Sustainability, 8, pp119-137

3 Barlow, M., 2007, Blue Covenant: The Global Water Crisis and the Coming Battle for the Right to Water, McClelland & Stewart

CASE STUDY 12 - WINONA NSW

Other case studies and the full *Soils for Life* report are available at: www.soilsforlife.org.au.

The production of the report was supported by funding provided by the Federal Government's *Caring for Our Country* initiative.

© Outcomes Australia, Soils for Life Program 2012

CARING FOR OUR COUNTRY

SoilsForLife
AN OUTCOMES AUSTRALIA PROJECT
www.soilsforlife.org.au

Soils for Life is actively working to change landscape management from the top down and the ground up - but we need your help! Be part of the solution - join in, contribute, share learning with others and change your practices!

Engage with us online at www.soilsforlife.org.au. Like us on Follow us on @soilsforlife