Shifting mindset from animals to the land

GUNNINGRAH

Farm Facts

20 km north-west of Bombala
NSW Southern Tablelands

Enterprise: Cattle. Sheep. Goats

Angus beef, sheep and goat meat production; medium wool Merinos

Property Size: 4200 hectares

Average Annual Rainfall: 550 mm

Elevation: 800-1000 m

Motivation for Change

- Ecological deterioration and dependence on rainfall for profit

Innovations

- Constructing leaky weirs across creeks and gullies
- Time-controlled rotational grazing matching stock numbers to land carrying capacity
- Introducing goats for weed control
- Innovations commenced: 1995

Key Results

- Increased profit stability – even with decreased rainfall
- Labour inputs reduced by 40%, providing increased time to pursue other activities
- Healing erosion gullies
- Greater water retention in pastures
- Flexible stock management

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Initially inspired to perform a trial of new management practices to better manage received rainfall, Charlie and Anne Maslin ended up following their instincts - fully changing focus from their animals to the land - and they have never looked back.

Upon assuming management of Gunningrah in 1987, Charlie Maslin observed significant annual variations in rainfall and profit. Examination later revealed the significant impact of rainfall on the cost of production. Additionally, a mid-1990s comparative pasture analysis undertaken by an external agency revealed alarming outcomes in terms of actual ground cover available for stock feed.

Charlie realised that while you cannot change how much rain falls, you can change how you manage the rain you are lucky enough to receive. By changing their mindset to focus on the health of the land, the Maslins found themselves managing poorer years more effectively and not over-using resources in abundant years. Maximising the retention of available rainfall and striving for much improved ground cover has in turn delivered more consistent profits on reduced inputs. In addition, erosion is being controlled, weed invasion has reduced, stock are healthier and management is more flexible.

Charlie sums up their new approach, "Rather than us dictating to the land what stock it has to carry, we try to evaluate what the land has to offer and then attempt to stock it accordingly – and hopefully learn as we go".

Gunningrah

The Maslin family have managed Gunningrah for 100 years. A property of 4200 hectares, it is located at the southern end of the Monaro Tablelands of south-eastern New South Wales. Currently, 3700 hectares of the property is grazed with cattle, sheep and goats.

Native grasslands make up approximately 60% per cent of the farm area. In the other 40% per cent, which had been pasture improved, introduced species of grasses coexist with the native grasses, in some cases the introduced dominate, in others, the natives.

Approximately 20% of the property has scattered remnant to heavier tree cover, mostly on the sedimentary soils adjacent to the Meriangah Nature Reserve, located along the western boundary. Soils are approximately 75% derived from basalt, 20% sedimentary rock and 5% granite.

Embracing Change

After managing the property for almost a decade, Charlie realised that Gunningrah was gradually facing ecological deterioration and profitability was becoming increasingly variable. Two main factors provided the initial impetus for change.

Firstly, a Meat and Livestock Australia trial conducted on the property in the mid 1990s revealed some alarming results. Whilst the property appeared to have sufficient pastures to support stock grazing, actual ground cover levels measured were substantially below perceived coverage. The agricultural assessment of ground cover showed approximately 30% bare ground. This was seen as unsatisfactory.

Secondly, the impact of the varying annual rainfall on the cost of production also presented a stark reality. Charlie reports, "Comparative analysis of inputs showed wool production costs could double, varying from $2.50 to $5.00 a kilogram, and beef more than triple, ranging from $0.40 to $1.40 a kilogram". These variations were largely dependent on the rainfall received, accounting for supplementary feeding or agistment costs when existing pastures were insufficient.

A neighbouring property to Gunningrah holds continuous rainfall data from 1858 and Charlie accessed this to try to obtain a better understanding rainfall in the region. However, little evidence of rainfall patterns or consistency over months or years was found. Charlie notes, "The only recurring theme appeared to be that for every year of above-average rainfall, there were two years below average".

This information made it clear to the Maslins that effective management of inconsistent rainfall was a key factor in maintaining profitability.

Learning about the principles of *Natural Sequence Farming,* the Maslins identified an opportunity to make the most of the rainfall they received. They found that through this technique the health of watercourses could be significantly restored by slowing the rate of water flow, especially after rain, by a series of physical interventions in the landscape. These would enable the capture of sediment to help repair eroded watercourses, also holding nutrients to improve soil health and feed plant roots. As a result, water would be captured in the soil for longer, better supporting vegetation regeneration and continued pasture growth. This process would also aid in reconnecting streams to natural floodplains and wetlands, reforming the chain of ponds that used to dominate the landscape.

Capturing sediment through establishing weirs has helped to fill erosion gullies

The Maslins also learnt about stock rotation from others in the region and through attending grazing courses, such as *Grazing for Profit*. The cell grazing method they chose to adopt is based on the observations and trials of Allan Savory and Terry McCosker. This technique involves dividing the land in some cases into an increased number of smaller paddocks which then are intensively grazed for short periods followed by sufficient recovery periods to allow pasture to regenerate.

Applying the principles required a detailed understanding of pasture management, particularly the ability to accurately assess pasture growth, recovery rates and their differences site by site across the property.

After around six months of deliberation on changing their management methods, the Maslins initially decided to trial the new practices on 20% of their property. However, taking the opportunity to capitalise on an above average rainfall event, they ended up following their instincts that the technique would work, and instead committed to implement across 100% of the property.

"Measuring and documenting the important variables was essential to our change process..."

Changes to infrastructure were made incrementally, to allow for the learning process. An extensive capital outlay was needed in water reticulation as the water cycle slowed down and dams could not be relied upon. Additional expenditure was required for fencing and other necessary structural changes. Whilst these new capital costs were significant, they did not restrict implementation of the new methods.

Overall, the new business plan for Gunningrah comprised specific aims for managing the land to support production outcomes, focusing on water management and cell grazing methods to improve stock and soil health, vegetation, pasture, and weed control. Indicators were developed to monitor progress in these areas. "Measuring and documenting the important variables was essential to our change process," says Charlie, "we regularly took photos from strategic points so that changes could be monitored and evaluated". Though substantial records were kept, Charlie indicates that he would capture even more data and keep better track of changes if he were to undertake the change process again.

Better Use of the Rain, Where it Falls

Annual rainfall on Gunningrah averages 550mm and has varied from 250mm to 1000mm over the past 100 years. The main source of water inflow to the property is the Cambalong Creek, which rises around 15km to the north. It flows though the property for 16km, and then 10km downstream flows into the Bombala, Delegate and Snowy Rivers. Three smaller streams also flow into the farm.

In the past, three of the four streams were permanent, however, over the last two decades all have been intermittent at various times.

Ninety per cent of runoff from Gunningrah land flows down the Cambalong Creek, the remaining 10% flows to the west to the Maclaughlin River.

Prior to the introduction of grazing to the region, the valley floors were resilient, with substantial wetlands along the main creeks and streams. Charlie indicates points across the landscape, "There is clear evidence of many earlier chains of ponds, on convex valley floors – the result of silt build up where water would slowly flow through the landscape. However, due to many years of traditional grazing methods and stock damage along water courses, the streams became incised and the surrounding land, which was once wet, became dry". Dams and existing water courses were long relied on for watering stock, which had continual access.

To reduce dependency on rainfall for profit, the Maslins adopted three main approaches to more effectively use rainfall and manage water flowing through the landscape. These incorporated the construction of leaky weirs, changing from set stocking to cell grazing and fencing off the most degraded stream corridors.

Charlie explains, "Leaky weirs serve to slow down runoff through water courses, converting intermittent torrents into constant gently flowing streams. Trapped by the weirs, sediment is deposited, reducing erosion and consequently downstream water quality is improved".

Since the mid 1990s, the Maslins have constructed over 30 weirs across Gunningrah streambeds and gullies. Charlie points out, "The weirs vary in size and have been constructed with excavators, tractors, and in some instances by hand with whatever resources were available, such as old fencing materials". The construction of two major weirs in the late 1990s cost $2500, however, since that time only $200-$400 has been spent per weir on most of the remaining structures. The Southern Rivers Catchment Management Authority (CMA) has viewed the water management practices applied.

Leaky weirs slow the flow of water courses (note pipe)

With the introduction of rotational cell grazing and by fencing off selected riparian areas, water courses are now only exposed to animal activity for short periods of time, or not at all. This protects banks from damage and further allows sediment build up. Vegetation has been given time to rest and a chance to germinate in the riparian areas. As a result there have been vast changes to bank stability, also providing much greater ability to handle high flood flows.

Application of these approaches has had significant impacts on riparian areas. Whilst in some areas it has taken 10 to 15 years for water courses to heal, other areas showed dramatic improvement in just two years. Charlie notes, "There is abundant evidence of silt deposition in streams with weirs. An estimated 50 tonnes collected in one weir in the first three years after it was built, significantly filling eroded areas. Downstream, a neighbour was puzzled to see a 'clear flood' after rainfall, as opposed to the usual silty runoff". This was a result of the sediment remaining trapped in the weirs, rather than flowing off the landscape.

"In one small stream, a one-off flood filled weirs, and the usual one to two day flow lasted six weeks at 10,000 litres a day. Another larger stream flowed for 12 weeks. This slowing of the water is now a consistent feature on the property." Charlie now has greater access to water for longer, retains more of his soil on his property and his neighbours enjoy the benefits of quality water runoff from Gunningrah.

Vegetation coverage has also improved as a result of the increased water in the landscape, as well as through the cell grazing methods. Growing periods have extended as the water is now held in the pasture for longer, rather than running off straight into the dams, which are no longer a reliable storage for rainfall capture.

Evidence of silt build-up upstream of an established weir

The construction of leaky weirs and protection of degraded stream corridors has lead to significant erosion improvement

Establishment of cell grazing and reduced dam water did also necessitate other changes to water management, with water provision one of the main logistical issues with having mobs of stock in multiple paddocks. The Maslins constructed additional water points in paddocks without other water courses. All troughs are gravity-fed, so no fuel is required for pumping. Charlie points out, "While costly, establishing the troughing system is ultimately much more water efficient than dams. There is now less evaporation, wastage, land damage, and the stock have access to cleaner water".

Grazing on Gunningrah

Focusing on the land rather than animals does not reduce the importance of the stock on Gunningrah. Instead, the health of the land and the natural resource base is better understood as the source of profit rather than the animals. The animals still have a very important role to play in maintaining the health of the land.

"We believed that grazing could be profitable and sustainable by shifting the focus from maintaining a set level of stocking to varying the stocking level according to the productive potential of the pasture."

Charlie recalls previous management methods, "Gunningrah was traditionally set stocked with around 75% sheep and 25% cattle. Creeks and dams provided watering points and feed was trucked in during lean years. Rainfall may have varied by 60%, yet stocking by only 30%".

The rotational grazing program was identified as a tool to deliver a number of benefits to Gunningrah. Using this method would help to increase ground cover levels, from a then base of around 70%, ensuring a continual feed supply. This would also help to generate healthy soils by increasing the organic component of the soil and subsequently enhance rainfall infiltration to maintain water in the landscape.

The program would also improve the composition of the pastures from a quite high annual species base, to a predominantly perennial base and reduce weeds. As a result, animal health would improve through more diverse species to graze and the pasture worm burden would be reduced through the spelling of pastures. Additionally, labour efficiencies would be gained through less manual inputs to production operations.

Charlie describes their method, "We chose to match our stock numbers with the carrying capacity of the land, using a formula to determine a stocking bandwidth within which we try to operate".

The formula involves calibrating the relationship between available feed and stock numbers. Rainfall and stock numbers are measured monthly to evaluate stock pressure. Computer software is used to continually monitor the carrying capacity of the property and adjust stocking rates of a mix of sheep, cattle and goats to ensure profitability. The Maslins use a formula of DSE[1] days per hectare per 100mm of rain to determine the carry capacity of their land (see graph overleaf).

[1]DSE is a stock measurement, 'dry sheep equivalent' based on the feed requirements of a 45kg wether. This can be multiplied for various types of stock, for example a ewe with one lamb is measured as 1.5 DSE, and a dry cow is equivalent to 6-8 DSE.

To implement the rotational grazing system, stock were combined into larger herds. This presented a logistical challenge and used all the available infrastructure at the time. Charlie notes, "Refinements were made to overcome problems as they arose, as we continue to do today". Paddocks of approximately 100 hectares were established. Each paddock is intensively grazed for five to seven days, with approximately 10% of land stocked and 90% rested at any one time. In winter this is varied to accommodate requirements with available pasture, with approximately 40% of land stocked and 60% rested.

Charlie speaks positively of the greater flexibility they have experienced in terms of managing their land and animal requirements as a result of adopting rotational cell grazing. This includes the ability to:

- 'finish' stock better, for example, by fattening lambs on best paddock prior to sale;
- prioritise stock for best feed, such as for breeding ewes at joining or twin bearers at lambing;
- adjust rotation times to account for season growth or animal requirements, such as lambing;
- skip paddock rotation for recovery or if different terrain has inherently different recovery rates;
- target certain paddocks to reduce risk of fire or provide greater recovery time; and
- achieve early identification of when feed is getting low and allow selective reduction of stock numbers.

Stock is grazed at a high density for short periods of time as per the determined carrying capacity

Stock management is much more informed when numbers are tied to carrying capacity. The Maslins are now better able to manage their stock rates according to the seasons and the resources available in poor or abundant years. Charlie points out, "Stock rotation provides an early warning system of land recovery. If the pasture in the first paddocks is not fully recovered after a rotation cycle has been completed, an informed decision can be made on stocking rates. With set stocking, it was only when stock condition started to deteriorate that pasture problems were identified" .

Other benefits the Maslins have experienced include improvements in stock health. "The worm burden has been substantially reduced by the continual stock movement. Animals are now only drenched once or twice annually, as opposed to four times a year previously. Twin lambing pregnancies are 20% higher than two decades ago and stock classing is more consistent."

In terms of inputs, larger mobs enable more efficient management. Movement, drenching and stock checks now require less human input. Stock are becoming easier to handle with more even temperaments due to greater human exposure.

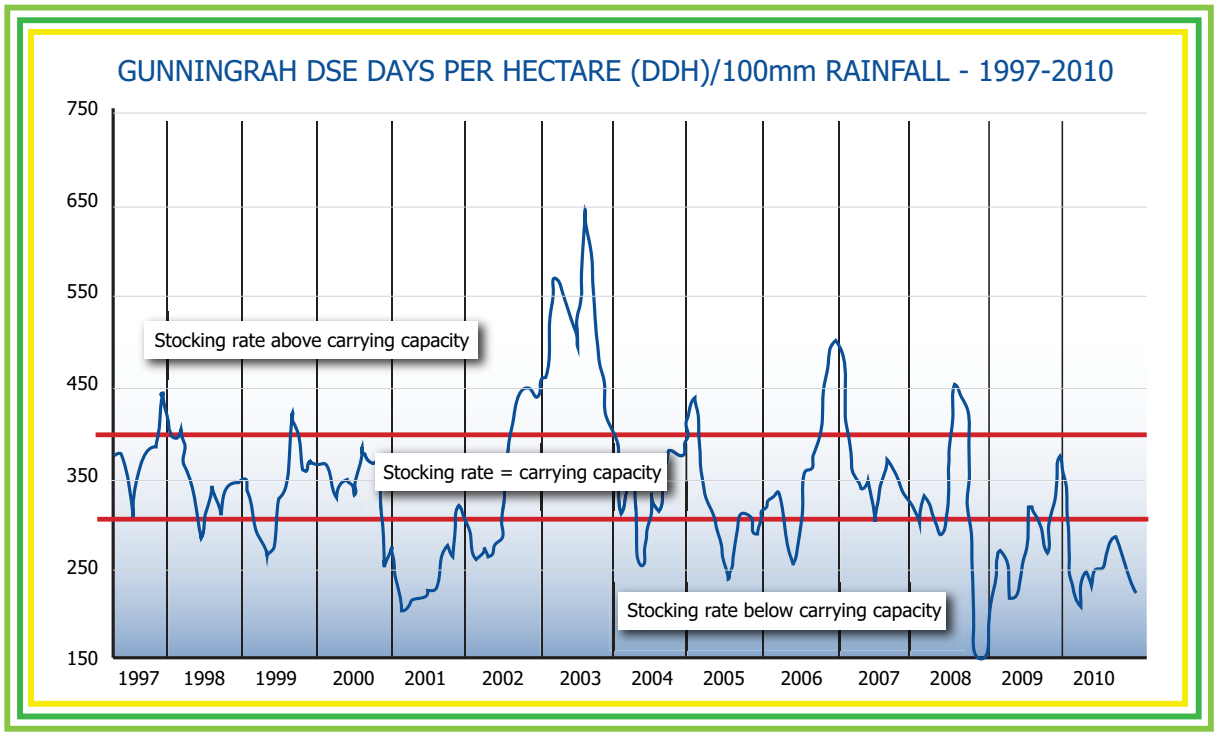
Improved Natural Resource Base

Vegetation improvement was an inherent outcome of the Maslin's new water and stock management programs. This directly addressed Charlie's initial concern at the results of the Meat and Livestock Australia assessment of ground cover.

Providing all plants with adequate rest to grow well, establish deep roots, to keep in a vegetative state, and to be able seed, is the essence of the stock rotation theory.

As a result of the new practices, the ground cover improved from 70% to around 85% in the first five years. In 2011 some areas had close to 100% ground cover. Native pastures have increased substantially.

Charlie says, "Our aim is to maintain 90% ground cover 90% of the time with as much plant diversity as possible. 100% would be the ideal but with the vagaries of climate this goal is unattainable for the long term, so we are content with the average 85-90% coverage that tends to be the plateau".



The changes to grazing practices at Gunningrah have also benefited the soil in a number of ways. Most importantly, managing stocking to ensure close to complete vegetation cover at all times prevents or minimises erosion by wind and runoff. At the same time, vegetation cover ensures that rainfall infiltrates, and coupled with the leaky weirs, the water cycle has slowed, minimising runoff and reducing or halting sheet and gully erosion. The increased plant biomass also leads to increased soil organic content, which improves water holding ability and nutrient cycling. Reducing chemical use has also enhanced the soil health.

The grazing changes and increased ground cover have also assisted in reducing weed invasion.

Gunningrah previously suffered from a range of dominant invasive weeds, including serrated tussock (*Nassella trichotoma*), scotch (*Onopordum acanthium*) and nodding thistle (*Carduus nutans*), horehound (*Marrubium vulgare*), Bathurst burr (*Xanthium spinosum*), sweet briar (*Rosa rubiginosa*), and saffron (*Carthamus lanatus*), black (*Cirsium vulgare*) and variegated (*Silybum marianum*) thistles. Fireweed (*Senecio madagascariensis*), love grass (*Eragrostis curvula*) and Chilean needle grass (*Nassella neesiana*) were seen as having the potential to be problematic in the future.

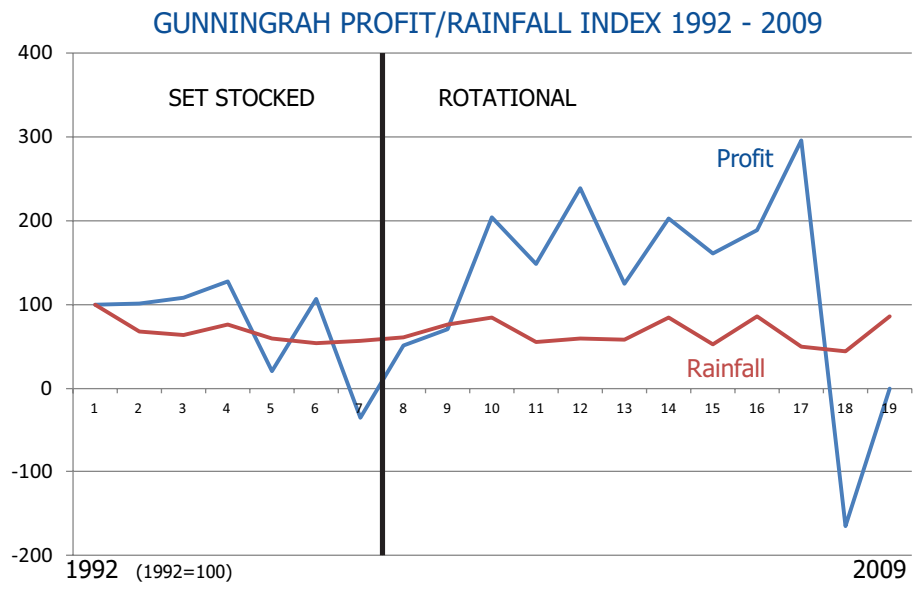
However, with the increased ground cover and competition, weed problems have declined. This was especially observed with serrated tussock.

Attending a field day to see the use of goats for weed control also provided insight to the Maslins, "We saw goats as an opportunity to reduce labour and the use of chemicals on the property." Understanding the different grazing preference of goats for weeds such as briars and thistles rather than pasture highlighted the possibility of a complementary enterprise which now comprises approximately 10% of stock. The Maslins happily report, "Goats are strategically grazed to address specific weed problem areas and have now almost completely suppressed the briars and have had a strong impact on thistles, to the point that spraying is rarely required". By selecting a mixed breed to maximise meat production as well as weed control, extra income has also been achieved through the sale of kids.

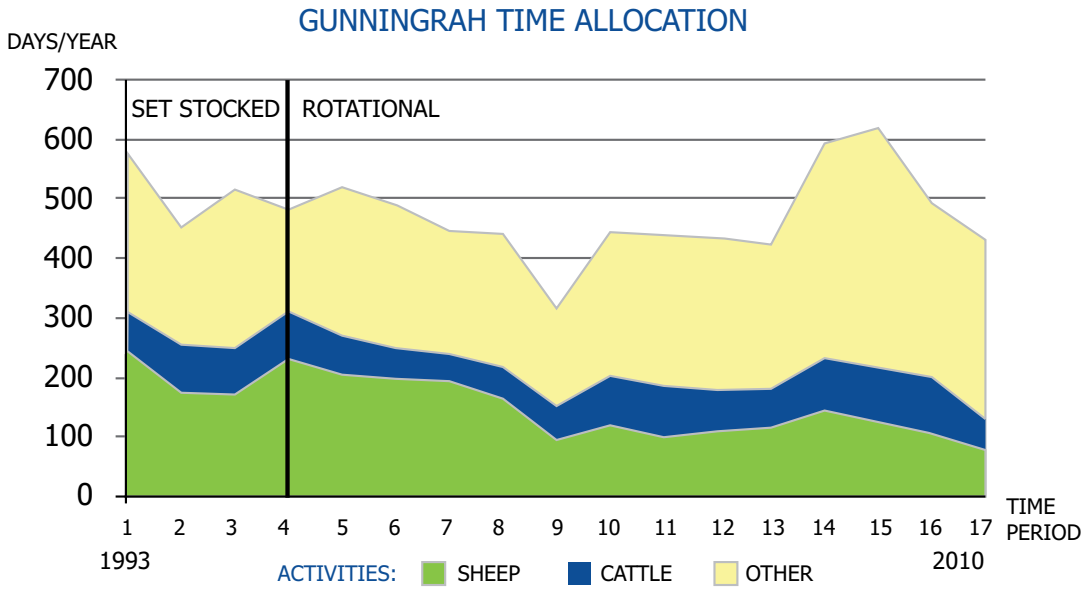
The Maslins have undertaken broad tree planting activities, supported by Landcare. Paddock trees have also been replaced and replanted in main watercourse area with fast-growing species found to thrive in the region as advised by a neighbouring tree nursery, not just with local species of eucalypt.

Goats provide weed control and complementary meat production

The Maslins have undertaken broad planting of tree species found to thrive in the region



Actual rainfall data shows twice as many years below than above the long-term annual average of 550mm.
Profit downturn was as a result of agisting cattle for "too long".



Innovation Successes

The Maslins have found that grazing can be profitable and sustainable if pastures are maintained by matching stocking rates to carrying capacity.

Charlie describes the success of their innovations, "Gunningrah is only a moderate/conservative producer, so not necessarily comparative to high performers, however there is strong evidence of consistent profit increase with stock rotation methods despite lower rainfall".

"Net farm income has been graphed against rainfall received for the period four years before we changed the grazing and then for 14 years since. While it is a crude measure, and there are a multitude of variables which affect the result, there appears to be an upward trend in profit, and a reduction in variability. There is one year which goes badly against this trend, when we kept cattle away on agistment for too long, but hopefully we learnt something." (See graph, left top.)

"Human inputs have been greatly reduced, and labour efficiency has improved around 40 per cent since mobs have been put together. Larger mobs are easier to move, muster in and assess for fly strike or other activities. As labour comprises approximately 50 per cent of operating costs, these efficiencies are delivering substantial financial results." (See graph, left below.)

The land has been the ultimate winner with the changed methods on Gunningrah. Changes to water management and grazing practices made by the Maslins ultimately complemented the other, further enhancing outcomes in relation to water use efficiency, soil health and vegetation cover. Improvements to soil and water quality strongly support increased biodiversity. In addition to increases in pasture and birdlife diversity, platypus are regularly observed in the Cambalong Creek running through Gunningrah.

As an added bonus resulting from the changes they have adopted, the Maslins have also found that more time has now been freed to do other activities they enjoy; the extra family time in particular has been greatly appreciated.

Furthering their focus on the land they continue to seek learning opportunities to improve their production management. These have included Landcare group activities and projects on issues such as erosion control, shelter belts and connective corridors; holding and attending field days covering topics such as water and streams (run by Peter Andrews and the CMA) and grazing techniques (run by the CMA and small groups of interested farmers).

Stock health and ease of handling has improved on Gunningrah

"Get together with like-minded people to discuss plans, problem solve and dream – broaden the range of achievable outcomes."

Charlie and Anne also dedicate some of this spare time to acting as a change agent in the community to support better land management practices. Charlie notes, "Farmers using different management tools are generally keen to share their experiences. Don't be afraid to ring up and ask. There are many simple ways to conduct a trial on how you would like to change things with grazing or with water, which don't involve much risk or cost, to reassure your thought process."

And overall, he advises, "Get together with like-minded people to discuss plans, problem solve and dream – broaden the range of achievable outcomes."

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 8 - GUNNINGRAH NSW

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

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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!

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