2020 FAIRHALT CASE STUDY NARRATIVE REPORT

Prepared by Greg Hosking

Introduction

Garry Kadwell has been managing Rosedale and neighbouring property Fairhalt since the 1970s. His family acquired the first parcels of the properties in 1901. The properties are located on the Great Dividing Range south of Crookwell, New South Wales. Up until 1980 the main enterprise of the Kadwell family was an apple orchard. Under Garry's management the enterprise of the property has changed to producing seed stock potatoes and fat lambs.

Over the years Garry has worked tirelessly protecting remnant stands of vegetation as well as planting habitat corridors to connect stands of vegetation across the properties. Currently 32% of Fairhalt is protected for conservation. Garry has also created numerous wetlands across the property providing vital habitat for birds and other fauna, such as the platypus *(Ornithorhynchus anatinus).*

Figure 1. Garry Kadwell and his son Daniel.

Background

Growing up on the family property Garry Kadwell realised he did not want to be an orchardist. One of the first management decisions he made after taking control of the family property was to trial a crop

of potatoes to assess their viability. The potato trial was a success and Garry quickly adopted potato production as the main enterprise on his property. In the early years of producing potatoes, Garry used synthetic fertilisers to ensure crops were produced each year. His management practices were gradually degrading soil biology. Garry realised this quite early on and started focussing on improving the health of his soil to create a more productive environment.

One of Garry's earliest memories is of planting eucalyptus trees on the property with his grandfather. His grandfather advised him that he wouldn't see the benefit of the tree plantings, but Garry would. This is a message that has stuck with Garry his entire life. He has farmed with an attitude of conservation and improvement, aiming to leave the natural state of his property in better shape than before. Garry has also demonstrated vision, the ability to take risks and find innovative solutions to problems.

The first parcel of land Garry purchased as a young man was viewed as an unproductive, run-down block with limited potential. He viewed it as a perfect opportunity to regenerate a parcel of land. In a few short years Garry had turned the block into a highly productive working landscape with areas of revegetation plantings and native forest set aside for conservation purposes.

Figure 2. Habitat corridor planted by the Kadwell's and an apiarist's beehives.

Over the years, Garry has adopted techniques to improve soil health and productivity. These include, applying lime to optimise soil pH levels for producing potatoes, applying compost annually, rotations of lucerne and ryegrass after a rotation of potatoes to repair and improve soil health and adopting "one pass" tilling methods to reduce soil disturbance from planting.

Garry's property is a testament to his family's vision and courage. Conducting tree plantings during the 1970s and conserving remnant stands of forest is a rarity among farm managers from that era. The words of Garry Kadwell's grandfather ring true to this day, anyone who visits Fairhalt can pay testament to this statement and see the benefits of tree planting.

The Landscape

The Kadwell's properties are located just south of Crookwell, New South Wales. They own two properties, Rosedale and Fairhalt, and lease a third parcel of land close by; a total of 690 hectares. The largest parcel of land by size is Fairhalt. For the purpose of providing an accurate description of the Kadwell's land management practices, the reports will focus on Fairhalt. Fairhalt is located on top of the Great Dividing Range. Its highest point sits at 1000m above sea level and its average annual rainfall is 813mm.

The four main soil types and their total carbon content found on Fairhalt consist of:

- red basalt (5.02% Total Carbon) on the undulating slopes
- grey loam (2.47% Total Carbon) on the flats
- quartz (3.18% Total Carbon) on the hill tops
- some sedimentary soils (1.42% Total Carbon) in the gullies and watercourses.

The red basalt and grey loam country are considered to be the most productive land on the property and cropping is conducted exclusively in these soil types.

Vegetation on the property is a mix of remnant forest and conservation plantings conducted by the Kadwell family. The remnant forest is dominated by an overstorey of eucalyptus species such as mountain gum *(Eucalyptus dalrympleana)*, broad-leaved peppermint *(Eucalyptus dives)*, ribbon gum *(Eucalyptus viminalis)* and exceptionally large specimens of snow gum *(Eucalyptus pauciflora)*. Black gum *(Eucalyptus aggregata),* which is listed as vulnerable in NSW, is also found on Fairhalt. Mid and understorey species found within the remnant include acacias, bracken, numerous native grasses and native orchids. The remnant forest areas on the property are all fenced and protected from livestock grazing.

Conservation plantings conducted by Garry Kadwell consist of habitat corridors to provide linkages through the landscape. As well as patterns of plantings along the roadside to create a view that the entirety of the property is vegetated. Garry continues to conduct revegetation work across the property when time and resources allow. Greening Australia has helped him select and obtain the correct species of flora to plant in the new revegetation works as well as providing volunteers to aid in planting.

Figure 2. A conservation planting conducted in support of Land For Wildlife.

Since the 1980s Garry has created a number of wetlands on his property. Garry has trained in conservation earthworks and is adept at reading the flow of the landscape to create functioning wetlands. The wetlands act as a filter to clean and purify water flowing through the landscape and the water stored within the wetlands is utilised for irrigating crops. The wetlands provide vital habitat for all matter of fauna, livestock are also excluded from entering the wetland areas.

Surveys of flora and fauna species on the property have been conducted by the Crookwell Flora and Fauna Club in conjunction with Dr McComas Taylor of the ANU. In a survey of birds visiting the wetlands on Fairhalt, 50 species were recorded. Five species of birds that are listed as vulnerable or threatened within NSW were observed. These were:

- Powerful Owl (*Ninox strenua)*
- White-fronted Chat *(Epthianura albifrons)*
- Varied Sittella *(Daphoenositta chrysoptera)*,
- White-bellied Sea-Eagle *(Haliaeetus leucogaster)* and
- Scarlet Robin *(Petroica boodang)*.

Garry's revegetation and conservation work combined with the wetlands he has created have provided a healthy habitat for many different species.

Production

The main enterprise on Fairhalt is producing seed stock potatoes. Other enterprises include fat lamb production, gourmet potatoes and occasionally lucerne/silage fodder production. Garry applies a minimum 5-year cycle management regime to each parcel of land on the property. Potatoes are not planted more often than one year out of every five. Typically, in the other four years Garry conducts a crop rotation of lucerne for a few years, then pasture grasses for the remaining year. The lucerne, having a deep root system, helps repair the damage done to soil structure by the potato crop. It also returns some nitrogen to the soil. He extends the five year cycle up to 15 years in certain circumstances. That is, a potato crop once every 15 years. Garry has adopted this management regime to ensure his soils are given adequate rest periods after each potato crop. This allows soil structure to repair and avoids nutrient depletion.

Garry has recently purchased a "one pass" tilling implement. Reducing the amount of tillage his soil is subjected to reduces the damage to soil structure and fungal life.

Garry also applies a yearly dosage of 10 cubic metres of compost per hectare. Lime is also applied to regulate pH levels to ensure they stay between 5.0-5.8 (5 tonnes per hectare every 10 years). That practice was started in the early 1970s to provide the optimal pH for producing potatoes.

The seed potatoes Garry produces are sold to major growers throughout Australia. Garry ensures that the potatoes are free from disease by replanting and harvesting each individual potato a number of times over the course of a few years and removing the potatoes which show signs of disease. This ensures that only potatoes which are free from disease reach the market. This also multiplies the number of potatoes Garry can produce without having to purchase more seed stock.

Figure 3. Harvested potatoes are stored in a refrigerated warehouse.

The gourmet potatoes Garry produces are a special variety known for their ability to resist absorbing oil during cooking, which results in a lower fat content. The gourmet potatoes are sold to high end restaurants in Sydney and Canberra at a premium price.

Garry runs around 1800 lambs on the property, the lambs are grazed on lucerne and mixed grass species paddocks. Garry has the ability to cut and bail fodder to be stored and fed out to the lambs when required.

Community Engagement

Garry Kadwell has been an active member of the Crookwell community for many years. He has served in the local Rural Fire Service Brigade, assisted the local public school in gaining equipment and volunteered with the local aged care facility.

During the millennium drought Garry recognised that the community was doing it tough and many people were facing mental health issues. He organised an event called “Looking after your mate” which was aimed at bringing the community together and giving people a space to share what was happening in their lives. The event was a huge success with many organisations supporting it and large numbers of the community attending. Some of the feedback received after the event highlighted that the event had changed lives.

Conclusion

Garry Kadwell has achieved significant results in improving the health of his soil and landscape as well as improving production results.Garry has managed to extend the minimum five-year rotation between potato crops out to 15 years, whilst maintaining profitability. This has resulted in significant environmental benefits to the property by reducing crop stress. Yearly applications of compost have seen the carbon levels within Garry's soils rise up to 5%. Currently 32% of Fairhalt is protected for conservation purposes. The conservation land provides critical habitat for numerous native species of birds and mammals. Garry has developed a business model which is financially viable and employs a number of locals whilst protecting and conserving the land. This is a considerable achievement. Garry's innovative approach to farming has led to him running one of the most successful potato production businesses in the Crookwell region.

2020 FAIRHALT CASE STUDY SUMMARY ECOLOGICAL REPORT

Prepared by Greg Hosking

Fairhalt is a 300ha mixed enterprise property producing potatoes and fat lambs, the property is managed by Garry Kadwell. Fairhalt is located to the South of Crookwell on top of the Great Dividing Range in New South Wales.

Fairhalt is split into 22 paddocks. Water supply on the property consists of an ephemeral creek, a number of dams and two large wetlands which Garry constructed to provide a healthy water supply and wildlife habitat. The property sits at an elevation on 1000m above sea level and the average annual rainfall is 813mm.

The two major soil types on Fairhalt consist of red basalt and grey loam, both soil types are used to produce potatoes and pasture for fat lambs. Remnant stands of vegetation consisting of numerous eucalypt and acacia species are found throughout Fairhalt. The land holder has protected and conserved the remnant vegetation on the property as well as planting habitat corridors to provide linkages between the stands. The wetlands on Fairhalt were constructed by the land holder to provide a clean water supply for the property as well as providing habitat for wildlife.

The ecological values[1] of the property were assessed based on the known history of management of the property from 1980, when Garry Kadwell had detailed knowledge of its management, and his assessment of potential effects of changes in management initiated since then. The ecological values assessed include resilience to disturbance and soil nutrients, hydrology and biology. Because there is little empirical data, the assessment is necessarily based on observations and a subjective judgement of likely effects of management. This report shows that significant improvement of condition was observed across nine of the ten criteria since 1980. These assumptions are based on the theory that implementing rotational grazing, planting and conserving native vegetation, multispecies cropping and maintaining high ground cover levels should have positive outcomes on the majority of the ten criteria.

The trend for eight of the ten criteria is therefore similar – gradual increase in the early years of management followed by a small increase then a significant increase in later years as the manager refined and improved their management practices. An example is provided below. For further details and commentary, please see the Supplementary Ecological Report.

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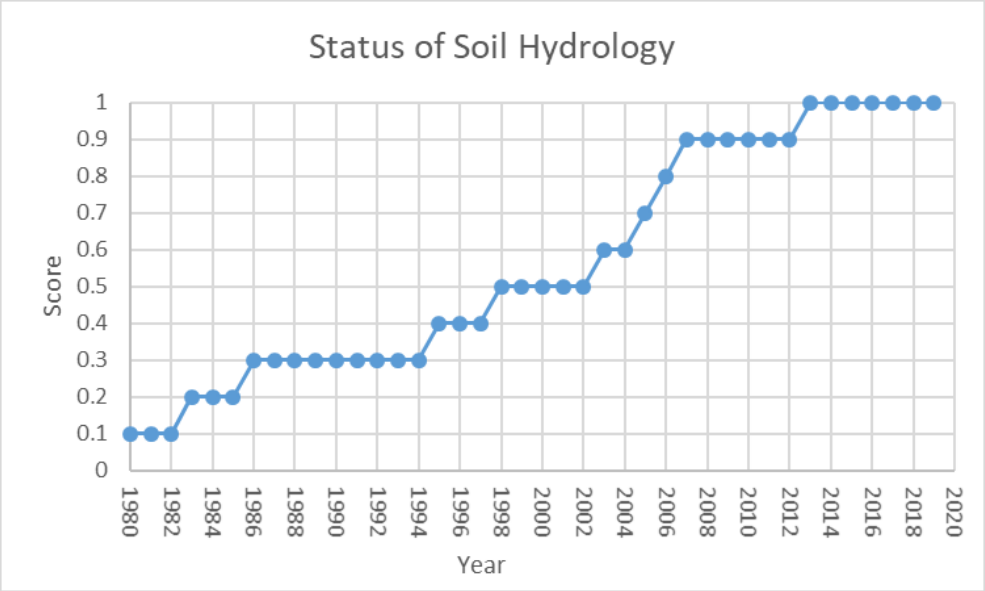
[1] The ecological values assessed were: Resilience of landscape to natural disturbances – flood, drought and frost; Status of soil nutrients - including soil carbon; Status of soil hydrology - soil surface water infiltration; Status of soil biology; Status of soil physical properties – as a medium for plant growth; Status of plant reproductive potential; Status of tree and shrub structural diversity and health; Status of grass and herb structure - ground cover; Status of tree and shrub species richness and functional traits; and Status of grass and herb species richness and functional traits.

The remaining two criteria follow their own individual trajectories and reflect the management strategies undertaken by the land owner. For further details and commentary, please see the Supplementary Ecological Report.



2020 FAIRHALT CASE STUDY DETAILED ECOLOGICAL REPORT

Prepared by Greg Hosking

Key findings

Fairhalt is a 300ha mixed enterprise property which has been managed by Garry Kadwell since the 1970s. The property has been owned by the Kadwell family since 1901. The property is located to the South of Crookwell on top of the Great Dividing Range in New South Wales. This ecological assessment commences in 1980, a date which reflects the time that Garry had detailed knowledge of the management of the property.

Fairhalt is split into 22 paddocks, water supply on the property consists of an ephemeral creek, a number of dams and two large wetlands which Garry constructed to provide a healthy water supply and wildlife habitat. The property sits at an elevation on 1000m above sea level and the average annual rainfall is 813mm. The Crookwell district was first settled in the 1820s, when land was progressively cleared for agricultural purposes. Growing wheat, potatoes and fruit orchards along with producing sheep, cattle and dairy products were the main enterprises of the Crookwell region in the years post-settlement. The production of wheat in the region was slowly phased out and replaced with wide scale production of potatoes by the early 1900s.

Vegetation on Fairhalt is a mix of remnant forest and conservation plantings by the Kadwell family. Dominating the remnant forest is an overstorey of eucalyptus species such as mountain gum *(Eucalyptus dalrympleana)*, broad-leaved peppermint *(Eucalyptus dives)*, ribbon gum *(Eucalyptus viminalis)* and snow gum *(Eucalyptus pauciflora)*. The vulnerable species black gum *(Eucalyptus aggregata)* is present on Fairhalt. Mid and understorey species found within the remnant include acacias, bracken, numerous native grasses and native orchids. The remnant forest areas on the property are fenced and protected from livestock grazing.

Prior to 1980 the main enterprise on Fairhalt was growing apples. In 1980, Garry conducted a trial crop of potatoes and found that they grew well on the property. Over the course of a few years, Garry transitioned from growing apples to growing potatoes and producing fat lambs. Currently seed stock potatoes are the chief product of Fairhalt, accompanied by fat lambs, gourmet potatoes and lucerne hay. A minimum five-year cycle on Fairhalt ensures that potatoes are planted a maximum of one year out of every five. The intervening four years Garry conducts a crop rotation of lucerne for a few years, then pasture grasses for the remaining year. Garry extends the five-year cycle out to 15 years when seasons allow, e.g. a potato crop once every 15 years. The minimum five-year cycle is required when producing seed stock potatoes to ensure the presence of disease in the potato crops is detected and the diseased potatoes removed from production. Adequate rest periods after each potato crop also ensures repaired soil structure and minimal nutrient depletion.

To ensure the health of the soil on the property Garry utilises a “one pass” tilling machine when planting crops to reduce tillage damage. Ten cubic metres of organic compost is applied per hectare annually to provide nutrients and organic matter to promote biological activity in the soil. Lime is

applied every ten years at the rate of five tonnes per hectare to ensure pH levels stay within the optimal range for producing potatoes (4.8 – 5.8). Garry also utilises soil carbon content as a measure to determine the health of his soil. Typically, the carbon content on Fairhalt ranges from 2.47% - 5.02% depending on the soil type.

The wetlands Garry Kadwell constructed on Fairhalt provide habitat, resulting in a wide range of biodiversity. Sixty-four species of birds were recorded on one of the wetlands in surveys conducted by the Crookwell Flora and Fauna Club. Garry Kadwell has also observed platypus *(Ornithorhynchus anatinus)* in the wetlands as well as a number of fish species. Many of the bird species observed at the wetlands utilise them for breeding. Vulnerable or threatened bird species seen on the property include: powerful owl (*Ninox strenua)*; white-fronted chat *(Epthianura albifrons)*; varied sittella *(Daphoenositta chrysoptera)*; white-bellied sea-eagle *(Haliaeetus leucogaster);* and scarlet robin *(Petroica boodang)*.

This report demonstrates a close relationship between the land manager's goals/ideals and the ecological outcomes in each of four phases.

This assessment identified four phases of land management regimes including production regimes and biodiversity enhancements.

	Production regimes
Phase one: 1980-1985	Trials of potato crops leading to whole scale up take of potato cropping. Farmed conventionally with major focus on production.
Phase two: 1986-1997	Continued farming conventionally with small scale trials of regenerative practices; wetland construction, pasture improvement and the use of lime to regulate pH levels. Synthetic fertiliser application started during this phase.
Phase three: 1998-2010	Started planting large habitat corridors across the property and protecting areas of remnant vegetation. Synthetic fertiliser application ceased, replaced with organic compost. Lucerne cropping started and the landholder gained control of fodder production and storage.
Phase four: 2011-2019	Continued vegetation conservation works and plantings. Maturation of regenerative management principals. One pass tilling adopted to reduce soil damage from crop plantings. Ground cover maintained in pasture paddocks.

An assessment over time of the responses of ten ecological criteria shows that by phase four, compared to the previous three phases, most ecological criteria have been assessed as nearly fully achieved or having achieved their reference state (i.e. scores between 0.8 – 1.0). For example:

- Minimizing effects of extreme climatic events, which considers the whole property and its place in the broader catchment, including preparedness for drought (Criterion A)
- Maintaining high levels of ground cover across the property (Criterion H) and increasing the number of ground cover species present (Criterion J)

- Maintaining and increasing woody vegetation on the property (Criterion G) and increasing the number of woody vegetation species (Criterion I)
- Improving soil health and function. Ecological changes include: soil nutrients and soil carbon (Criterion B); soil hydrology (Criterion C); soil biology (Criterion D); and soil physical properties i.e. soil as a medium for plant growth (Criterion E).

Transformation of the farm toward a regeneratively managed property has been achieved through deliberate planning and is based on a sound understanding of the links between land management regimes and ecological responses. Consistent implementation of management ideas has enabled the land manager to produce quality potatoes in a healthy soil medium as well as developing high-quality pastures which produce fodder for livestock throughout the year.

Independent scientific assessment

An independent assessment of the land manager's self-assessment across all ten ecological response criteria supports information presented by the land manager.

Assessing responses to land management regimes according to the ecological criteria

This Supplementary Report is underpinned by the Soils for Life *Conceptual Model* and *Assessment Framework* that documents the responses of ten criteria corresponding to ecosystem function, composition and structure.

Prior to undertaking a field visit in December 2019, the landowner, Garry Kadwell, was asked to document the production systems that have been developed and implemented. This includes land management regimes associated with the following: soil and vegetation condition (pastures, shrubs and trees); weed and pests; surface and ground water; and animal production. That production history aimed to document land management phases which led up to the current regenerative landscape management in this agricultural setting.

This included collation of all relevant available published and unpublished ecological data and information about the farm and how it was managed. It also included paddock-based photographs, fertiliser history, paddock-based management histories, as well as grazing charts, soil surveys and names of interested parties who had visited the farm over time (Attachment A). This 2019 assessment has incorporated information which was compiled in September 2012 as part of the Soils for Life (SFL) Case Study Project.

Assessment of Response Criteria

This ecological assessment commences in 1980 this year reflects the date that Garry Kadwell had detailed knowledge of the production history.

A. Resilience of landscape to natural disturbances – drought preparedness

Why track changes and trends in resilience to major natural disturbance/s?

Resilience to major disturbance/s includes the following factors depending on the agro-climatic region (wildfire, drought, cyclone, dust storm, flood). A major natural disaster or natural disturbance event can occur at any time. Some disturbances give a warning, such as a wind storm or electrical storm

preceding a wildfire or a flood. Once a disaster happens, the time to prepare is gone. Lack of preparation can have enormous consequences on farm life including social, ecological, economic and production.

Assumptions and definitions

Drought is the most frequent natural disturbance affecting the property. Drought preparedness is an aggregate score across all paddocks. Appropriate drought management dictates dynamic monitoring of stock numbers and available pasture to avoid groundcover loss and expensive fodder purchases.

Results and interpretation

Phase one extended from 1980-1985 and was associated with conventional farming. During this phase, the land manager changed from growing apples to producing potatoes and fat lambs. The focus of the land manager was on production with little regard for soil health or ground cover vegetation species. The ability of the property to cope with drought events was limited due to poor water supply and a soil medium which was not adept at retaining water.

Phase two extended from 1986-1997 and was associated with conventional farming with small scale trials of regenerative practices occurring. The resilience of the property to drought events improved during this phase due to the land manager constructing wetlands on the property. The wetlands provided a year-round water source which could be used to irrigate crops when necessary. During this phase the land manager started applying lime across the property to regulate pH levels. Pasture improvements were also undertaken during this phase.

Phase three extended from 1998-2010 and was associated with large scale adoption of regenerative management practices. During this phase the land manager ceased the application of synthetic fertiliser on pastures and replaced it with organic compost. Further wetlands were also constructed, and habitat corridors were planted across the property linking areas of remnant vegetation. Lucerne cropping was also adopted during this phase to repair soil health post potato cropping. The deep root system on lucerne is known for its ability to repair soil health and fix nitrogen.

Phase four extended from 2011-2019 during this phase the land manager's regenerative ideals and production systems fully matured. A "one pass" tilling machine was adopted to reduce tillage damage when planting crops. Cropping cycles of potatoes were extended out to give land time to rest and repair between potato crops. The land manager purchased equipment to bail and store fodder enabling the land manager to control feed supply for livestock year-round and through drought periods.

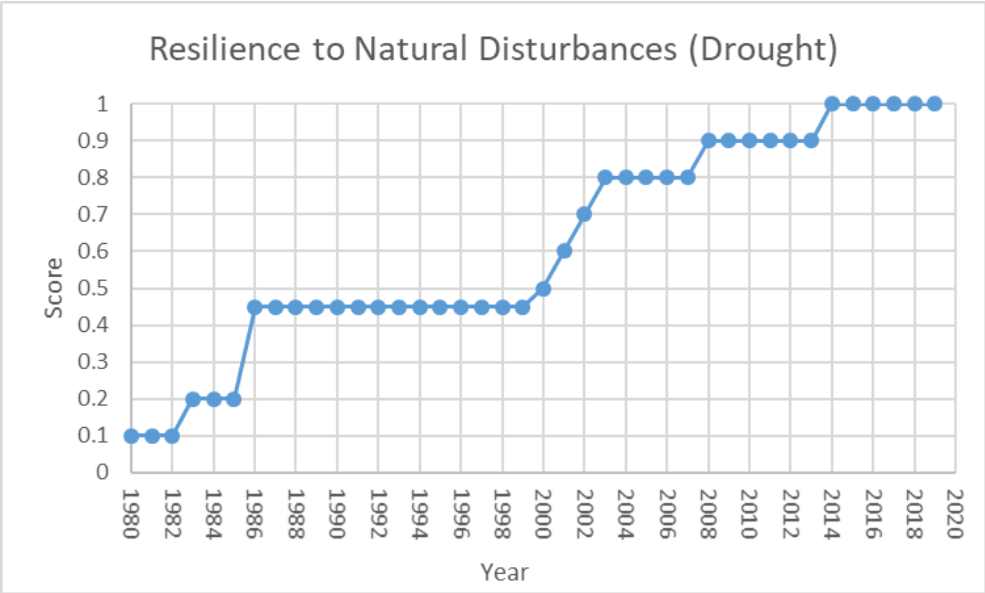


Figure 1. Landholder's graphical assessment of drought resilience change over time.

B. Status of soil nutrients – including pH level

Why track changes and trends in soil nutrients – including pH level?

pH level is an important indicator when producing potatoes. Potatoes grown in a soil medium with a pH level above or below the desired range will be of inferior quality. This occurs due to the plant being unable to absorb nutrients from the soil. When the plant cannot absorb nutrients due to high or low pH levels, it results in poor quality potatoes in terms of size and taste. It is important to regulate and track pH level to ensure the soil medium is kept at the optimum level for producing potatoes.

Assumptions and definitions

This is an aggregate score of the soil nutrients of all paddocks found on the property. This includes pH level, soil carbon and a range of plant nutrients.

A typical treatment to regulate acidic pH levels is to apply quantities of lime, as that ameliorates acidity and raises the pH level of the soil.

Table 1. Classification of pH levels.

Classification	pH range
Ultra acidic	< 3.5
Extremely acidic	3.5–4.4
Very strongly acidic	4.5–5.0
Strongly acidic	5.1–5.5
Moderately acidic	5.6–6.0
Slightly acidic	6.1–6.5
Neutral	6.6–7.3
Slightly alkaline	7.4–7.8
Moderately alkaline	7.9–8.4
Strongly alkaline	8.5–9.0
Very strongly alkaline	> 9.0

Results and interpretation

Within phase one, pH levels on Fairhalt were between 4.1-4.2, meaning the extremely acidic soil was not optimal for producing potatoes. The potatoes produced during this phase were missing nutrients provided from the soil during the growth stage. Fertiliser application during this time was minimal, as the landholder was focused on small scale production of potatoes.

During phase two, the landholder started applications of lime to regulate pH level. This resulted in minor improvements of pH. Synthetic fertiliser application increased during this phase.

At the beginning of phase three, the landholder started to focus on improving pH levels across the property as he gained knowledge relating to nutrient uptake from soil in plants. The pH level across the farm in 1999 was 4.8. The landholder increased the application of lime across the property. The landholder also ceased applying synthetic fertilisers on the property in 2002. The landholder started crop rotations including lucerne and mixed grass species after potatoes. Lucerne was utilised due to its deep roots which are known to repair soil and fix nitrogen.

During phase four, the landholder started applying compost at the rate of ten cubic metres per hectare per year. Lime is now applied every ten years at the rate of five tonnes per hectare. The current pH level is 5.5-5.6. This falls within the optimal range for producing potatoes. Post-potato planting and harvest ground cover levels are maintained across the property. The land holder currently runs 1800 fat lambs on the property which are rotated around paddocks when ground cover is reduced. The landholder also has the capacity to cut and bail fodder to feed the lambs during the non-growing seasons. Soil carbon levels on the property vary between soil types. The red basalt soil contains 5.02% total carbon and the grey loam soil contains 2.47% total carbon.

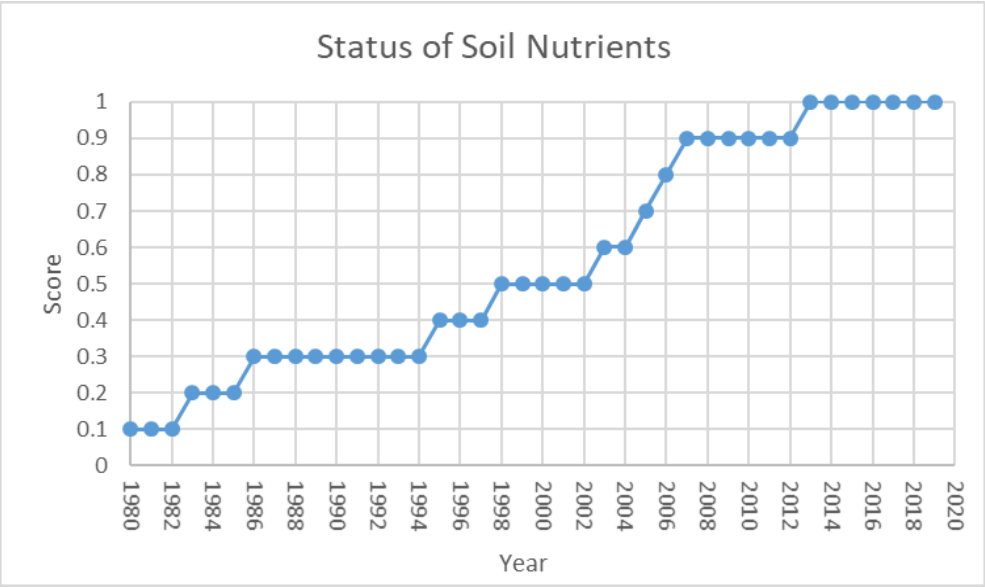


Figure 2. Landholder's graphical assessment of soil nutrients change over time.

C. Status of soil hydrology

Why track changes and trends in soil surface water infiltration?

Soil physical properties have a direct relationship to soil moisture. Soil texture and structure greatly influence water infiltration, permeability and water-holding capacity. Of the water entering a soil profile, some will be stored within the root zone for plant use, some will evaporate and some will drain away. In agro-ecological settings, by increasing water infiltration, permeability and water-holding capacity, this will usually act as a stimulus to ecological function.

Assumptions and definitions

This is an aggregate score of the soil surface water infiltration and water holding capacity across all paddocks found on the farm.

Plant available water is the difference between field capacity (the maximum amount of water the soil can hold) and the wilting point (where the plant can no longer extract water from the soil) measured over 100cm or maximum rooting depth.

Results and interpretation

Phase one as seen above in Criteria A and B.

Phase two as seen above in Criteria A and B.

Phase three as seen above in Criteria A and B.

Phase four as seen above in Criteria A and B.

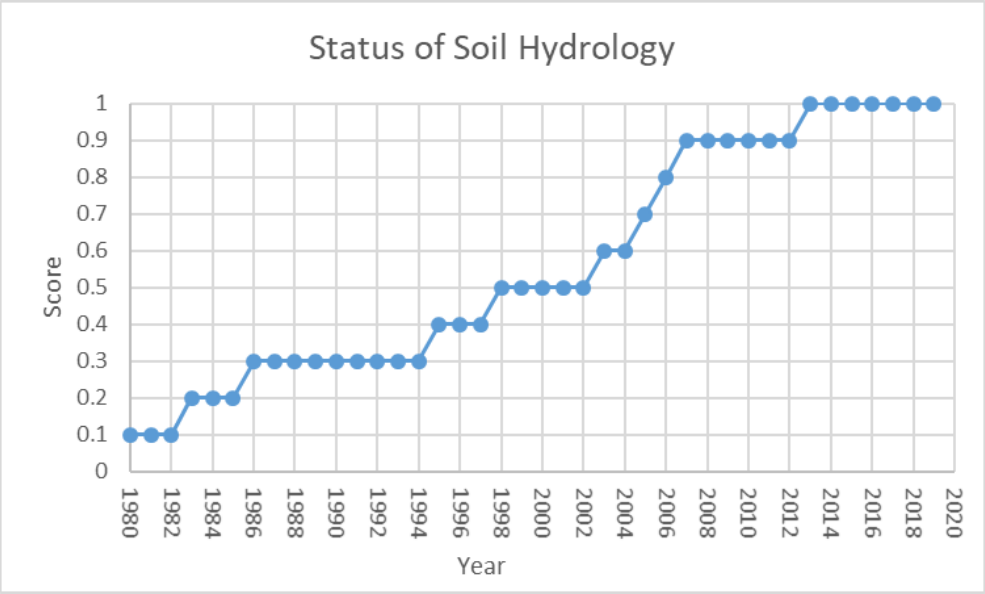


Figure 3. Landholder's graphical assessment of soil hydrology change over time.

D. Status of soil biology

Why track changes and trends in soil biological activity?

Soil biology affects plant (and animal) production by modifying the soil physical, chemical and biological environment within which plants grow and persist. The ratio of fungi to bacteria is important for land managers to understand; too many bacteria can indicate an unhealthy and unproductive soil. Soil fungi contribute to:

- natural processes (litter transformation, micro-food web participation and soil engineering)
- the decomposition of organic material resulting from compost applications and disturbance from cattle grazing
- enhancing nutrient distribution for plant health and productivity.

In healthy soils, invertebrates including arthropods and worms also form a vital part of the soil food web.

Assumptions and definitions

This is an aggregate score of the soil surface condition properties of all paddocks found on the farm.

Decomposition of plant and animal residues is a dynamic process involving trophic levels. While some of the residues are being broken down for the first time by the litter transformers (detritivores), other residues have already been sequestered by soil microflora, which are in turn consumed by microfauna predators.

Results and interpretation

During phase one, the landholder applied minimal fertilisers and the property was in transition from an apple orchard to producing potatoes and fat lambs. Minimal pest spraying occurred during this phase. The landholder remembers worms being fairly present in the soil during this phase suggesting that the soil biology was relatively healthy.

Within phase two, the landholder started applying synthetic fertilisers to boost production of potatoes. Pest sprays were also adopted and used regularly to reduce pest damage on crops. The application of chemicals on the property damaged soil biology and worms were observed less often.

During phase three, the landholder recognised the damage synthetic fertilisers were causing the soil and the biological life within it. The landholder ceased the application of synthetic fertilisers and reduced the number of pest sprays each year.

Within phase four, the land holder started the application of compost and only sprays for pests when absolutely required, typically once per year. As a result of the land holder's management strategies during this phase, biological life within the soil has greatly improved. Worms are now commonly observed across the property at all times of the year.

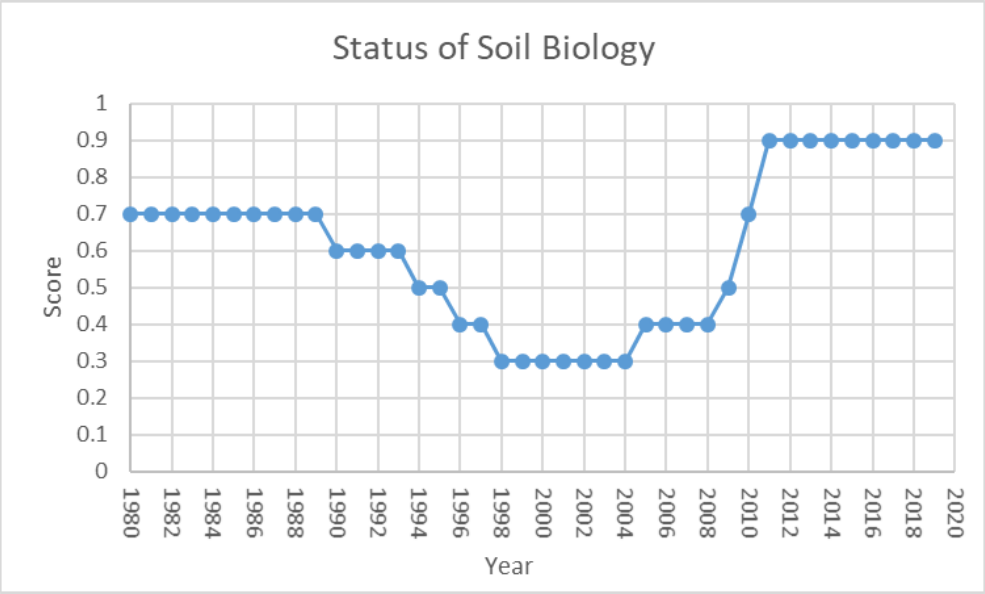


Figure 4. Landholder's graphical assessment of soil biology change over time.

E. Status of soil physical properties – as a medium for plant growth

Why track changes and trends in soil physical properties?

Declining soil surface condition involves the depletion of nutrients, soil organic matter and of key elements of the soil biology. Soil degradation is the result of high levels of bare ground, water erosion, wind erosion, chemical and physical deterioration. It is often associated with unsuitable land management regimes. Over time loss of soil physical properties will have consequences on production, as well as other ecological criteria and economic and social outcomes.

Assumptions and definitions

This is an aggregate score of the soil physical properties of all paddocks found in the farm. This includes effective rooting depth of the soil profile and bulk density of the soil through changes to soil structure or soil removal.

The rooting depth of plants was observed by the landholder over time when the soil was ploughed or dug with a shovel. Under more intensive management involving continuous grazing, grass tussocks were observed to be low in height and relatively shallow rooted.

Indicators of landscape function over time include soil surface rain-splash protection; cryptogam cover; soil surface erosion (type and severity); washed/deposited materials; physical features on the soil surface to retain resources during surface flows; and ground cover complexity, which influences permeability.

Results and interpretation

The landholder observed that the physical properties of the soil on Fairhalt did not change between phases 1-3. The landholder based this assumption of the quality of the soil structure.

Within phase four, the land holder observed that the application of compost increased the carbon content in the soil and improved water holding capacity.

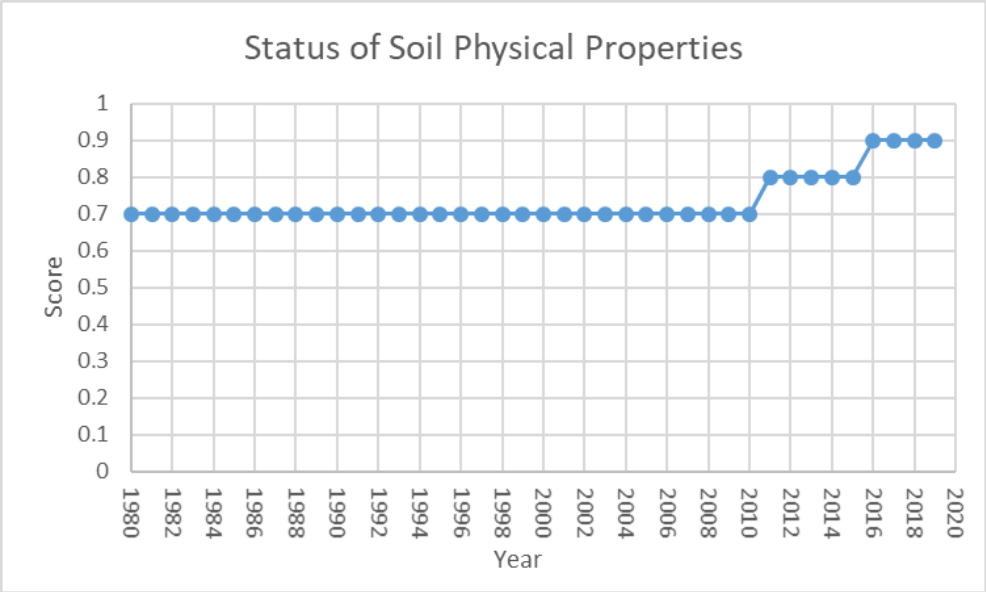


Figure 5. Landholder's graphical assessment of soil physical properties change over time.

F. Status of plant reproductive potential – reproductive potential of pastures

Why track changes and trends in reproductive potential of pastures?

An understanding of successful reproduction, germination, establishment and development of plants is important in managing agro-ecological ecosystems. This understanding of successful plant reproduction is vital in the manipulation of planned production outcomes - e.g. grazing regimes can prevent seed-setting by undesirable or invasive plants and for increasing the longevity of perennial pastures before they need to be resown.

Assumptions and definitions

Reproductive potential is the relative capacity of a species to reproduce itself under optimum conditions including trees, shrubs and grasses. In the context of grazing land management regimes, this is an aggregate score assigned across all pastures found on the farm.

Where continuous grazing is the preferred grazing management regime or where total grazing regimes limit or prevent reproductive success of a species mix in pastures, this can lead to bare ground and to the dominance of some species which may have low feed value for grazing animals.

Results and interpretation

The reproductive potential of grasses on Fairhalt has not changed across the four phases. The landholder observed that this was due to the production systems implemented on the property.

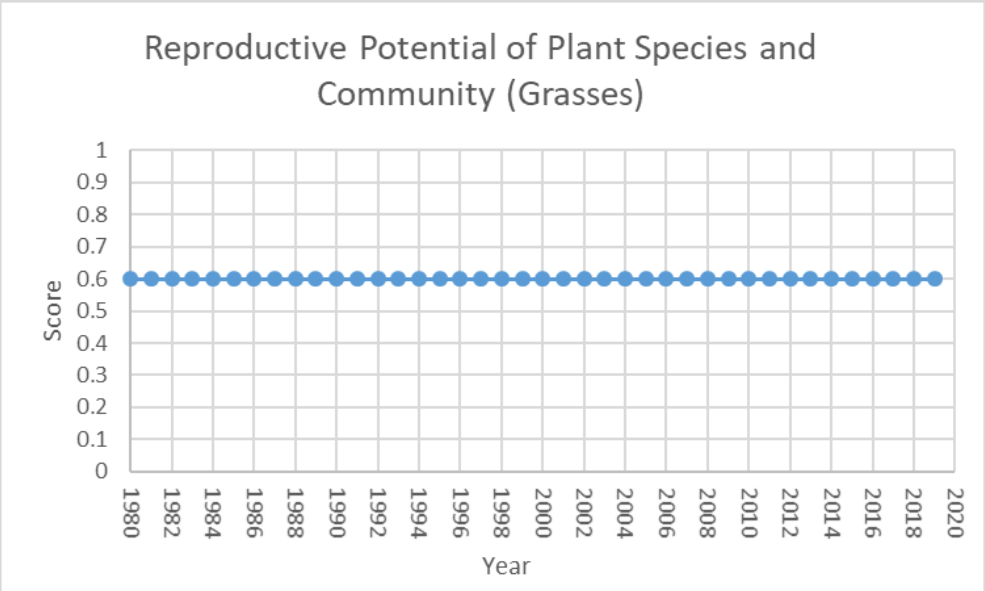


Figure 6. Landholder's graphical assessment of reproductive potential of grasses change over time.

G. Status of tree and shrub structural diversity and health

Why track changes and trends in extent of tree cover?

Tree cover in agricultural landscapes provides important ecosystem benefits including mitigation of soil erosion, shelter for pastures and improved animal welfare. This enables added revenue from stacked enterprises; habitat and breeding sites for pollinators and predatory insects, birds and animals; improved salinity management; improved interception of rainfall; and improved aquifer recharge management.

Results and interpretation

Prior to phase one the landholder remembers planting trees on the property with his father and grandfather. During this phase, the landholder did not conduct any extra tree plantings.

Within phase two, the landholder conducted a few small scale tree plantings and fenced off the existing remnant patches of vegetation from livestock.

During phase three, the landholder conducted widespread plantings of habitat corridors linking patches of remnant vegetation across the property. Green Australia assisted the land holder with selection of species and plantings.

During phase four, the landholder continued further plantings of trees and conducted fencing work around existing woody areas to protect them from livestock grazing.

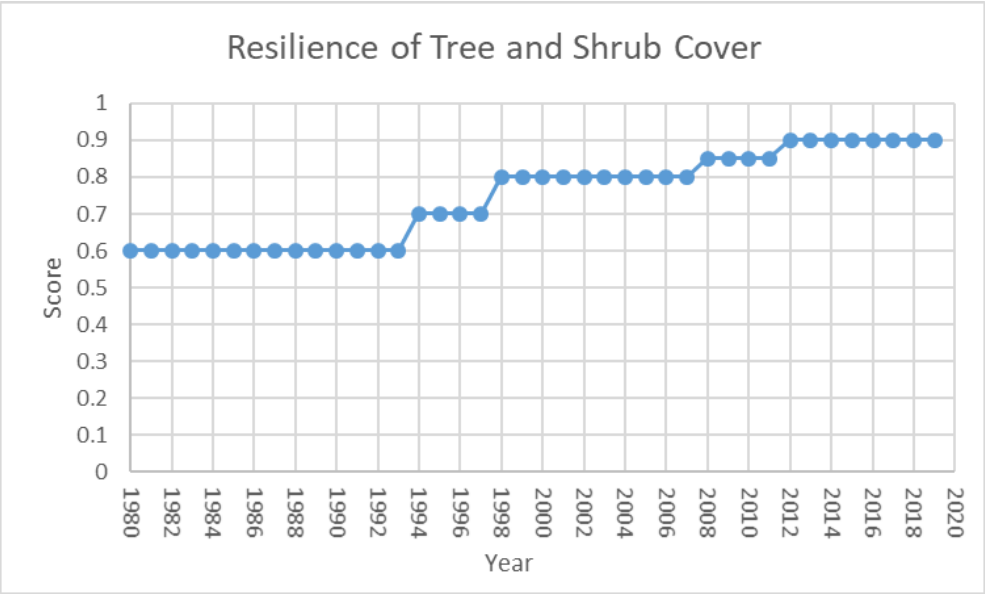


Figure 8. Landholder's graphical assessment of tree and shrub cover change over time.

H. Status of grass and herb structure - Ground cover

Why track changes and trends in ground cover?

The quality of ground cover in summer provides essential protection to keep the soil cool against direct, searing summer heat by reducing evaporation, protecting bare soil against raindrop splash and wind erosion. Good summer pastures also slow overland flows during the storm season and assist with infiltration of intense rainfall events, thus mitigating water erosion and replenishing soil moisture.

Winter grazing is an important management consideration in landscapes that are managed for livestock production. Conservative grazing land management is both ecologically and economically sensible.

Definitions and assumptions

This is an aggregate score across all pasture production paddocks on the farm.

The commonly espoused grazing land management regime in the district is that of continuous or set stocking throughout the year with two growing seasons and two feed gaps between the growing seasons. Typically, landholders cut and harvest pasture during the growing seasons to later feed out to livestock during the feed gap seasons.

In contrast to continuous or set stocking, holistic grazing of pastures involves short duration grazing followed by a relatively longer duration of pasture resting.

Results and interpretation

During phases one and two, the landholder utilised continuous set stocking. Pasture improvements were conducted slowly over the course of the two phases. The landholder did not plan ahead for feed gaps during this phase.

Within phase three, the landholder commenced mixed cropping. The mixed crops provided the land holder with the ability to plan ahead for future feed gaps. Maintaining ground cover levels across the pasture paddocks became a significant component of the landholder's management regimes.

Within phase four, the landholder adopted rotational grazing. The landholder assesses when ground cover levels reach a certain point before moving livestock to a different paddock. This ensures that ground cover levels are maintained. The landholder also purchased equipment which enables him to cut and bail fodder. The landholder now has the ability to plan ahead to control feed gaps on the property.

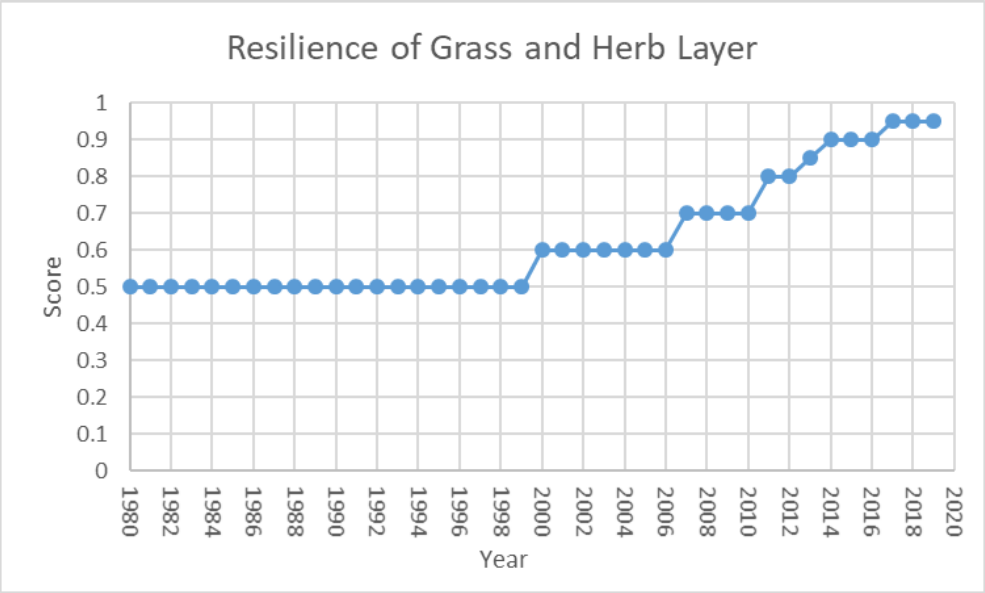


Figure 8. Landholder's graphical assessment of ground cover change over time.

I. Status of tree and shrub species richness and functional traits

Why track changes and trends in the status of tree and shrub species richness?

Functional richness refers to the number of species inhabiting a place and what is/are their roles in that place. Functional diversity reveals how evenly the species are distributed in an area. A decrease in functional richness and evenness decreases an ecosystem's productivity and stability. How an ecosystem is managed in an agricultural setting will determine its productivity and stability.

Grazing land management regimes typically result in a reduction in the numbers of species of trees and shrub species as the landscape is modified for pasture production. Grazing animals can inhibit the regeneration of trees and shrub species.

Definitions and assumptions

This is an aggregate score across all paddocks.

Results and interpretation

During phase one, tree and shrub species composition on the property did not alter.

Within phases 2-4, the landholder planted different species of trees and shrubs and constructed fences around the vegetated areas. Within the vegetated areas, natural regeneration of species also occurred due to the exclusion of livestock from the vegetated areas. The overall number of tree and shrub species on the property has increased due to the conservation management ideals and practices of the landholder.

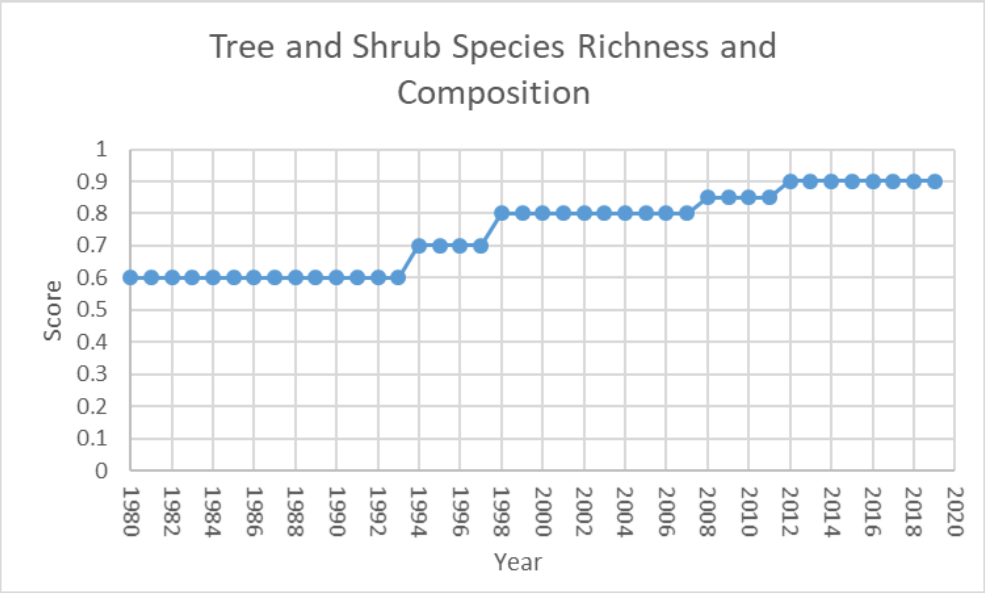


Figure 9. Landholder's graphical assessment of tree and shrub species richness and composition change over time.

J. Status of grass and herb species richness and functional traits

Why track changes and trends in grass species diversity?

Functional richness refers to the number of species inhabiting a place and their roles in that place. Functional diversity reveals how evenly the species are distributed in an area. A decrease in functional richness and evenness decreases an ecosystem's productivity and stability. How an ecosystem is managed in a production setting will determine its productivity and stability.

In many grazing land management regimes, the variety of pasture plants (annuals and perennials) can improve production, protect natural resources (soil and water) and build the capacity of farming systems to adapt to future production and environmental challenges. The intensity of the grazing management system will determine the health and vitality of pastures and their longevity.

The selection of which perennial pasture species on which to base a grazing production system should be based on considerations of climate, soil conditions and performance of pasture species under different management regimes.

Assumptions and definitions

This is an aggregate score across all pasture species found on the farm.

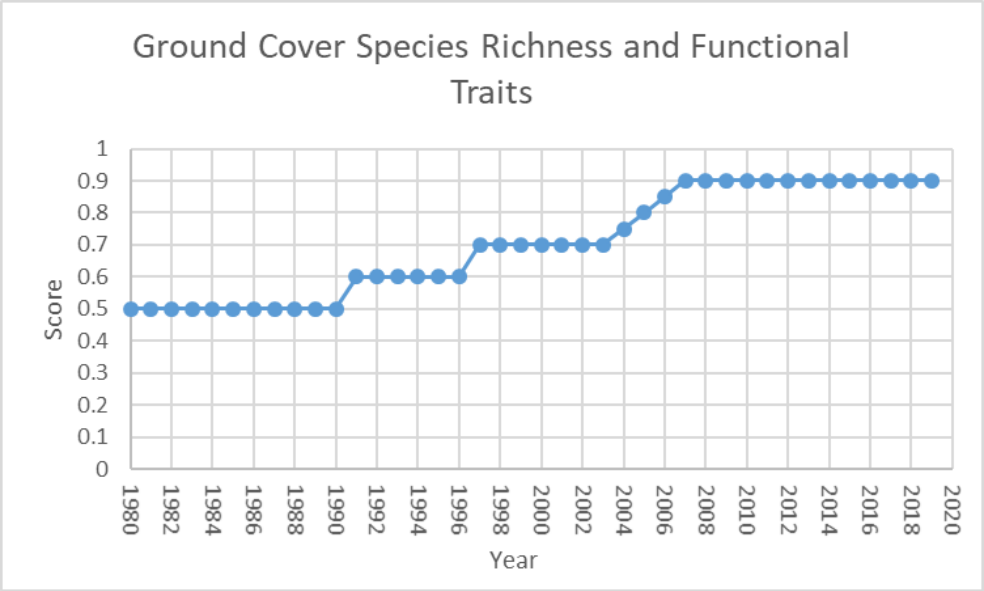
Results and interpretation

Phase one as seen above in Criteria H and I.

Phase two as seen above in Criteria H and I.

Phase three as seen above in Criteria H and I.

Phase four as seen above in Criteria H and I.



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Attachment A

Production systems

Information below describing land management regimes or production systems was compiled from a field visit and interview with Garry Kadwell, conducted December 2019.

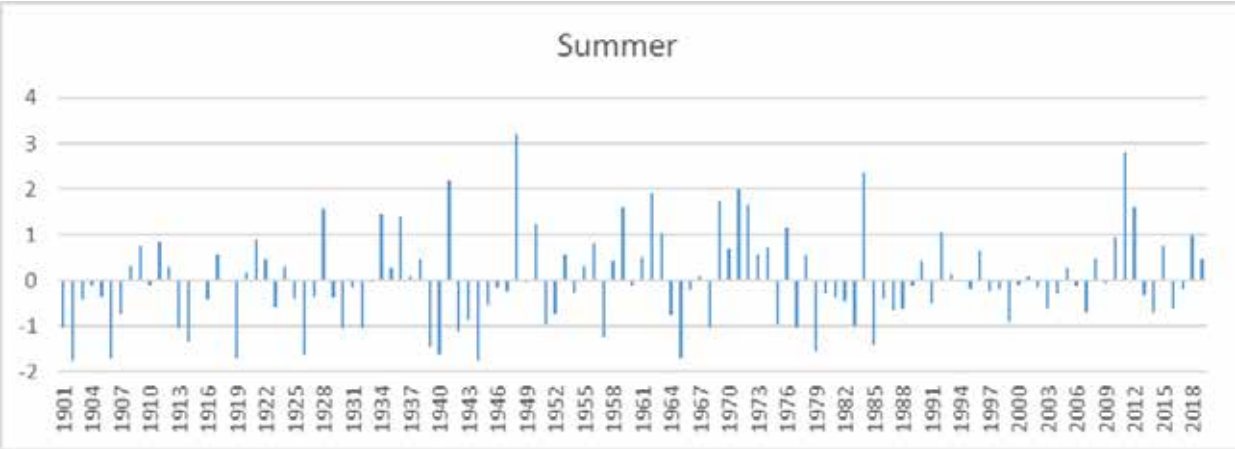
The following chronology was established as a partnership with the land manager for each of the phases 1-4:

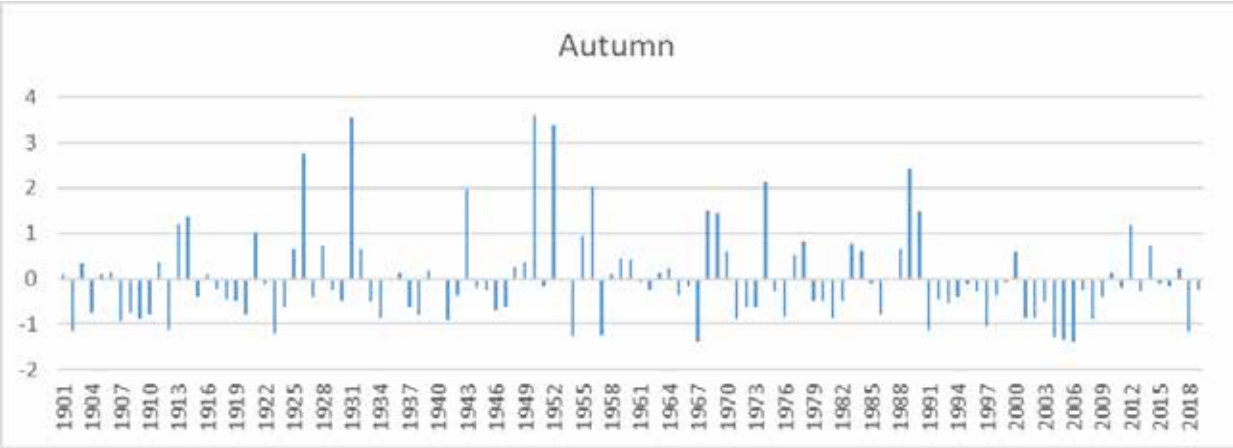
Date	Action
1901	Kadwell family purchased Fairhalt
1901-1980	Fairhalt was utilized to grow apples
1960's-70's	Garry Kadwell planted trees with his Grandfather and Father
1980	Garry Kadwell started managing Fairhalt
1980	Small scale trials of potato crops
1980-85	Switched main enterprise of Fairhalt to potatoes and fat lambs
1985	Constructed the first wetland on Fairhalt
1985	pH level of 4.1-4.2
1990's	Pasture improvements commenced
1990's	Lime applications commenced
1995	Synthetic fertiliser applications commenced
1990's	Commenced fencing off remnant vegetation
1999	pH level of 4.8
2001	Commenced planting tree corridors across the property
2001	Commenced Lucerne cropping
2001	Fenced off the wetlands
2002	Ceased synthetic fertiliser application
2002	Constructed the second wetland on Fairhalt

2003	Mixed cropping of grass species commenced
2011	Commenced compost application
2013	One pass tilling machine adopted
2015	Started producing gourmet potatoes
2015	Purchased fodder harvesting and bailing equipment
2010's	Continued to conduct conservation plantings

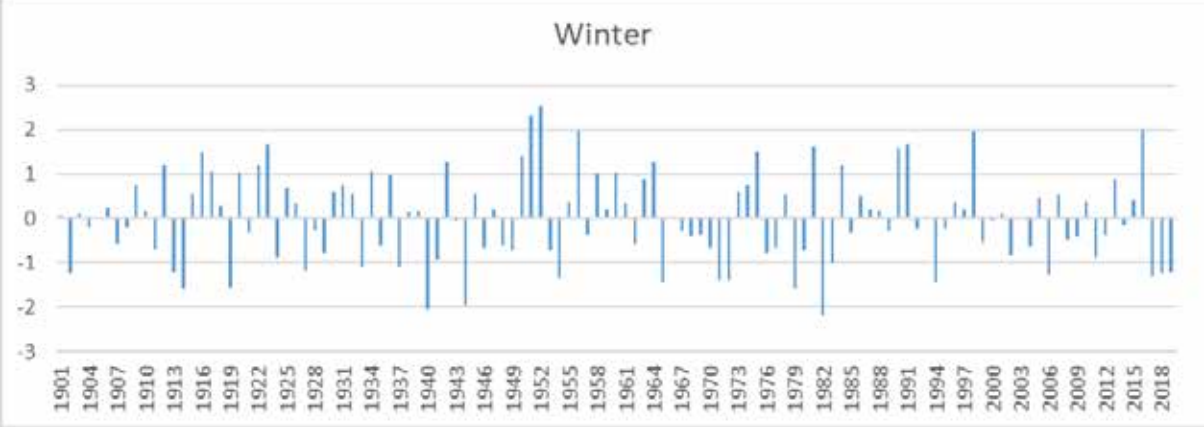
Attachment B

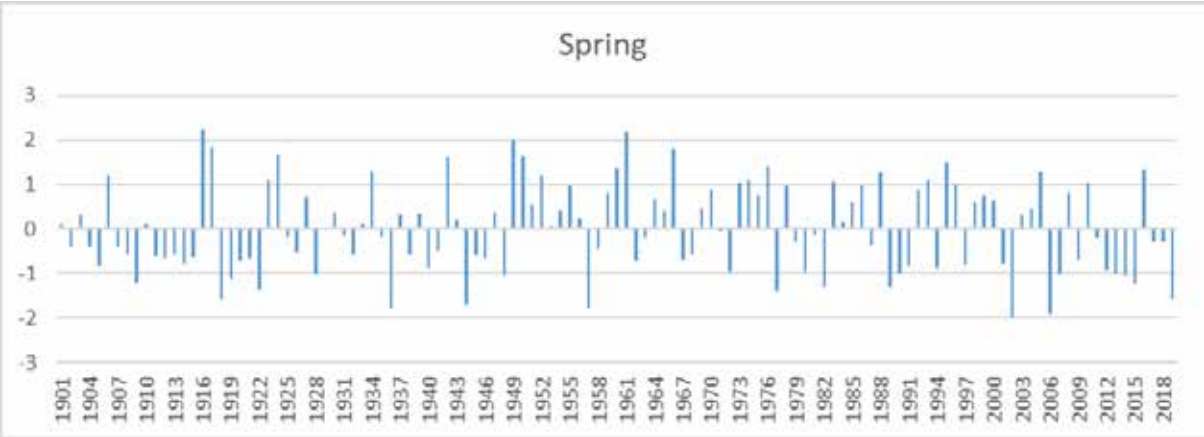
Patterns of seasonal rainfall derive from modelled monthly rainfall data for Fairhalt[1] showing variants around the mean.





[1] Source: Bureau of Meteorology modelled 5-kilometre resolution rainfall data. Seasons are defined as the standard 3 monthly intervals e.g. summer comprising December, January and February





Acknowledgements

Shane Cridland and Richard Thackway provided the seasonal rainfall record from modelled monthly rainfall data for The Olsen Family Farm (Attachment B).

Phil Tickle of Cibolabs provided the spatial analysis of regional ground cover.

2020 FAIRHALT CASE STUDY ECONOMICS REPORT

Prepared by RSM

Introduction

Fairhalt (and adjacent property; Rosedale) is located in Crookwell NSW. The properties are managed by Garry Kadwell and have been in his family for over a century. The primary production on Fairhalt is potatoes – Garry produces an average of 2,000 tonnes of potatoes annually. In particular, Garry produces a combination of seed potatoes (that are grown to be sold to and replanted by large potato growers) and gourmet potatoes (grown to be sold to high end restaurants in Sydney and Canberra).

Other than potatoes, Fairhalt is also a significant prime lamb producer. Garry stocks an average of 1,800 prime lambs each year. Occasionally, Garry will also use his pastures to produce lucerne for silage and fodder production.

Since early on in his ownership of Fairhalt, Garry and his family have strived to ensure regenerative farming practices are effectively implemented on their land. These regenerative practices include:

- Consistent application of compost to maintain soil nutrients
- Reduced tillage of the soil to limit soil damage
- Targeted species (lucerne and other grasses) cropping to improve soil health post potato crops
- Systematic and adjustable crop and pasture rotation to promote soil health and regeneration

These practices ensure the carbon level and nutrients in the soil remain consistent – despite depletion from potato cropping activities. The consistent soil health allows Garry to maintain high production of potatoes year on year.

Please note – in the interests of privacy the data throughout this economic report has been 'de-identified'. That is, the data has been reported so that it does not represent the owner's actual financial position, rather it proportionally highlights the changes of incorporating regenerative farming practices. In particular, we have used an index to proportionally represent the financial figures. Where two datasets are compared, we index both sets of data to the benchmark data.

All data in this analysis is presented on the basis of the financial year.

Due to data availability, some years may be missing throughout our analysis.

Report Data Sources:

Industry Benchmarks – AUSVEG & AGSURF Farm Survey Data

Financial & Production Data – Garry Kadwell Financial Accounts

Seasonal Conditions and Rainfall Data – Australian Bureau of Meteorology

Industry Insights – Published Industry Reports by:

- Australian Bureau of Agricultural and Resource Economics
- Department of Agriculture
- Department of Primary Industries
- AUSVEG & AGSURF

Benchmarking

Throughout the analysis for this Economic Report, we have compared the financial and production data to relevant industry benchmarks. This illustrates the success of Fairhalt and Garry's management practices. The benchmark data in this report is referred to as the 'Average Farm'.

The primary benchmark for the Average Farm is a vegetable-growing farm business in New South Wales. The data for the Average Farm is published in ABARES Vegetable Growers Farm Survey Reports.

Please note: oABARES Vegetable Growers Farm Surveys Reports provides an average of all vegetable growers in Australia – not just potato growers. According to AUSVEG, potatoes make up the majority (42%) of vegetables grown in Australia – the next highest is tomatoes (14%). Therefore, we feel it is appropriate to compare Fairhalt's potato enterprise to the ABARES Vegetable Growers Farm Survey averages.

Where appropriate, we have used relevant benchmarks – other than the one described above – as the Average Farm.

Production & Income

Throughout our analysis, we noted that the regenerative practices Garry has implemented on Fairhalt have led to significantly increased production levels when compared to the Average Farm. With increased productivity, the income generated on Fairhalt is also significantly higher than that of the average Farm. In addition, the increased productivity has allowed Garry to deploy a more diversified production mix – leading to a more sustainable enterprise as a whole.

The following sections will illustrate the increased productivity and income on Fairhalt when compared to the Average Farm due to the implementation of Garry's regenerative farming practices.

Diversified Productivity

Fairhalt is first and foremost a potato production enterprise. However, Garry also receives significant income from his Lamb and fodder production activities. Table 1 illustrates the production mix on Fairhalt for each year over the period of 2010 to 2018. Figure 1 illustrates the average production mix for 2010-2018.

Production	**Percent of Revenue**								
Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Potato Sales	46%	57%	76%	67%	63%	78%	73%	82%	53%
Gross Profit from Livestock	44%	36%	19%	21%	28%	11%	13%	5%	13%
Hay & Fodder	11%	7%	5%	12%	9%	7%	10%	9%	28%
Wool	-	-	-	-	-	4%	4%	4%	6%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 1 Production Mix (2010-2018)

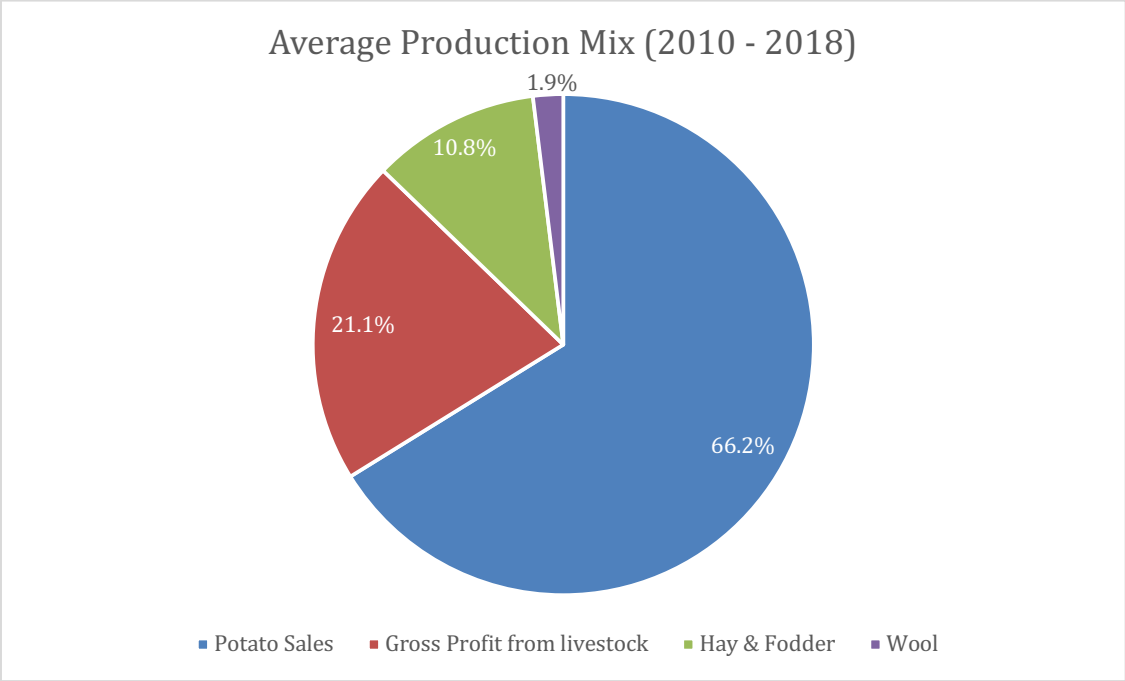


Figure 1 Average Production Mix (2010-2018)

The sale of potatoes is clearly the primary source of production on Fairhalt. However, there is still significant production from diversified sources each year. In particular, livestock (predominately lambs) and hay and fodder production.

The consistent soil health that Garry has been able to maintain through regenerative farming practices, allows him to diversify production on Fairhalt. In particular, Garry's rotational cropping practices enables full utilisation of the available productive land capacity throughout the year.

Following the potato harvest in a particular paddock, Garry will crop lucerne and (later) other grasses. This repairs the soil health after potatoes have been cropped. The lucerne and grasses grown in this process are used to feed lambs with excess being harvested and sold as fodder and silage. The rotational cropping system is adjusted based on the requirements of each paddock to regenerate soil health. For example, the rotation cycle for a paddock could be anywhere from 5 years to 15 years – as needed – in between crops.

In this process, there are significant amounts of fodder (particularly lucerne hay) that are grown and stored. The excess fodder is stored and sold in favourable market conditions – for example; drought. The effects of this practice can be seen in Table 1 – the percent of revenue for fodder significantly increases to 28% during the 2018 drought.

In this rotational cropping system, the productivity of the land is always being utilised. The length of time when pastures are being repaired after harvesting potatoes (or 'downtime') is effectively used to produce fodder and livestock that provide an additional source of revenue for Fairhalt.

Diversity in production allows a farming enterprise to be less susceptible to both market and seasonal fluctuations. For example, if significant market or seasonal fluctuations (e.g. fall in market price or poor rainfall) occur that limit the profitability or productivity of farming potatoes, falls in revenue could be supplemented by other income sources (lambs and hay/fodder). This means more consistent and stable revenue year on year.

Potato Production

Figure 2 illustrates the tonnes of potatoes produced per hectare for Fairhalt and the Average Farm. As can be seen, Fairhalt produces significantly higher tonnes per hectare of potatoes than the Average Farm in all years since 2010.

The overall production levels for both Fairhalt and the Average Farm have increased since 2010 (as noted by the trendline). However, the growth in production is happening more rapidly for Fairhalt when compared to the Average Farm.

The significantly increased productivity is due Garry's regenerative farming practices. Garry ensures that there are high levels of nutrients and carbon in the soils, therefore he is able to boost productivity levels. By maintaining this soil health each year, Garry is able to consistently achieve productivity levels well above that of the Average Farm.

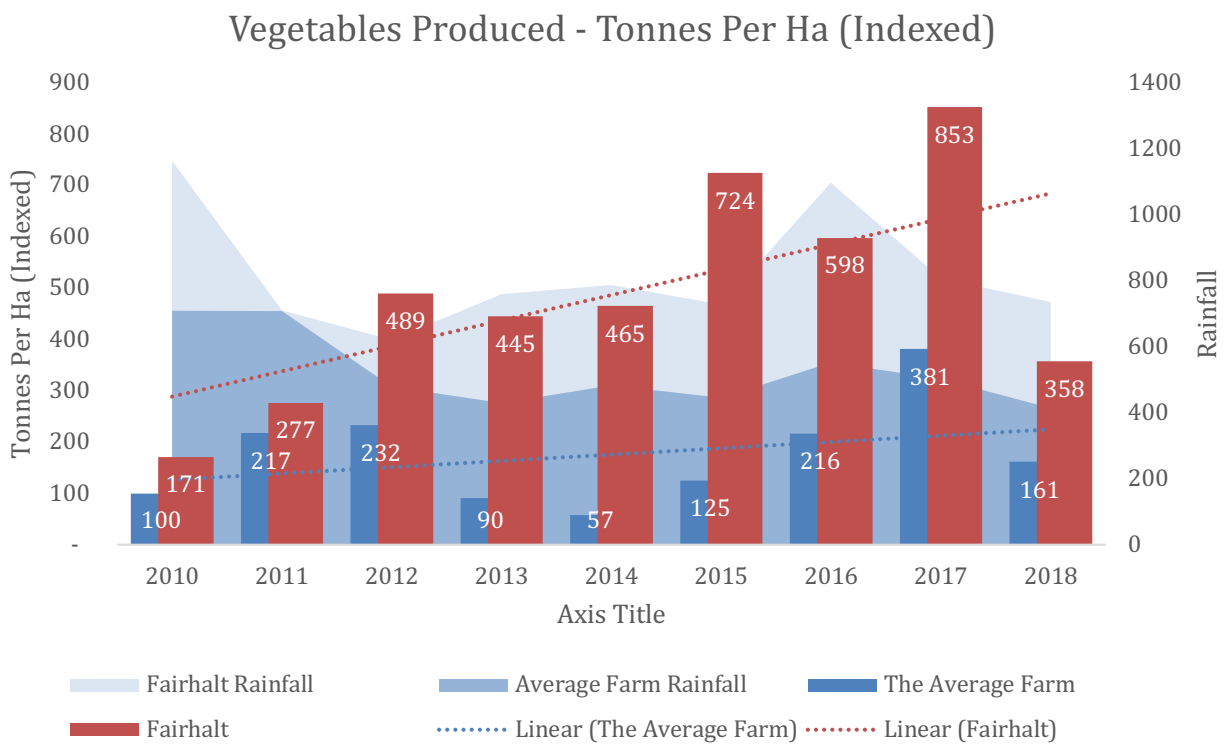


Figure 2 Vegetables Produced – Tonnes Per Ha (Indexed)

Data Insights:

- In 2017, Garry increased the area sown for the potato crops. This resulted in significantly more potatoes being produced in this year.

Lamb Sales

Lamb sales are a significant source of supplementary income on Fairhalt. As noted previously, diversified production allows Garry to maintain more consistent revenue each year. Due to Fairhalt's success in consistently producing lambs for sale, this income source is able to be relied upon as a supplementary revenue source going forward. Figure 3 illustrates the lamb gross margin of Fairhalt compared to the Average Farm. Gross margin is a measure of total sales minus the cost of goods sold. In the case for Figure 3, lambs gross margin is simply the profit on lamb sales.

From 2010 to 2014, Fairhalt is generating a consistently higher gross margin compared to the Average Farm. Since 2015, the gross margin for lambs produced on Fairhalt has been consistent with the Average Farm.

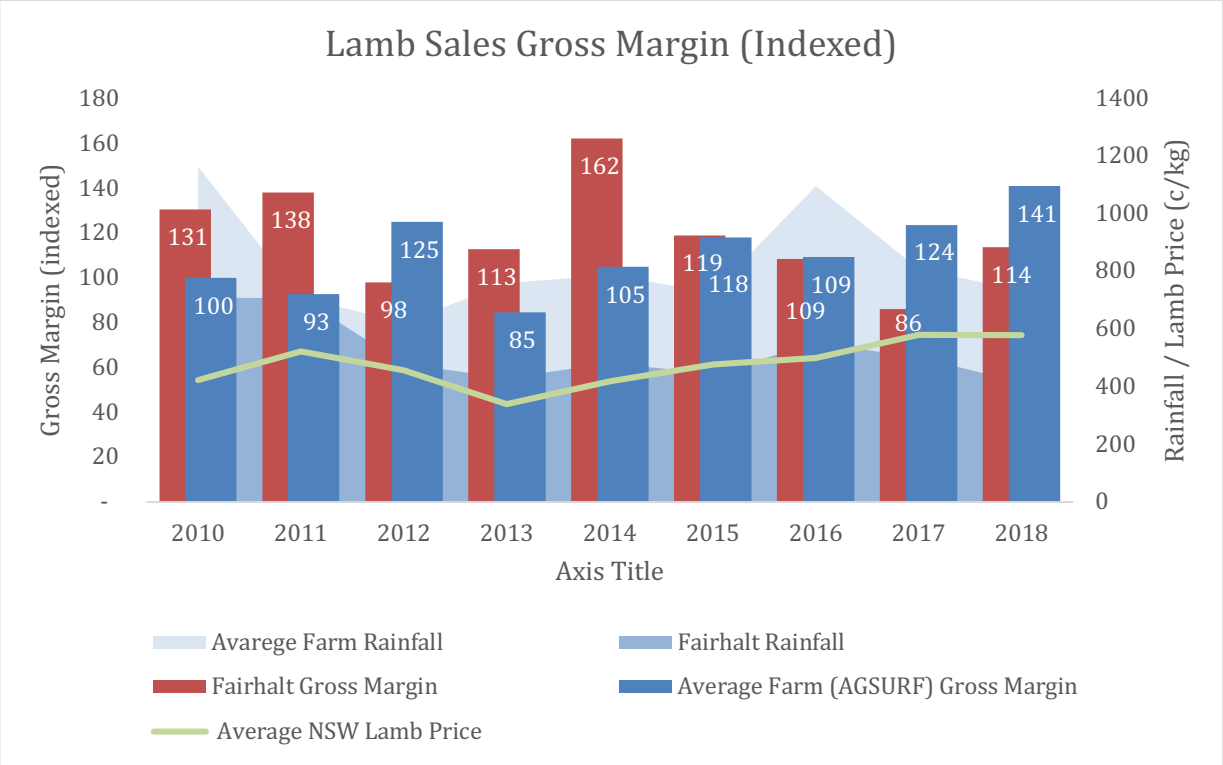


Figure 3 Lamb Sales Gross Margin (Indexed)

Data Insights:

- Garry sells a consistent number of lambs each year – despite market conditions and price fluctuations. Therefore, the main drivers that cause changes in gross margin for Fairhalt are the market price of lambs and the price of input costs. The gross margin for 2010 -2013 are consistent with the fluctuations in the MLA Average Sheep price (c/kg).
- In later years (2014- 2015) the lambs gross margin for Fairhalt varies when compared to the MLA Average Sheep price. As gross margin is the net of revenue minus costs of goods sold (i.e. purchases), the primary cause for the variation is due to changes in costs of goods sold in these years.

Expenses

Despite Garry's investment in pasture management and soil health maintenance every year, expenses on Fairhalt are still significantly lower than the Average Farm. The cost of implementing regenerative farming practices may be a major concern for farmers that are yet to do so. However, the comparison of Fairhalt's and the Average Farm's key expenses (explored below) shows that the costs of regenerative farming is not as high as some farmers may expect.

Pasture Expenses

'Pasture Expenses' are those that are necessary to maintain the soil and pasture health in a farming enterprise. In this analysis, we have considered the following expenses as 'Pasture Expenses' and compared them to that of the Average Farm:

- Crop and Pasture Chemicals
- Fertilisers
- Fodder & Supplements
- Seed

Please note – Pasture improvement expenses that have been incurred by Fairhalt and the Average Farm have not been included in this analysis.

Pasture Expenses in Figure 4 are shown on a per hectare basis so that different sized farms can be compared effectively. In Figure 4 the Average Farm includes the average Pasture Expenses for vegetable growers in NSW and Australia.

As can be seen, the Pasture Expenses for Fairhalt are significantly lower than the average for NSW and Australia. Furthermore, Pasture Expenses are consistent on Fairhalt (except for 2017) across the 4 years analysed. Conversely, the average Pasture Expenses for NSW and Australia have grown significantly in the years of this analysis.

Since 1998, Garry has not used synthetic fertilisers on Fairhalt. This significantly reduces the cost of yearly pasture expenses. Instead, organic compost is used to provide nutrients to crops and soil. Typically, the application of organic fertilisers has an added bonus of improving soil biology and increasing, organic matter. Over time this has improved the soil condition on Fairhalt leading to higher production.

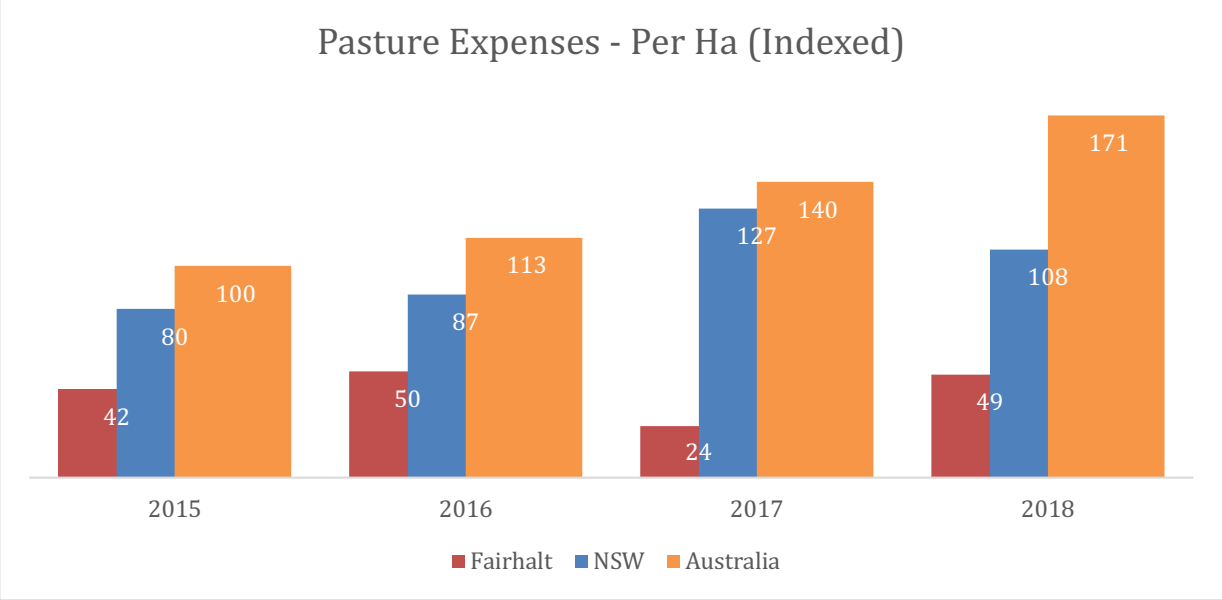


Figure 4 Pasture Expenses - Per Ha (Indexed)

Data Insights:

- Pasture Expenses for Fairhalt fell significantly in 2017 due to a large reduction in natural fertiliser purchased in this year. The amount of natural fertiliser purchased in 2018 returned to the usual level.

Farm Overhead Expenses

Overhead expenses are the expenses that are necessarily incurred by an enterprise but not directly related to sales or production. In this analysis, we have considered the following expenses for Fairhalt and the Average Farm as 'Overhead Expenses':

- Repairs and Maintenance
- Fuel, Oil & Grease
- Electricity & Gas

Figure 5 illustrates the Overheard Expenses for Fairhalt and the Average Farm. As can be seen in Figure 5, Fairhalt has significantly lower Overhead Expenses for all years except 2018. On average, Fairhalt's indexed Overhead Expenses per Ha are $62. The average indexed Overhead Expenses per Ha for the average farm is $91.

Typically, Fairhalt's expenses are lower than the Average farm. We noted that the primary reason for reduced overhead cost was a focus on 'insourcing' – wherever possible. Examples of this include; in-house repairs and maintenance, pasture maintenance (applying compost), farm improvements (fencing and earthworks) and so on. By limiting the amount of services required from external sources, there is an overall reduction in running costs to maintain the enterprise.

However, this does lead to increased labour time spent from Garry and his family. There will also be increased wear and tear on machinery and equipment due to increased usage.

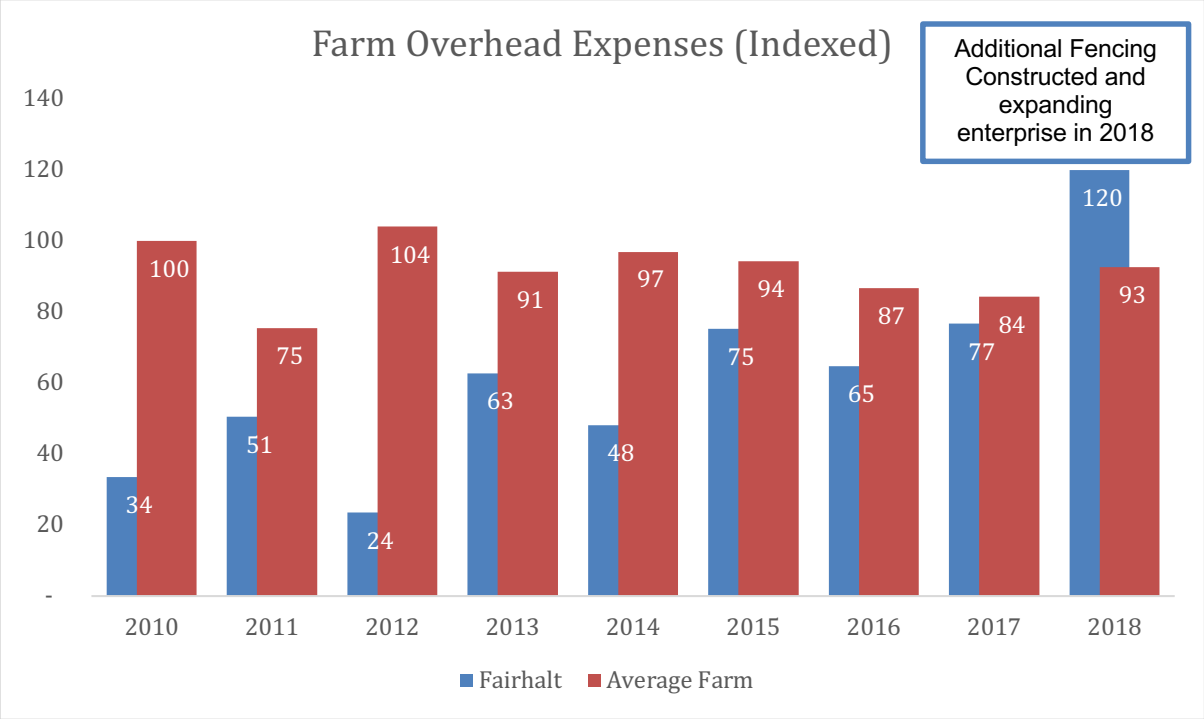


Figure 5 Farm Overhead Expenses (Indexed)

Data Insights:

- Fairhalt's Overhead Expenses fell significantly in 2012. This is due to a reduction in Repairs & Maintenance expenses.
- Since 2015, Fairhalt's Overhead Expenses have increased. This is due to an increase in Fuel & Oil expenses since 2015.
- Overhead Expenses increased significantly for Fairhalt in 2018.This is due to an expansion of Fairhalt by 1,000 acres. As a result of this expansion, Garry undertook significant repairs and upgrades to the fencing on the new section of Fairhalt.