


# LANDSCAPE REGENERATION IN ACTION

The challenges outlined in Chapter One can be best met through the wider adoption of high performance regenerative landscape and water management, facilitated by comprehensive strategic coordination. Such landscape management is already taking place through a small number of innovative farmers across Australia and around the world, but these efforts are not yet being sufficiently supported or coordinated to maximise results.

Outcomes from a comprehensive approach to regenerative management have the potential to heal landscape degradation, support the sustainable provision of sufficient quality food and fibre for the growing population, improve the environment and restore the earth's natural biosystem.

This chapter discusses how these outcomes are already being achieved by participants in the *Soils for Life* case studies. These farmers, and others taking similar approaches, must be recognised not just as producers of food, but for the positive work they are performing in regenerating the Australian landscape and achieving sustainable outcomes.

Experiences shared by the 17 innovative farmers and two community organisations in the *Soils for Life* case studies in Chapter Three demonstrate successful action being taken to restore the landscape. The case studies describe a range of techniques being used to obtain positive, regenerative outcomes.

These techniques and their relation to the key process drivers are discussed through selected examples in this chapter and include:

- 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;
- Reducing or ceasing synthetic chemical inputs; and
- Integrating enterprises.

Healthy soil is fundamental to landscape regeneration and sustainable food production. Restoring soil physical, mineral and biological qualities is essential in order to maximise biosystem functioning. Healthy soil can only be achieved through a good understanding of the inter-linkage of sound water management with a biodiversity of functional vegetation. Together, supported by the constant flow of solar energy, soil, water and vegetation management are the process drivers to a healthy regenerative landscape.

As illustrated in the case studies, due to their interrelated nature, benefits can be experienced across all process drivers regardless of the particular area of focus.

Changing from conventional to regenerative landscape management practices involves making a commitment and constantly challenging and testing decisions made to ensure that they are economically, environmentally and socially sustainable. Case study participants' experiences in undertaking change and how adoption of change can be supported are also summarised in this chapter.

Policies and actions required for a comprehensive, coordinated approach to high performance regenerative landscape management are recommended at the conclusion of the chapter. These efforts will contribute to delivering process outcomes of restored landscape function, that include increased production, an improved natural resource base, healthy nutrient cycling, increased biodiversity and enhanced resilience. These will benefit not only the primary producers, but also the community - economically, environmentally and socially - and will significantly contribute to addressing the national and global challenges outlined in Chapter One.





*Innovative farmers, such as those in the Soils for Life case studies, should be recognised for their work*

## SOIL

As presented in Chapter One, a healthy soil is fundamental for the functioning of the natural biosystem.

Soil health refers to the condition of the soil and its potential to sustain biological functioning, absorb water and promote plant and animal nutrition and health. Such resilient soils are better able to retain function during, and recover after, stress or disturbance, such as too much or too little rain.

Many of the case study participants address soil health directly, identifying its causal role in successful production.

Of many examples, the experience of Bill and Rhonda Daly of *Milgadara* in the NSW South West Slopes (CS13, pg. 152) demonstrates the broad positive outcomes achievable from focussing primarily on soil health. The Dalys place great emphasis on the importance of balancing and restoring the physical, mineral and biological qualities of soil. This perspective moves from the conventional agricultural view of soil which focuses primarily on the mineral qualities, in particular, increasing the levels of phosphorus (P), nitrogen (N) and potassium (K).

The Dalys restore soil structure, chemistry and biology through applying specially formulated humus compost. As a result, they have increased soil organic carbon (SOC) levels, improved cation exchange capacity (CEC), their pastures are more diverse and prolific and their crops are producing greater yields. The Dalys have also experienced an improvement in the quality of the wool their sheep are producing and lambing percentages have increased. This could potentially be linked to the improved nutrition in their pastures.

## Soil Chemistry and Structure

The carbon content of soil plays a primary role in the soil's physical qualities and its structure. It is a key indicator of its health. Carbon content is fundamental to its water-holding capacity and ability to cycle nutrients. The amount of SOC can reduce rapidly through oxidisation as a result of unsustainable management and changing land use[1]. Regenerative practices however, are demonstrating how this loss can be reversed.

SOC is the main constituent of soil organic matter (SOM). SOM is formed by the biological, chemical and physical decay of organic materials on the soil surface and below the ground. On average, SOM is composed of 50% carbon, 40% oxygen, 3% nitrogen and smaller amounts of other elements as micronutrients. SOM varies in its stability. Some is labile, relatively quickly biodegradable, and other components are more stable (non-labile). The ratio of labile to non-labile depends on microbial conditions.

Generating SOM was revealed as a primary step for many case study participants in addressing their soil health.

The carbon sequestration potential under conventional farming practices should not be seen as the maximum possible or be the drivers of policy, when there is evidence that numerous innovators have been achieving greater bio-sequestration outcomes by some orders of magnitude.

Colin Seis of *Winona* in the NSW Central Highlands (CS12, pg. 144) has developed and implemented a cropping technique - 'pasture cropping' - which has led to dramatic increases in soil and soil minerals, including SOC. Pasture cropping involves direct-drilling crops into dormant native perennial grasses. Time-controlled planned grazing is integrated with the cropping, with sheep being employed prior to sowing, during growth before seed-set, and after harvesting. This technique promotes ongoing groundcover and minimal soil disturbance, supporting high biological functioning and constant formation of fertile soil.

Extensive soil testing on *Winona*, including paired-site analyses by the University of Sydney through the *Communities in Landscape* project, has shown that this technique has increased SOC by 203% in ten years. SOC has been measured up to depths of 500mm. In total, this equates to around 45 tonnes of SOC a hectare, or per hectare storage of around 170 tonnes of $CO_2$ (equivalent).

Importantly, 78% of the newly sequestered carbon on *Winona* is in the non-labile (humic) fraction of the soil. This is therefore much more stable and significantly less subject to degradation.

*Samples from a paired-site analysis showing the healthy and carbon-rich soils on* Winona *(left) achieved through Colin Seis' 'pasture cropping' technique, compared with a neighbouring paddock (right) which is farmed conventionally*

In a very different environment in the NSW North West, Graham and Cathy Finlayson of *Bokhara Plains* (CS2, pg. 60) are restoring the soil structure to claypans in the rangelands, seeking to reach the previous potential of this landscape. Through planned grazing practices, stock are being used to break up the surface of the claypan, which formerly comprised 50% of their land, turning it into productive pasture.

The herd impact from high density stock levels triggers soil disturbance, exposing seed already present or carried in from manure, stock hooves and/or hide to a germination opportunity. The stock density used by the Finlaysons also ensures nutrient deposit from urine and manure that has been carried from other areas of higher natural fertility. By allowing water and seeds to penetrate and also leaving manure fertiliser deposits, the claypan and degraded areas of *Bokhara Plains* are becoming revegetated. Plant succession is possible because the first plant species create groundcover, which allows moisture retention, pushes roots down to create SOM in the claypan and in turn provide a pathway for carbon from leaf photosynthesis to feed soil micro-organisms around the roots. This then initiates the nutrient cycle where previously it would not have been sustained due to the absence of plant life and an energy source.

As a result of these regenerative land management practices, which commenced in the early 2000s, the soil structure on *Bokhara Plains* is continuing to improve and SOC levels are increasing from the greater plant biomass and root systems in soil. By regenerating the soil and increasing groundcover, the Finlaysons have significantly increased productive land on their property and improved their sustainable carrying capacity. Through addressing the health of the soil, the Finlaysons are creating a viable business and are moving towards drought-proofing their property.

Whilst *Bokhara Plains* has not yet been subject to scientific soil testing, a number of other case studies have recorded measured increases in SOC since the implementation of their regenerative practices. For example, Martin Royds and his partner, Trish Solomon, on *Jillamatong* in South-Eastern NSW (CS7, pg. 102) have seen available SOC increase from a low of 0.8%-2.4% in various paddocks ten years ago, to best sites now measuring close to 7.0% SOC.

On Clover Estate, *David Clayfield has converted nutrient-poor sandy soils (left), to rich and fertile soils (right) through supporting soil biology*

## Soil Biology

Within healthy soil, trillions of micro-organisms recycle and release nutrients to drive plant growth. Mycorrhizal fungi are central to this process enhancing the ability of plant roots to access soil moisture and nutrients, and form stable organic matter. Use of chemical fertilisers and bio-cides (herbicides, pesticides, etc.) within modern conventional farming practices can decrease soil microbial life and destroy the balance between soil microbes and plants, negatively impacting production and sustainability.

In both Western and South Australia, case study participants have demonstrated that by supporting the biological activity in their soil, they have been able to convert nutrient-poor sands into productive and resilient soils. Ian and Dianne Haggerty of the *Prospect Pastoral Company* (CS16, pg. 172) are producing consistent crops and 'boutique' fat lambs on very limited rainfall and David Clayfield of *Clover Estate* (CS6, pg. 96) is now 'growing' calves for export as dairy heifers at a rate of 600-700 a year on 100 hectares.

Conversely, on the heavy, boggy soils of the Victorian Western Plains, Brian and Sandra Wilson of *Briandra* (CS15, pg. 166) have combined raising crop beds to improve drainage with the application of beneficial fungi to break down crop stubble and the application of bio-amendments to improve soil structure. Both their cropping and sheep production outputs have increased and their soil is visibly improved.

Limiting soil disturbance through the practice of direct-drilling or no-till cropping is also important to maintain biological functioning of micro-organisms and fungi. This technique has been applied successfully in both cropping enterprises, such as on *Prospect Pastoral Company* and *Winona*, and with grazing, for example on Jillamatong and Greg and Sally Chappell's *Shannon Vale Station* on the NSW Northern Tablelands (CS3, pg. 68).

Each of the case study participants in these examples believe they would not be able to produce what they do without investing in the soil; in these instances through the application of organic composts, worm juice and biological amendments comprising beneficial bacteria and fungi. Combined with stock management practices to control grazing and distribute nutrient, direct-drilling of seed and reducing or ceasing chemical inputs, the biological functioning and overall health of the soils on these properties have greatly improved. Consequently, as have sustainable and nutrient-rich production.

## Supporting Natural Nutrient Cycling

Producing sufficient nutritional food is essential for future wellbeing, and healthy nutrient cycling underlies this production.

Nutrient cycling refers to the movement and exchange of organic and inorganic matter back into the production of living matter. Bacteria, fungi, insects, earthworms, and other organisms release nutrients from various sources, enhancing the fertility of the soil. The minerals and nutrients in the soil are then made available for uptake for the production of crops or fodder for stock. This natural process is regenerative and functions most effectively when naturally balanced. A healthy cycle produces more nutritious crops and animal protein than one in which nutrients are imbalanced or not cycling effectively.

Many of the case study participants are supporting healthy nutrient cycling through making better use of nutrients available on-farm, rather than introducing supplements from external sources.

On their property, *Lana*, on the NSW Northern Tablelands (CS9, pg. 120), Tim and Karen Wright have been applying Holistic Management practices for almost 20 years, optimising natural nutrient cycling processes and achieving significant production increases.

The Wrights are using their grazing management as a farm tool, redistributing soil nutrients from areas of high to low fertility through controlled stock movement. Due to the time it takes for animals to digest the nutrients and turn them into waste, the use of high density rotational grazing practices (discussed in greater detail later), relocates the livestock before this cycle has occurred. Nutrients are thus deposited in a different part of the property from where they are taken. This process achieves increased biological activity as a result of the more even spreading of nutrient from manure and urine as a result of greater density of stock grazing over each hectare of grass.

A greater level of above ground plant litter, combined with root exudates (which come from the short periods of intense grazing), soil food sources from greater root biomass, as well as above-ground trampling of unpalatable mature plant matter (containing nutrient), in effect, equate to the application of fertiliser - though internal to the farm and not from external sources. Such processes support microbial links in the chain needed to make previously applied nutrient into a plant-available food source. These actions explain an increase in the availability of key nutrients to pasture production.

*Mycorrhizal fungi forms symbiotic relationships in and on the roots of host plants, enhancing the nutrition of both the host plant and the fungi*

By maximising the use of nutrients already available on the property, the Wrights have been able to reduce their reliance on chemical fertilisers.

Improved fertility without fertiliser through spreading on-farm nutrients may not happen indefinitely, however. Whilst there is a great deal of cycling of nutrient through the animal while it is on the farm, there is still export of nutrient off farm in the form of the harvested product, such as beef, milk, lamb or wool. Whilst nitrogen can be replaced *ad infinitum* from legumes, phosphorus and calcium, amongst others, cannot be. As such, these holistically managed systems should expect to reach a plateau where minerals may need to be imported again to maintain production levels. As healthier systems however, these will be able to make use of forms of nutrient that are not immediately plant available, as opposed to granular fertilisers, as the soil/biological system is better placed to degrade the more insoluble forms over time. Through good monitoring and measurement, these farms are able to respond to such situations.

The Dalys of *Milgadara* and Cam and Roxane McKellar of *Inveraray Downs* in the NSW North West Plains (CS14, pg. 160) are already responding to any loss of nutrients from harvested products, by the regular application of organic compost. This allows for recycling of off-farm nutrients by re-introducing composted materials back on to the property.

Greg and Sally Chappell of *Shannon Vale Station* undertake comprehensive chemical analysis of plant tissue and sap in order to apply organic fertilisers targeting specific deficiencies in nutrient availability. Balancing soil and plant nutrients enable effective cycling. By combining specific grazing management practices with the use of solid organic fertiliser tailored to their soil and liquid foliar fertiliser to address plant nutrient deficiencies, the Chappells have rejuvenated once weed-infested pastures. SOC and fertility have increased and pasture quantity and quality have improved. The Chappells believe that these improvements to the nutritional value of their pastures have directly lead to increased growth in their Angus bulls.

With 300 dairy cows and a 60 bail shed, Ian and Wendy Klein of *Pine Lodge* in the Victorian Central North (CS17, pg. 180) were producing more 'nutrient' than they could manage – in the form of dairy effluent. Too rich to use as fertiliser, it was when the Kleins adopted natural methods across their farm that they identified an option to treat the effluent. Now, by adding aerobic and beneficial bacteria to add oxygen and convert the ammonia into amino acid, those nutrients can be returned to the soil as an economically valuable fertiliser, re-establishing the nutrient cycle.

*Top: Livestock contribute to nutrient transfer and cycling; Below: Crop stubble on* Milgadara *is now retained to break down and return nutrient to the soil*

In cropping situations, crop production, in terms of higher test weights, is also known to occur when plant nutrition improves. As a result of improved soil structure, nutrient cycling and water holding, it is possible to achieve the same yield with lower applied nitrogen. Improved translocation and allocation of other nutrients to the grain, as well as improved water and carbohydrate transfer occur when plants are less moisture stressed.

On *Inveraray Downs* on the Liverpool Plains, the McKellars are regenerating what used to be some of Australia's best soils, which had become degraded through cultivation and use of inorganic fertilisers and bio-cides. The McKellars have re-designed ecological cropping practices by altering crop rotation, applying compost and introducing stock into production – all of which are contributing to restoring essential biological processes, nutrient cycling and healthy soils. As a result, they now produce better quality and more healthy and nutritious food – more sustainably and with lower input costs.

Cam and Roxane are capturing increased nutrients such as carbon and nitrogen from plant growth through incorporating green manure legume crops, and through the retention of crop stubble. Consequently, greater soil microbial population response is promoted, which in turn feeds improved cycling of the other nutrients needed for plant growth. Under the previous conventional management system, this would have been lost to burning and oxidation.

By moving from synthetic to compost-based minerals for nutrient replacement, the McKellars are now also adding trace elements, organic matter and biological by-products of the compost process that contribute to soil fertility over and above simple nutrient replacement. Short term responses in crops are also being promoted through the use of organic liquid fertiliser stimulants. As a result of changing his practices, Cam has reduced production costs, increased crop yields and nutritional value and restored soil structure and fertility.

As on *Inveraray Downs*, the Wilsons of *Briandra*, and the Dalys of *Milgadara*, have also adopted the practice of stubble retention on their properties, using stock or cellulose-digesting fungi to break down stubble, better hold water and return nutrients to the soil for uptake by plants.

# WATER

## Capturing Rain Where and When it Falls

Ninety-eight per cent of Australia's rainfall initially falls on soils, and case study participants who have improved their soil's structure are demonstrating that most of this rain can be captured where it falls, infiltrate deeply and be retained within the soil. It can then be available to slowly recharge floodplains, wetlands, streams and dams and not be lost to runoff and evaporation, as is common where soil structure is poor.

Soil structure is the key property that governs the effective infiltration, retention and availability of rainfall due to the increased water-holding capacity of SOC. The previous section discussed how soil structures can be improved, practically, rapidly and even profitably by simply restoring their natural SOM content. This aids the:

- infiltration, retention, availability and sustained supply of water from such soils;
- aeration and capacity of roots to proliferate and penetrate deep into soils;
- capacity for water to recharge and irrigate soils from below to limit loss due to evaporation; and
- restoration of in-soil reservoirs and aquifer recharge.

On grazing properties, the beneficial outcomes of time-controlled planned grazing are evidenced in facilitating capture, infiltration and retention of rainfall. This is what gives Shane and Shan Joyce of *Dukes Plain* in the Southern QLD Brigalow Belt (CS1, pg 48) and Charlie and Anne Maslin of *Gunningrah* on the NSW Southern Tablelands (CS8, pg. 112), amongst others, the capacity to manage production in periods of low rainfall. As discussed later in the Planned Grazing section, adjusting stocking rates in accordance with the feed resource available is also essential in maintaining resilient plant communities and thus production, long-term.

A number of the case studies were located in areas of low rainfall, and all areas had experienced inconsistent rainfall over the years. Traditionally, it can sometimes be challenging to address water management, especially in times of abundance when drought periods can be all too easily forgotten. However, a notable theme which emerged from the case study participants, such as on *Bokhara Plains, Dukes Plain* and *Gunningrah*, was to manage for low rainfall, rather than to rely on unpredictable higher rainfall events.

On an irrigated property, David Clayfield of *Clover Estate* is applying around half the water commonly needed for irrigation in the region due to the improved water holding capacity of his soils. On *Pine Lodge*, also an irrigated property, the Kleins have implemented a comprehensive recycling program to more effectively manage and use their water. Paddocks have been laser levelled to provide a gentle slope to enable flood irrigation. Any water runoff goes to the lowest point on the farm which is captured by a water reticulation system and re-used. Due to their improved soil structure, pastures which used to be irrigated every six days during the summer months are now only irrigated each nine or ten days.

On a dryland salinity effected region of the NSW Southern Tablelands, John and Robyn Ive of *Talaheni* (CS11, pg. 136) had additional reasons for capturing rainfall higher on their property. By achieving this through techniques discussed later in the Vegetation section, the Ives managed to lower the water table to below the level where saline ground water can rise to the surface, all but eliminating saline seeps across their property.

*Pastures remain green longer across the seasons on* Gunningrah *as a result of increased rainfall infiltration and retention*

## Slowing the Flow

Many of the case study participants are applying techniques which are based on the natural hydrology of the Australian landscape and how nature evolved and sustained immensely productive and resilient biosystems despite Australia being such a dry continent. By understanding these hydrological processes, resilient water systems can be designed and restored.

Australian creeks and rivers were unlikely to ever have been like those in Europe that constantly flow through the lowest level in the flood plain, draining away abundant water supplies. Substantial supplies of water on the Australian continent were mostly stored under the ground. The visible water in large rivers did not move much except in flood times. During major rainfall events, water levels would rise a metre or so and gently, without any erosive force, spill over the banks which, in Australia, in contrast to Europe, were at the highest level of the flood plain. Plentiful vegetation growing in hydrated soil along river banks would prevent significant erosion.

With the introduction of grazing across the Australian landscape, riverside vegetation was grazed and repeated stock access caused the banks to become eroded. Gradually, rainfall would wash into what was becoming a gully and only in significant rainfall events would it flow over the banks, each time washing away more soil. Confined to a gully, water flow would continue in the one direction at increasing speeds and the gullies became more deeply incised.

The level of the water in the floodplain is generally reflected by the level of the water in rivers or creeks. Today, this level can be seen to be up to many metres below some river banks, and accordingly, so is the water level under the floodplain. Where previously, plants in the healthy floodplains had their roots in hydrated soil all the time, they now depend on direct rainfall to soak down to them.

A primary step by many of the case study participants in more effectively managing water on their property has been to fence off water courses to prevent stock access, or limit access through time-controlled planned grazing, to reduce further erosion of river banks. Combined with the establishment of leaky weirs, as drawn from *Natural Sequence Farming* methods, this enables regeneration of vegetation and restoration of riparian areas to function as they did prior to the introduction of grazing.

Craig Carter and his partner Nicky Chirlian of *Tallawang* on the NSW North West Slopes and Plains (CS10, pg. 128) employed the assistance of Peter Andrews to design structures and leaky weirs for his creeks. Mainly constructed from dead trees, later in conjunction with plantings of native reeds, these structures created a ponding effect and retarded water flow. Six years on, previously bare soils and gravel beds are covered with regenerating plants and considerable siltation is evident as the vegetation traps sediment carried from upstream. The creek on *Tallawang* is now a 'chain of ponds', and while inflow varies with rainfall, outflow is constant due to improved water retention in the soil and subsequent hydrological processes.

The Maslins of *Gunningrah* have also constructed over 30 weirs across streambeds and gullies on their property since the mid 1990s. Whilst two major weirs cost around $2500, very little has since been spent on other constructions, with weirs made by hand with whatever materials were available. Combined with time-controlled planned grazing, these approaches have had significant impacts in as little as two years, with increased bank stability providing a greater ability to handle high flood flows. One weir collected an estimated 50 tonnes of silt in just three years, significantly healing erosion, and streams now flow for considerably longer after flood events, with clear, rather than silty runoff.

*The river on* Tallawang *is healing from an exposed basalt rock base (top) to a gently flowing 'chain of ponds' (below)*

*Establishment of weirs on* Gunningrah *has lead to significant gully restoration in as little as two years - 2006 (left), 2008 (right)*

On a much larger scale, Ben and Graham Forsyth of the 480,000 hectare *Three Rivers Station* in the WA Mid West (CS5, pg. 84), are constructing major earthworks to try and protect their land from the infrequent but heavy rainfalls which have washed away topsoils and caused massive erosion. After de-stocking their property in response to increasing landscape degradation, they are now investing in regeneration activities to build perennial grasses and enable effective planned grazing in the future. Plant life regeneration since destocking has already assisted in restoring soil health to support better rainfall absorption. To slow the flow of water, the Forsyths have built bunds and rakes - rows of sturdy poles at about one metre spacing - to capture sediment and debris and slow water flows. The captured sediment and decomposing organic matter provide fertile soils in which grasses and shrubs can grow, and seed banks become established to spread further as the soils improve.

Similar techniques are being used in the landscape as well as in waterways; indeed groundcover management, for example through time-controlled planned grazing, has a pivotal role in capturing and slowing the flow of rainfall. On *Tallawang*, swales have also been constructed to slow, retain and more effectively use water in the upper parts of the landscape. This has enabled surface water to better infiltrate, and pastures higher in the landscape are maintained longer in quality and quantity. On *Jillamatong*, Martin Royds has shallow drains radiating out from weirs to divert water from the waterway across the paddock, and the Joyces have employed Keyline design principles to contour water away from gullies and as required to dams on *Dukes Plain*.

For Craig Carter, Martin Royds, the Maslins the Joyces, and many others who have increased their groundcover and soil water absorption, dams no longer provide a reliable gauge for rainfall capture. The water is held in the landscape rather than flowing rapidly across it and draining to the lowest point. The water quality of any overland flow and storage is also improved by greater groundcover acting as a filter for sediment in runoff into dams, as well as reducing nutrient inflows from livestock which are now excluded from dams most or all of the time.

*Heavy rainfall washes away bare topsoils to expose hard subsoils on* Three Rivers Station *(top); rakes have been constructed in water courses to catch debris, build up sediment and spread water back out to the floodplain (below)*

## Reticulation

Many case study participants have established reticulated water systems to provide trough water for their stock as a function of reducing stock access to waterways as well as implementing time-controlled planned grazing on increased numbers of paddocks. This practice is evidenced in the extreme on the million-plus hectare property of *Beetaloo Station* on the NT Barkly Tablelands (CS4, pg. 76), managed by the Dunnicliff family. Discussed further in the later Planned Grazing section, John Dunnicliff is establishing a network of bores and pumps connected by hundreds of kilometres of 75mm pipe in order to access previously untouched grazing land and support a potential stock rate of 100,000 head of cattle – or more.

Establishing a reticulated troughing system also contributes to more effective water use, minimising evaporation and waste. It also ensures clean water for stock, that has health benefits over high-use dams which are often contaminated by excessive animal nutrient from wastes.

*Top: Hundreds of kilometres of pipe are required to reticulate water across* Beetaloo Station*;*
*Below: Many farmers gravity-feed water to troughs from 'turkey's nest' dams located high on the property*

# VEGETATION

Managing for increasing biodiversity in vegetation will sustain ecological processes critical to delivering the ecosystem services that provide the life support systems for the planet. Vegetation and its life-cycle processes form the basis of food chains, purify the air, protect water quality and yield, store carbon, maintain soil fertility and stability and support the industries of forestry, agriculture and aquaculture[2]. Nutrient cycling, as previously discussed, is essential for maximising plant – and food – nutrition.

Managed landscapes provide the major opportunity for revegetation and sequestration of carbon back into the soil and for restoring natural hydrological cycles. Establishment or re-establishment of biodiversity in pastures, crops, trees and other plant life through regenerative land management practices is therefore achievable across much of Australia.

Each of the case study participants emphasised the importance of vegetation in their regenerative landscape management practices, especially in maintaining groundcover. The previous sections have described how groundcover is fundamental in generating SOC and maximising the water-holding capacity of the soil. Vegetation can therefore be seen as the engine driving the water/carbon cycle.

## Tree Cover

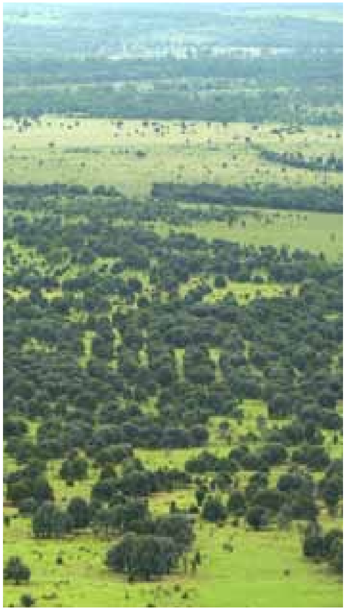
Trees can improve agricultural production by providing shade and shelter that protects stock and crops from wind and extremes of heat and cold. Vegetation contributes to an effective water cycle through the restoration of diverse woodland communities. Together with extensive, slow biodegrading litters, such vegetation reduces surface wind speeds and extreme temperatures that would otherwise encourage significant evaporation losses.

Studies on a wide range of sites have shown that shelterbelts can improve crop productivity, typically by 5% to 20%[3]. Trees established as shelterbelts and woodlots can be managed to produce timber and other tree products, thus increasing diversification of farm income[4]. Experiences of case study participants have further demonstrated the benefits of tree regeneration and/or revegetation.

On *Dukes Plain*, Shane Joyce is measuring the financial benefit of increased vegetation in his pastures, after observing the increased production of paddocks with regenerated stands of brigalow (*Acacia harpophylla*) than those that had been cleared.

Shanes' own observation and monitoring on *Dukes Plain* identified the importance of shelterbelts and tree canopy levels in relation to production, as well as for regeneration of natural resources. Shane observed a balance between sunlight reaching the grass understorey for photosynthesis and the benefits to that understorey of having shade during hot periods when photosynthesis would otherwise shut down. He noted that shelterbelts also provide protection from wind shear on both moisture loss and animal performance in cold, as well as a barrier to frost impact on leaf production. As trees have deeper roots, they also intercept nutrient from depth, recycling to topsoil and subsequently grass production via fallen leaf and residues.

Whilst the Joyces observed that approximately a 40% canopy provided optimum pasture production, this is not a fixed ratio and will change from area to area relative to seasonal values of temperature, wind and rainfall frequency. The optimum level will vary from farm to farm, but is an area that can be investigated to maximise individual outcomes.



*On* Dukes Plain*, the Joyces experimented with narrow (right) and wide (below) shelterbelts to determine optimal vegetation cover to support production. Natural regeneration with approximately 40% canopy cover evidenced the best results*

On *Talaheni*, John and Robyn Ive are using revegetation to capture rainfall higher in their property to lower the water table and subsequently reduce salinity problems. They have used innovative techniques, employing strategic grazing to exploit variable seasonal conditions, and using livestock to disturb hard ground surface to facilitate germination. Together with additional manual planting, the Ives estimate they have established more than 200,000 trees on their property. Data from regular monitoring over 20 years shows a significant decline in watertable levels and salinity levels of groundwater, suggesting that they have achieved success through revegetation and other on-farm actions.

*Revegetation has been fundamental to the Ive's approach to regenerative landscape management on* Talaheni*, converting bare soils with visible saline seeps (1982, top) to productive pastures (2012, below)*

## Pastures

Planned grazing, discussed overleaf, is demonstrated in many of the case studies as an effective technique for increasing groundcover and preferred pasture species. Vegetation succession to more productive species of grass and shelter in turn promotes stronger mineral and water cycles and attracts a greater diversity of animals to then recycle nutrient back to plants.

Establishing and maintaining perennial grasses through these techniques assists in providing resilience to the landscape. Increased persistence of native perennial species in the pasture provides for more continuous groundcover. This protects the soils from erosion and weed incursion, produces root biomass, builds SOM to enhance water holding capacity and enhances resilience against drought. Many case study participants cited the goal of "100% groundcover, 100% of the time". Preferred species can be encouraged through grazing techniques and by monitoring and responding to plant life cycles to maximise – or minimise – plant succession.

On *Winona*, Colin Seis' 'pasture cropping' technique aligns with perennial grass lifecycles, ensuring continuous groundcover and delivering multiple production lines from his land. Colin sows crops into dormant perennial pastures and has integrated his grazing enterprise to graze the crop stubble and regenerating pastures.

Deeper rooted plants can draw on deeper moisture and nutrient for plant production. This in turn increases water holding capacity and structure to receive moisture infiltration where there is greater groundcover. As illustrated by Martin Royds of *Jillamatong*, deep rooted plants can be sought out to facilitate this. Martin elected to encourage growth of chicory (*Cichorium intybus*) and plantain (*Plantago major*), after observing the deep tap roots of weeds that he was removing from his more shallow-rooted pastures. He also observes that by allowing pastures to grow longer through planned rotational grazing practices, the dew condensing on the tall perennial grasses each night now provides additional water that helps sustain soil moisture and healthy pasture growth.

Another technique being applied to increase pasture quality and quantity is the establishment and protection of seed banks – or "seed orchards", as Ben and Graham Forsyth of *Three Rivers Station* call them. By protecting clumps of preferred grasses enabling them to complete their lifecycle, seed can spread and increase the population of the preferred species.

*Flourishing native perennial pastures on* Winona *(top) and* Jillamatong *(below)*

*Tap-rooted plants, such as chicory, help to draw nutrients and moisture from deep within the soil*

## Planned Grazing

A key theme displayed by the majority of case study participants was the recognition of grazing management and animal impact as effective farm tools. Driven by holistic decision making, livestock management can be used to shift the landscape towards increasing diversity, and thus resilience.

Many of the case studies demonstrate the positive production and environmental outcomes that can be obtained by using planned grazing. In the mixed enterprise case studies, animal impact is also shown to be integrated very successfully into cropping enterprises.

Positive environmental outcomes span across each of the key regeneration process drivers of soil, water and vegetation, actively driving the water/carbon cycle and include:

- increasing groundcover quality and quantity;
- improving rainfall infiltration;
- encouraging preferred species;
- minimising weed incursion;
- optimising pasture use;
- supporting nutrient cycling;
- increasing SOC;
- increasing long-term carrying capacity; and
- providing early feedback of feed supply to enable adjustment of stocking rate.

The grazing management technique used by many case study participants is a form of time-controlled planned grazing. These comprise variations on rotational or cell grazing, though display similar principles; primarily:

- reducing paddock size and rotating stock through the paddocks;
- matching stocking rate to the carrying capacity of the land;
- determining the pasture rest and recovery period by plant growth rate;
- controlling graze period; and
- adjusting stock density, usually through paddock size and number.

These techniques are based on observations and research, firstly by Frenchman Andre Voisin (as documented in *Grass Productivity*, initially published in 1959) and later developed into Holistic Management practices firstly in Zimbabwe and later in the United States by Allan Savory. Implementation and management experiences of case study participants are as follows.

### Infrastructure

Each of the case study participants using planned grazing have made some investment in infrastructure, generally fencing and watering points. However, many commenced the practice just by mobbing their stock into larger herds and moving through existing paddocks. Paddock sizes observed in the case studies vary with property size and capital available for construction. Evidence from the case studies indicate that it is the application of the technique rather than a prescribed paddock size that will deliver results. For example, on 3350 hectare *Lana*, paddock size is continuing to decrease, now averaging between 10-15 hectares each, with some as small as four hectares. In comparison, on the 1,054,700 hectare *Beetaloo Station*, the Dunnicliff family is aiming to reduce their paddock size to 1200 hectares. Regardless, different versions of the same approach are being applied.

Across the numerous case study participants using this technique, paddock designs also vary significantly. Some have combined paddocks into cells, others are using 'wagon wheel' designs around water points, and others have laneways running between paddocks. Some paddocks are designed to facilitate nutrient transfer and others to group landscape types. Some properties incorporate a mixture of these designs. This indicates that there is no single way of successfully applying this technique, and the fundamental principle is to tailor the approach to individual requirements.

Many case study participants commented that capital investment in increased infrastructure can be recouped within two to three years through increased production and reduced inputs.

*Fencing and water-points, such as the 'wagon wheel' design adopted on Tallawang, are fundamental infrastructure for effective planned grazing*

The provision of water is fundamental to support rotation of stock through multiple paddocks. To take advantage of the available resource base of *Beetaloo Station*, John Dunnicliff is investing millions of dollars to establish a stock watering system and fences to enable his stock to graze the far reaches of the property. He understands the critical role that animals play in ensuring constant pasture regeneration when combined with planned grazing and what that means for production. These practices also replace the use of fire to encourage new growth, which in turn better protect the soil microbiology for healthy functioning. John's innovative vision is demonstrating possibilities for a new approach to grazing in the vast regions of Australia's north which could significantly increase cattle production – whilst regenerating the landscape.

*On Lana, sheep and cattle are grazed separately or together, depending on desired pasture and stock outcomes*

## Flexibility

Once implemented, planned grazing has been illustrated to provide flexibility in stock and pasture management.

Martin Royds of *Jillamatong* demonstrates an unswerving commitment to looking after his pastures by stocking accordingly, moving from the traditional measure of success being the size of his herd. Martin has trialled a number of paddock configurations to gauge the carrying capacity of his land, ultimately adopting a design which enables his stock to move from areas of high to low fertility, spreading nutrients as the Wrights do on their farm *Lana*.

Animal management priorities on *Jillamatong*, like many others, are on stock weight gain. Martin uses a flexible balance across cattle trading/breeding/agistment to enable him to manage stock numbers in accordance with pasture availability to maximise animal health and weight gain results. The Joyces of *Dukes Plains*, Finlaysons of *Bokhara Plains*, Craig Carter of *Tallawang* and the Maslins of *Gunningrah* also use a similar approach. These practices not only ensure continuous improvement of the natural resource base, but also maximise animal health and reduce input requirements, such as buying additional stock feed.

On *Lana* the Wrights are managing greater diversification of enterprises, providing flexibility and risk management in the farm ecosystem. The Wrights apply a level of sophistication in the complexity of their grazing rotation, mixing stock classes and animal types, gaining greater level of pasture utilisation and subsequently nutrient cycling. In terms of the differing requirements of animals in their enterprises through time, the Wrights are able to spread the feed demand between production for fine wool, fat lambs, breeding cattle and fattening cattle, better utilising the resources naturally available at different times of the year.

A reduction in labour input required to manage their stock has also been experienced by those using planned grazing. On Lana, labour requirements have reduced from one person per 5,000 DSE to one per 12,000 DSE. On *Gunningrah*, labour efficiency has improved by 40%. While animals are being moved regularly, a pattern with which they become familiar, this increased human exposure also makes them easier to handle and monitor for general farm practices.

These enterprises have changed from grazing practices with poor relationship and feedback loops between monthly feed availability and the stock rate being run, such as set stocking. They now have the flexibility and capacity to proactively respond to influences on production they cannot control, such as seasonal rainfall and temperature and related grass and water resource availability. They can then manage carrying capacity to match the resources on hand whilst there is time to manage the outcome of too much or too little feed, without degrading the natural resource base.

## Improvement of the Natural Resource

The use of grazing management as a farm tool has been clearly demonstrated as a technique for improving the natural resource – soil and vegetation naturally linking to greatly improved water infiltration and holding capacity.

Planned grazing practices enhance nutrient cycling, as discussed earlier, and trigger succession from low order species to more palatable and productive plants, particularly perennial species. This is due to the removal of grazing pressure for long enough for the preferred plants to compete for moisture and nutrients with the less palatable species, as demonstrated on *Bokhara Plains*.

By using higher density stocking, regrowth of unpalatable mature grasses is knocked down and this, plus any other plant litter is trampled into the soil enabling it to break down more rapidly. This also strongly contributes to the generation of SOM and ultimately SOC level improvements.

Observation and measurement play key roles in these practices. This enables the maximisation of solar energy flow to plant life for recovery and regrowth. By including measures of groundcover and rainfall infiltration, farmers using these methods are ensuring change in production is not at the expense of the resource base. Case studies on *Jillamatong, Gunningrah* and *Lana* clearly display the importance of monitoring pasture recovery periods in between grazing. On *Dukes Plain*, Shane Joyce, like a number of others, highlights the advantage of investing in the best and most productive pastures first, the returns from which can then be invested in regeneration of less productive areas.

The health of these property landscapes, including increases in organic matter and resilience to extreme weather conditions, provides evidence that farmers are not making a trade-off between production and soil health, but achieving long-term economic and environmental success.

The quantity and quality of pasture being regularly produced for the carrying capacity on many of the case study properties, hints at the amount of carbon that may be being sequestered through theses regenerative landscape management practices. While significant testing such as that performed on the practices at *Winona* has not yet been performed, depending on management practices, up to 80% of the total biomass produced as a result of the continuing vegetation growth, could potentially be converted into stable soil carbon via the microbial ecology of the animal gut and/or soil.

## Breaking Weed and Parasite Cycles

On *Shannon Vale Station*, the Chappells are following similar grazing management principles but using a technique suited to their particular circumstances. Bull breeding does not allow for the high density herd grazing and trampling needed for plant succession, so the Chappells are mimicking the action of planned rotational grazing by employing a mulcher to mechanically provide the same process. This has been successful in helping them to combat their weed problems by breaking the weed lifecycle and to generate healthy, productive pastures.

Many of the case study properties using planned grazing have also demonstrated a reduction or cessation in the use of drench for intestinal parasites. By using planned rotational grazing, the parasite lifecycle can be broken. Stock are moved from being in contact with hatching parasites and then not returning until after worm burdens have been degraded by the environment in the absence of a host to pick them up from the pasture. This outcome is likely to require some time to achieve, but, as demonstrated on *Lana* and *Gunningrah*, a reduced dependence on drenches can be accomplished through good grazing management.

*Planned grazing techniques have been adjusted on Shannon Vale Station to accommodate  for social pressure between bulls and to convert weed-infested pastures*

## SUPPORTING BIODIVERSITY

Biological diversity - biodiversity - reflects the health of the natural system and is an indicator of healthy soil, water cycle and vegetation cover. Biodiversity is the variety of all life forms on earth. It includes the plants, animals and microorganisms, and the terrestrial, marine and freshwater ecosystems of which they are a part[5].

Biodiversity provides a measure of the existence of species robust enough to survive and rebuild ecosystems in the face of disease, climate change, fire and drought[6]. A healthy functioning natural system will support biodiversity to effectively continue providing fundamental life support services.

A number of case studies with good biodiversity of pasture species, such as *Shannon Vale Station, Jillamatong* and *Briandra* reported increased stock weight gain or health. An improved diversity of pasture species with associated increase in total root mass and depth accessing a greater level of nutrient, results in greater mineral content and quality of feed. Where trees are part of the grass system, their ability to draw minerals from significant depths and to cycle that back to topsoil via fallen litter explains a further contribution to improved feed quality. The greater feed quality during critical times of stock joining is a possible explanation for the increased conception percentages experienced on a number of properties.

In addition to obtaining biodiversity outcomes through holistic practices, a number of the case study participants are actively dedicating portions of their property as biodiversity areas. *Lana* has been gazetted as a wildlife refuge since the 1960s and pastures are actively managed to encourage biodiversity, particularly of native species.

It is not just the amount of biodiversity that signifies health in the system, but sufficient variety, particularly in microorganisms, to ensure the life support services can be delivered. Moving away from monocultures is important in supporting this, as demonstrated on *Inveraray Downs* where green manure crops are being incorporated into crop rotation, organic compost is being applied, grazing is integrated to break down sorghum and corn stubble and dedicated biodiversity zones are being maintained.

Below the ground, investment in biological management of the soil, such as that being undertaken by the *Prospect Pastoral Company*, and on *Milgadara, Clover Estate* and *Briandra*, is ensuring than there are sufficient microorganisms, beneficial bacteria and fungi to perform essential services within the soil.

*A combination of techniques focusing on soil health have overcome weed invasion, resulting in lush, nutrient-rich pastures on Shannon Vale Station*

## WEED REDUCTION

The existence of weeds in the landscape is often a bio-indicator of poor soil health and insufficient vegetation cover. Due to their survival and reproductive habits, weeds are often the first species to colonise disturbed or debilitated terrain. With many current land practices impacting on soil health, it is unsurprising that weeds continue to invade many areas and thrive.

The consequences of weed invasion are felt on many levels. Economically, all Australians are directly or indirectly affected by weeds. Agricultural, horticultural and forestry industries lose productivity through impacts such as crop and water invasion, reducing crop yield or quality, or through contamination, such as harm to livestock. It is estimated that weed control activities cost Australian farmers around $1.5 billion a year, and a further $2.5 billion is lost in agricultural production[7]. In terms of time and money, in 2004-05, 73% of Australian agricultural establishments reported weeds as the natural resource management issue most affecting landowners. By comparison, only 46% of farmers reported soil and land issues and 38% water issues[8].

This problematic invasion is a symptom of the degraded natural system. Innovative farmers are observing that weeds can have a positive role in the environment as pioneer species to help improve the structure of degraded soil to promote the healthy growth of native plant communities[9].

The case studies of regenerative landscape management show that effort exerted in the areas of soil health and water management, actually reap benefits in managing weeds. Healthier soils help to maintain vegetation and biodiversity, competing with and eventually replacing weeds. Reductions in the use of chemical inputs has been demonstrated to further help to restore the natural system and repress weed invasion.

By using organic-based fertilisation targeted to address soil and plant nutritional deficiencies, combined with planned grazing techniques, the Chappells of *Shannon Vale Station* have rejuvenated their pastures. These activities replaced a chemical dependency that was economically unsustainable and still resulting in almost complete reversion to African lovegrass (*Eragrostis curvula*) after pasture sowing. Now, the Chappells can sustain growth rates in their bulls of a kilogram a day all year round.

On *Tallawang*, Craig Carter is encouraging natural processes to take place on his waterways and in his pastures. Supported by planned grazing practices, this is resulting in increased native plant biodiversity and groundcover. Craig has observed a natural reduction in weeds as the health of his landscape increases, so now manages weeds by allowing them to complete their natural sequence.

Charlie and Anne Maslin have adopted a different organic weed management approach on *Gunningrah*, integrating a herd of goats into their enterprise. Goats have a grazing preference for briars and thistles, and the Maslins are using strategic grazing to address any problem areas on their property with good success. Chemical use has also been greatly reduced. As an aside, the sale of goat meat is also providing a profitable complementary production line.

*Goats have been introduced to* Gunningrah *as an innovative form of weed control*

## REDUCED INPUTS

The case study participants' adoption of regenerative landscape management practices has shown a reduced reliance on off-farm inputs. For example, by using grazing management as a farm tool and maintaining groundcover, as discussed earlier, there is a reduced need for farm machinery, seed for re-sowing of pastures, synthetic fertilisers and related labour and capital.

A reduction in synthetic chemical inputs, such as non-organic fertilisers and bio-cides, has been an active decision for some of the case study participants, and for others a consequence of their changed practices.

The Kleins and the Joyces are producing certified organic produce, and in doing so have explored other methods to replace traditional chemical fertilisers. As discussed earlier, on *Pine Lodge*, Ian and Wendy Klein are now successfully treating their dairy effluent with aerobic and beneficial bacteria, enabling it to be used as an effective and economically valuable fertiliser for their pastures.

On *Dukes Plain*, Shane Joyce elected to pursue his interest in biodynamics. Through this he developed an innovative and cost-effective way to address nutrient deficiencies and improve soil fertility. By placing his biodynamic preparation in a 'tea bag' made from shade cloth and placed by the inlet valve in water troughs, the product is 'steeped' every time the cattle drink, passing through their digestive system and distributed across his property by his cattle waste.

Biodynamic preparations can have a highly concentrated population of rumen organisms, which have been cured in a controlled environment, and can achieve a pro-biotic response in ruminants. When delivered to cattle via aerated water from the float valve in a trough, this would provide an inoculant of those species naturally occurring in ruminant intestines. The outcome of increased rumen organisms is a greater utilisation of free nitrogen in the feed intake being converted to protein and taken into the bloodstream, rather than being lost to excretion in urine or manure. Nitrogen so utilised then remains in the body as a protein form for animal production, broken down over time into amino acid forms, which are ultimately excreted to the soil in a form that produces plant growth more palatable than that driven by free nitrate or ammonia forms.

Moving to organic and chemical-free practices has led to a reduced need for pesticides and herbicides in a number of case studies. This is due to increased biodiversity, such as beneficial predatory insects like spiders and ants, and the greater resilience in plant life through healthy nutrient cycling.

Though not seeking organic certification, some case study farmers, including those on *Jillamatong, Lana, Winona* and *Inveraray Downs* have all actively ceased or reduced their use of non-organic fertilisers and bio-cides with positive production and economic results.

With the demonstrated carry capacity increases, the decision not to use chemical fertilisers or bio-cides has not reduced the ability to grow sufficient quantity of quality desired species. Although the presence of weeds is still acknowledged by many of these farmers, increased groundcover often means that proliferation is much reduced.

As discussed earlier, many farmers using planned grazing are also experiencing a reduced need for drench for intestinal parasite control. This continues to reduce farm external inputs and associated costs, including labour and capital.

## PRODUCTION AND ECONOMICS

Sustainable production outcomes can also be an indicator of the health of the natural biosystem. By adopting regenerative landscape management practices some may experience short-term trade-offs in terms of production, yields and returns. However, as demonstrated in the case studies, many innovative farmers seek more than a production increase, with goals related to sustainability, better health or a balance in lifestyle.

Regardless of personal goals, case study participants have demonstrated gains across the whole of the farm balance sheet: increase in profits, production volume, water use efficiency, soil health and maintenance and improvement of the natural resource base. The positive result of such outcomes are being felt economically, environmentally and socially.

A consistent outcome of adopting regenerative land management practices for many of the case study participants was to even out production, smoothing out the profit peaks and troughs often experienced with varying weather conditions.

By having a comprehensive understanding of the production their land can support, the Ives on *Talaheni* and Colin Seis on *Winona* have adjusted their enterprise or integrated others to support both continuous improvement of the natural resource base and sustainable production. Many case study participants identified that the best production outcomes could be achieved, by first working on the best land and extending from there, rather than a more usual strategy of injecting resources into the poorest areas first. By maximising production on the best performing areas of the farm, profit can be leveraged to invest in changing poorer performing areas over time, without exposing the business to undue cash flow stress. Many also took a similar incremental approach to infrastructure enhancement, developing small areas first and investing production increases into further improvements.

The Finlaysons on *Bokhara Plains*, Martin Royds on *Jillamatong*, the McKellars on *Inveraray Downs* and the Dalys of *Milgadara*, are also diversifying their product lines, providing for both stability in income, whilst also reaping the benefits of complementary land use.

Overall, each of the 17 individual case study participants expressed their own motives for adopting regenerative landscape management practices, and correspondingly, each had varying production goals. However, by addressing soil health and focusing on their landscapes, particularly in terms of water management and biodiversity of vegetation, the innovative farmers in the case studies have experienced production and economic improvements as per the table on the following pages.

| Property/Enterprise | Production and Economic Highlights |
| --- | --- |
| 1. *Dukes Plain* (pg 48)<br>Cattle<br>Innovations commenced: 1993 | • 30% increase in productivity with introduction of cell grazing<br>• Increased productivity paid off infrastructure investment within 3 years<br>• External inputs costs for seed, labour and machinery have ceased<br>• Gross margin per hectare now between $64-$113; greatest in revegetated paddocks (about 40% canopy cover), measurably more than cleared paddocks |
| 2. *Bokhara Plains* (pg 60)<br>Cattle<br>Innovations commenced: 2001 | • Converted claypan and poor soils into productive pastures<br>• Carrying capacity so far increased from 56 DSE days per hectare per 100mm rain to over 100<br>• Diversifying production for income stability, including beef cattle trading and tourism |
| 3. *Shannon Vale Station* (pg 68)<br>Cattle<br>Innovations commenced: 2005 | • Cost of production reduced by 30-35%<br>• Overall production increased by 10%<br>• 2011 weight gain for bulls and heifers up 20% on earlier averages<br>• Carrying capacity increased<br>• Significant weed infestation overcome |
| 4. *Beetaloo Station* (pg 76)<br>Cattle<br>Innovations commenced: 2002 | • Significantly increased access to pasture for cattle, with a corresponding increase in carrying capacity<br>• Developed a potential model for sustainable grazing in Australia's Top End |
| 5. *Three Rivers Station* (pg 84)<br>Cattle<br>Innovations commenced: 2004 | • De-stocking to prevent further degradation of the natural resource base as a pre-cursor to landscape regeneration and re-stocking<br>• Working with lease-holding mining companies to revegetate the landscape |
| 6. *Clover Estate* (pg 96)<br>Cattle<br>Innovations commenced: 1995 | • Stock output increased by 33%, using 25% less irrigation water per animal weight produced<br>• Growing 600-700 dairy heifers cows off 100ha per annum<br>• Reduced irrigation to 5ML annually compared with region average of 8ML |
| 7. *Jillamatong* (pg 102)<br>Cattle, cottage industries<br>Innovations commenced: 1994 | • Productivity increased from 1.73 ha to 1.13 ha required to support one cow<br>• Weight produced per DSE 50% above regional average<br>• Diversification into complementary product lines to maintain cash flow<br>• Independent benchmarking showed total profit per hectare 14 times above the regional average |
| 8. *Gunningrah* (pg 112)<br>Cattle, sheep, goats<br>Innovations commenced: 1995 | • Consistent profit increase despite lower rainfall<br>• Labour requirements reduced by approximately 40%<br>• Twin lambing rates improved by 20%<br>• Stock class more consistent<br>• Goats introduced for weed control, now also providing additional income stream |
| 9. *Lana* (pg 120)<br>Sheep, cattle<br>Innovations commenced: 1990 | • Carrying capacity increased from average of 8,000 to 20,000 DSE<br>• Increased production maintained through periods of drought<br>• Wool staple strength increased from average 40 N/Ktx (newtons per kilotext) to 48 N/Ktx<br>• Wool fibre diameter improved from 17.5 to 16 micron<br>• Merino lambing increased from 80% to 90%<br>• Calving rate increased from 80% to 90%<br>• Permanent labour requirements reduced from one person per 5,000 DSE to one person per 12,000 DSE |

| Property/Enterprise | Production and Economic Highlights |
|---|---|
| 10. *Tallawang* (pg 128)<br><br>Cattle, sheep<br>Innovations commenced: 2002 | Stock trading model introduced to match stocking rate with seasonal conditions<br>Reduced input costs<br>Expected 15%-23% profit on cattle production through breeding and trading programs |
| 11. *Talaheni* (pg 136)<br><br>Sheep, cattle, native trees<br>Innovations commenced: 1980 | Markedly increased availability of productive land through salinity management<br>Specialist provider of ultrafine sharlea wethers<br>Revegetation provides timber for potential farm forestry<br>Beef cattle a complementary product line |
| 12. *Winona* (pg 144)<br><br>Crops, sheep, native grass seed, kelpie dogs<br>Innovations commenced: 1993 | Crop production maintained with annual input costs decreased by $120,000 including no herbicide and 70% less fertiliser<br>Concurrent enterprises ('vertical stacking') of grain, sheep wool and meat, native grass seed<br>Wool tensile strength improved by 60%<br>Vegetable matter in wool reduced by approximately 70% |
| 13. *Milgadara* (pg 152)<br><br>Crops, sheep, compost<br>Innovations commenced: 2001 | Increased crop yields and improved crop quality with less fertilisers (canola up to 3t/ha and 47% oil; wheat 5-6t/ha)<br>Increased carrying capacity<br>Lambing percentages 150% in cross bred ewes, 120% in Merino ewes<br>Wool staple strength not less than 36N/Ktx<br>Complementary business with client base of over 2000 |
| 14. *Inveraray Downs* (pg 160)<br><br>Crops, cattle, compost<br>Innovations commenced: 2000 | Increased crop bushel weight<br>Even yields across the property<br>Reduced disease<br>Reduced input costs (chemical fertilisers, herbicides, pesticides)<br>Complementary production lines in agistment and compost sales |
| 15. *Briandra* (pg 166)<br><br>Crops, sheep<br>Innovations commenced: 1996 | Increased cropping capacity through raising beds ($200/ha) at a fraction of the cost for installing sub-surface drains ($1000/ha)<br>Crop production sustained with reduced inputs<br>Increased sheep weight gain |
| 16. *Prospect Pastoral Company* (pg 172)<br><br>Crops, sheep<br>Innovations commenced: 1994 | Continuing production trend to higher yields and higher quality cereal grains and hay on growing season rainfall as low as 100mm<br>High quality 17-20 micron wool from sheep adapted to local environment<br>Premium grade fat lambs at a lambing rate of better than 115% |
| 17. *Pine Lodge* (pg 180)<br><br>Dairy<br>Innovations commenced: 1996 | Organic dairy produce delivering a 10% premium<br>Veterinary costs substantially reduced<br>Irrigation reduced by 30%<br>No ongoing external input costs |

# MAKING THE CHANGE TO REGENERATIVE LANDSCAPE MANAGEMENT PRACTICES

A common experience for most of the case study participants was the challenge in changing behaviours to regenerative landscape management and breaking away from the status quo, as illustrated in the *Dukes Plain* and *Jillamatong* case studies. Many cite that their existing knowledge and mindset was the biggest hurdle to overcome, having to learn different theories, techniques and approaches to their practices. Incorporating new knowledge against their own and others' traditional values and approaches took confidence and persistence.

To question and challenge convention was a common factor across many of the case studies. Prior to adopting change, many experienced low points in terms of production, landscape degradation or personal health challenges, and identified that there had to be a better way to manage their enterprise.

## Taking a Holistic View

Taking a more holistic view of farm management, including maximising natural system functioning, guided practice change for many of the case study participants. This included addressing the underlying cause, rather than visible symptoms, as illustrated on *Lana* and *Gunningrah*.

In adopting changed practices, this often involved 'seeing' the landscape differently to conventional management, to understand what degradation and healthy functioning looked like in order to facilitate natural processes. On *Tallawang* and *Bokhara Plains* this involved accepting weeds as pioneering species to allow vegetation to commence regeneration. On *Milgadara, Inveraray Downs* and *Briandra*, crop stubble was retained rather than being cleared. On *Shannon Vale Station* and *Jillamatong* direct-drilling was adopted, rather than conventional practice of fully cultivating and re-sowing pastures

## Commitment, Trial and Error

The case study participants demonstrated fortitude and commitment to persist when the techniques were new and results took time to achieve. Farmers emphasised trial and error as an important process in learning and adjusting practices to suit the landscape and personal goals. Many cited that they made mistakes along the way, but, importantly, persisted.  As highlighted by Tim Wright of *Lana*, "...we assume we could be wrong, and we monitor and replan. This is the holistic feedback loop, which is really important. Tomorrow is another day – nature is changing every minute and we have to change with Mother Nature".

## Continuous Learning

Most case study participants committed to self-education and continuous learning, searching widely to identify what would work for them in their circumstances. Many noted that relevant information is much more available now than it was a decade or more ago when they commenced practice change. Very few adopted one single theory or method, and the more common practice was to learn widely and adopt techniques and practices that aligned with their own individual goals and the local landscape. In the words of Shane Joyce from *Dukes Plain*, "Select the tiles that *you* want, and make your own mosaic".

## Observe and Measure

Observation and measurement were central to the adoption and maintenance of regenerative landscape management practices by many of those interviewed for the case studies. Maintaining regular records and observing the landscape through techniques such as keeping a fixed point photographic record allow incremental change to be tracked. This then provides a feedback mechanism to identify which practices are working and which are not, to determine what should be extended and what should cease. John and Robyn Ive of *Talaheni* provide a key example of these practices, capturing over 30 years of data. John notes, "If you do not measure it, you cannot manage it".

Some case study participants are maintaining a direct link between management practices and production. For example, on *Dukes Plain*, measurement of the planned grazing practices includes the stocking rate, shelter type,

*Understanding and performing soil tests helps to support regenerative practices* percentage of canopy cover as well as grazing pressure - which can be converted to grass consumed, based on the known consumption patterns of the stock class concerned. Production is measured in terms of kilograms of beef produced per hectare of pasture. Cause and effect relationships can therefore be determined and influencing factors adjusted.

Matching stocking rates to the carrying capacity of the land was evidenced as a very important factor by a number of grazing enterprises. The use of grazing charts to generate a benchmark carrying capacity per 100mm rainfall, as illustrated on *Gunningrah*, effectively provides a feedback loop from pasture to management about when to increase or decrease stocking rates. This has been demonstrated to good effect, especially on properties adopting stock trading strategies, such as on *Bokhara Plains* and *Tallawang*.

*Monitoring rainfall and matching stocking rates to the carrying capacity of the land helps to preserve - and improve - the natural resource*

## COORDINATED SUPPORT

The wider adoption of regenerative landscape management is a strategic imperative for Australia's future wellbeing. Support mechanisms are required to assist land managers who are adopting regenerative landscape management or who have attended training activities or demonstration days in order to provide confidence in changing practices.

Support from like-minded individuals, groups or organisations was noted as beneficial for many case study participants in adopting changed practices. This can be seen in the *Bokhara Plains, Jillamatong, Gunningrah* and *Briandra* case studies, amongst others. Attending presentations, field or open days provides the opportunity to visit and learn, creating a forum for information transfer and peer review. Overall this leads to a sense of empowerment amongst participants and encourages cumulative learning. Such activities also create a community, even if it is separated geographically – which is essential to support widespread adoption of change.

*Soils for Life* selected two case studies to investigate support mechanisms in particular. These examined extension activities underway which are successfully leading, guiding and encouraging farmers and land managers to learn about and adopt regenerative land management practices.

The *North East Catchment Management Authority* (CMA) in Victoria (CS18, pg. 186) and the Tasmanian Natural Resource Management body, *NRM South* (CS19, pg. 196), provide two of many possible examples of effective means which could be used to provide the required encouragement and support to farmers and land managers to adopt regenerative landscape management practices.

*North East CMA* is achieving catchment-wide change in knowledge of how to build healthy soils. By identifying a critical knowledge gap – the ability to understand and respond to soil tests – the CMA has developed the *Soil Carbon Programme*. This program provides practical action and advice, in the form of soil tests, agronomic advice on options on how to respond to the soil tests and ongoing engagement and information activities based on farmer and land manager requirements. With funding of $2.2 million over four years, over 500 farmers are actively involved and up to 1500 have been informed of improved soil management practices. This equates to around $1500 investment in each farmer over a four-year period.

The project demonstrates a very cost-efficient way of encouraging change in farming practice. If extended across Australia's 53 other CMA/NRM organisations it could potentially realise 25,000 farmers actively changing their soil health for the better, together with more than another 50,000 informed to make a change.

On a smaller scale, the projects being managed by *NRM South* are encouraging landholders to adopt regenerative landscape management practices in a low risk way that suits the situation of individual farmers.

*NRM South* provides a range of options to assist farmers to change their practices, with ongoing engagement to support changes beyond the initial enthusiasm experienced at field days or workshops. In particular, their *Building Evidence for Regenerative Agriculture* assisted trials in planned grazing are empowering farmers and land managers to understand new techniques at their own pace. Trial demonstration sites also allow for sharing of results and broader discussion and to generate interest across the catchment. Through this support technique, the landholders are a part of the change, with minimal disruption to their production, and they can choose whether or not to adopt practices based on their own evidence.

Through an expanded communications program, the results of projects such as those being run by the *North East CMA* and *NRM South* could be shared with not only land managers but also to local government, businesses and schools. This would provide wider community awareness of regenerative landscape management practices, the importance of soil health and the methods of achieving improved sustainable production.

In addition to government-funded organisations, there are also many private consultants working in natural resource management fields who are also having significant impacts in supporting the adoption of regenerative landscape management practices. A number of case study participants cited the use of consultants individually selected to provide specific advice on the implementation and management of their innovative practices. The panel of agronomists accessible to participants of the *North East CMA*'s *Soil Carbon Programme* was an important part of the project. Sourcing providers whose approach aligns with farmers' own goals is central to the success of such support.

## PRINCIPLES FOR REGENERATIVE LANDSCAPE MANAGEMENT

The *Soils for Life* case studies show that many different techniques can be applied to regenerate the landscape. Indeed, tailoring a variety of methods to the landscape and personal preferences of the landholders is a common theme. There is no single solution to landscape regeneration.

The following principles consistently emerge from case study participants 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

## CONCLUSION

The *Soils for Life* case studies illustrate that adopting high performance regenerative landscape management practices - focussing on and interlinking the key process drivers of soil, water and vegetation - can rebuild the natural and efficient biosystem. Using regenerative landscape management practices, the case study participants have also demonstrated reduced input costs, with less expenditure on machinery, synthetic inputs and labour, reducing the overall cost of production and subsequently increasing profits.

On the individual level, these case studies show how triple bottom line outcomes – economic, environment and social – can be achieved. However, the potential for these outcomes to be experienced on a national and global scale is also clear. These include, but are not limited to:

- soils that are increasing in organic content, microbial and biotic activity, with restored carbon and essential nutrients for plant growth to revegetate the landscape and provide the basis for sustained nutritious food and fibre production;
- environments that are resilient and can better cope with extremes of climate such as flood and drought, whilst positively influencing climate remediation;
- water efficiency to maximise the use of every drop of rain that falls onto the landscape;
- sustainability, through cycling essential plant nutrients rather than introducing off-farm inputs such as chemical interventions;
- landscape biosystems that are healthy, regenerative, productive, profitable and encourage diversity; and
- better returns to farmers and land managers through profitable production, maintenance and improvement of the natural resource base, leading to more balanced and healthier lives.

To realise the opportunities of high performance regenerative landscape management on a broader scale, land managers and agricultural communities Australia-wide will need to be encouraged to change their management practices. Regulatory and economic impediments need to be removed so that land managers can extend the adoption of such practices, to help regenerate degraded landscape profitably; and create the commercial conditions and incentives to foster such land regeneration innovation.

In essence, change will need to be inspired and encouraged by governments, potentially at the highest level, and coordinated 'on the ground' by knowledgeable, supported and willing land managers.

Such an approach could provide a model for others to follow, leading action to meet the demands of a growing population and changing climate.

# RECOMMENDATIONS

## 1. Strategic Direction

Foremost, Australians must recognise that our landscape is degraded and is not improving at the rate that will guarantee our future wellbeing. At the federal level, we need a simple policy statement that highlights this degradation; that practices must change and that we have the answers. This statement can then drive a strategic, holistic plan to regenerate our landscape, that is coordinated at the Deputy Prime Ministerial level (equivalent) and encouraged by local action on the ground. The plan must highlight the requirement for integrated improvements in soil health, water use and conservation, together with an increased biodiversity of vegetation across the landscape.

## 2. Policy

Supporting policies needs to be developed in the following areas. These need to be enabled to move quickly to implementation and action.

**A. Soil.** Recognise the potential to improve Australian soil health, to support production, sequester large amounts of $CO_2$, build resilience in the landscape and contribute to our ability to adapt to a changing climate.

**B. Water.** Adopt an in-soil reservoir approach in water management from when it first reaches the soil to redress the measurable declines in soil moisture, diminished rainfall, high evaporation rates and increasing temperatures. This would also assist water users to adjust to the much lower amounts of water likely to be available in dams and reservoirs in the future under current management approaches. Such 'front of pipe' policies could focus on:

- regeneration of wetlands (large numbers of which are in higher reaches), which would improve both the quality and the quantity of our water;
- Improving the capacity of slopes for water infiltration - restoration of soil carbon to improve capture of water into the landscape; and
- Regenerating riparian zones and flood plains (slowing movement) by reconnection of the creeks and rivers with their flood plains, to improve absorbance of overflow for productive use in dry times.

**C. Vegetation.** Target revegetation and natural regeneration, including effective pasture management, reduction of monocultures, increased diversity and establishment of diverse woodland communities and deep-rooted trees to restore natural pedogenesis, in-soil reservoirs, hydrological cycles and help to keep salinity within the subsoils.

**D. Recognition.** Actively support high performance land management innovators to ensure that they, together with their communities and regional authorities, can play a leading role in extending these solutions more widely. Farmers should be recognised as the primary stewards of our agricultural landscape and rewarded accordingly.

**E. Education.** Establish a program that informs, educates and mentors a broad range of stakeholders on leading performance in landscape management to provide confidence that changes will make a difference and to encourage wider adoption of these practices.

**F. Research & Development.** Reallocate proportions of funding for research and development to focus on addressing areas of land management that can have both immediate and long term effects, such as improving soil health and increasing efficiency of water use and conservation to achieve greater return from investment already available.

The *Soils for Life* case studies provide compelling stories of innovators achieving success in the landscape - with information available in the time frame elected to complete them. Further research and development capabilities should focus in these areas that are already achieving positive outcomes.