Case Study

2018

FFL WINLATON CASE STUDY: ECOLOGICAL SUMMARY REPORT

Prepared by

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This project enabled an opportunity to establish new enterprises and innovative land management regimes.

Key findings

Prior to 2007, and before to the purchase of the 35 properties that now comprise FFL Winlaton, each of the land parcels was independently managed freehold land. From 2007 the acquired land parcels have been progressively aggregated into one large farm, comprising a patchwork of multiple enterprises across multiple locations between Kerang and Lake Boga, northern Victoria.`

The pre-purchase landscape was highly degraded, largely a consequence of high salinity levels accumulating in the upper soil profile following a century of unsustainable flood irrigation practice on the Victorian riverine plain.

Knowledge of historic production systems and detailed soil analyses have been used to establish a four-class 'state and transition model' of soil condition (A-D).

Riverine flooding is arguably the greatest climatic-related risk to the region. Historical agricultural and irrigation development across the region has inevitably led to flood control infrastructure being laid over the landscape. Redevelopment and the location of new Infrastructure built by Kilter Rural is designed in the context of physical flood risk, but also from a perspective of potential future floodplain management opportunity (e.g. provision of flood mitigation services for community and ecological benefit).

Almost 50% of FFL Winlaton has been set aside for irrigated agricultural production. These areas are found across all soil-landscape types where soil is sufficiently arable.

40% of FFL Winlaton has been set aside for ecological protection i.e. minimal use conservation areas. Much of this area coincides with land deemed limiting for agricultural production, although there are readily identified ecological assets.

The balance of the land area of FFL Winlaton is either infrastructure or rural living related or is in transition to an end land use still in determination. It also includes small interstitial portions of land existing between active production areas that have some ecological value.

Riparian areas on FFL Winlaton are carefully managed and protected from agricultural utilisation.

Introduction

The FFL Winlaton property development model was based on renewal of an area of agricultural and social decline by investing expertise, time and capital to restore the land's agricultural productivity in part by activating local social capital. While agricultural productivity was a key focus, there was a realisation that this could only be sustainable if supported by improvements in the ecological health of the degraded land holdings (refer to the Supplementary Ecological Report).

Each of these land holdings on the previously privately owned farms has had a different history of land management regimes. There are three broad soil-landscape types on FFL Winlaton:

1) floodplains were primarily managed for dairy production using flood irrigation of pastures; 2) low sandier rises, and

3) lunette dunes which were variously dry cropped and grazed.

Historically, most of the native plant communities across the three soil-landscape types have been cleared, converted and managed to agricultural production. Small areas of remnant native vegetation remain as does a highly modified native and exotic groundcover mosaic within agricultural (cropping and grazing) paddocks. At the time of purchase of the holdings (2007-2011) their ecological health was in a significant degraded state with little prospect for improvement under the historic agricultural management regime. Inefficient irrigation practices within a sensitive hydrogeological environment contributed to a long declining eco-social state.

Much of the previous intensive agricultural activity had relied upon irrigated pastures and cropping, from channelled irrigation coming from the Murray via the Kerang Lakes system. An altered hydrological balance from early agriculture rapidly led to rising ground water levels and soil salinity in the district, which has been recognised for many decades. By the turn of the current century, the Millennium Drought had further set back the socio-economic state of the district and further challenged the prospect of rehabilitating and restoring a degraded landscape. A growing trend of selling of water out of the district would not help returning the land to a productive agricultural future. Through much of this time the remaining extent and condition of the native plant communities had become highly fragmented and transformed, relative to the original landscape.

Following the development of a new and visionary agricultural investment and rural rejuvenation concept plan, in 2007 Kilter Rural had begun implementing the FFL Winlaton project. This project enabled an opportunity to establish new enterprises and innovative land management regimes that were also designed to enable a reversal in the decline in the ecological health of the soil-landscape types. Kilter Rural's farming plan is continuously improved through the latest research relevant to each agricultural enterprise and forms of ecological rehabilitation. The farming plan is designed to:

- restore soil health through adopting improved irrigation and fertiliser delivery technologies;
- develop complementary crop - pasture rotations;
- retire low productive land from agricultural production; and,
- on this retired land employ revegetation strategies for ecological service production.

This plan, in combination with appropriate management regimes for the various enterprises, has led to improvements in productive (soil) capacity and the condition of native vegetation.

This report describes the ecological and biodiversity outcomes observed by Kilter Rural and its research associates for FFL Winlaton since 2005. Ecological and biodiversity outcomes are a response to implementing regenerative land management regimes.

FFL Winlaton has been managed over the four phases over the period 1900-2017:

Phase 1: 1900-2006	Conventional non-regenerative regimes and practices
Phase 2/3: 2007-2011	Phase 2: Conventional non-regenerative regimes and small-scale demonstrations. Phase 3: Transition to broader scale regenerative regimes
Phase 4: 2012-2017	Broad scale regenerative management regimes

Soil-landscape types, Land-use types and Soil condition

FFL Winlaton has three broad soil-landscape types:

1. Riverine floodplains with grey and black cracking clays;
2. Gentle low rises with lighter loamy clays
3. Lunette dunes on the eastern side of playa lakes.

The land area of FFL Winlaton has been classified into three land use types corresponding to the Australian Land Use and Management Classification (Version 7): intensive uses, extensive uses and minimal uses:

1) Intensive Uses:
    a) Intensive horticulture; Residential and farm infrastructure; and transport and communication
    b) Production from Irrigated Agriculture and Plantations
2) Extensive land uses:
    a) Production from Relatively Natural Environments
    b) Production from Dryland Agriculture and Plantations
3) Minimal uses: Conservation and Natural Environments

Across all three broad land use types a holistic assessment of the trajectory of the health of soils within FFL Winlaton has been developed to enable monitoring and reporting of both agricultural and native vegetation lands (Figure 1). Condition of soils is categorised within an A to D classification devised by soil scientists working for Kilter Rural.

Soils are classed for each of the 140 Land Management Units (LMUs) comprising FFL Winlaton, at 5yr intervals starting in 2007 (effectively pre-purchase condition). Land categorised as class A generally occurs on the lighter rises sitting on the floodplains, which has the highest soil condition and generally utilised for high value irrigated cropping (intensive use).

Figure 1 shows soil condition classes for four key reporting periods:

1 pre-purchase – before 2007;

2 pre-development – 2012;

3 aligned to this 1st report with ~75% of the landscape development completed - 2017;

4 projected 100% of the landscape redevelopment completed – 2022.

The 2012 assessment is assumed to be the same as 2007, as this was the date representing the beginning of FFL Winlaton's investment in large scale redevelopment. In-field soil assessment strongly underpins the 2017 condition assessment, and prudent assumptions are made to predict 2022 condition.

Soil condition is assumed to improve from active soil conditioning practices on cropping land, but as importantly also from the gradual rehabilitation of native vegetation on non-agricultural lands using both passive and active restoration methods.

Areas of intensive land use (irrigated cropping rotations and some perennial horticulture) currently comprise soil condition classes A, B and C. Areas of extensive land use - mostly rotational livestock (sheep) grazing - typically comprise classes C and D. Minimal use areas (managed ecological lands) are currently protected from both intensive and extensive agricultural production. Areas of minimal use currently mainly comprise soil condition classes C and D.

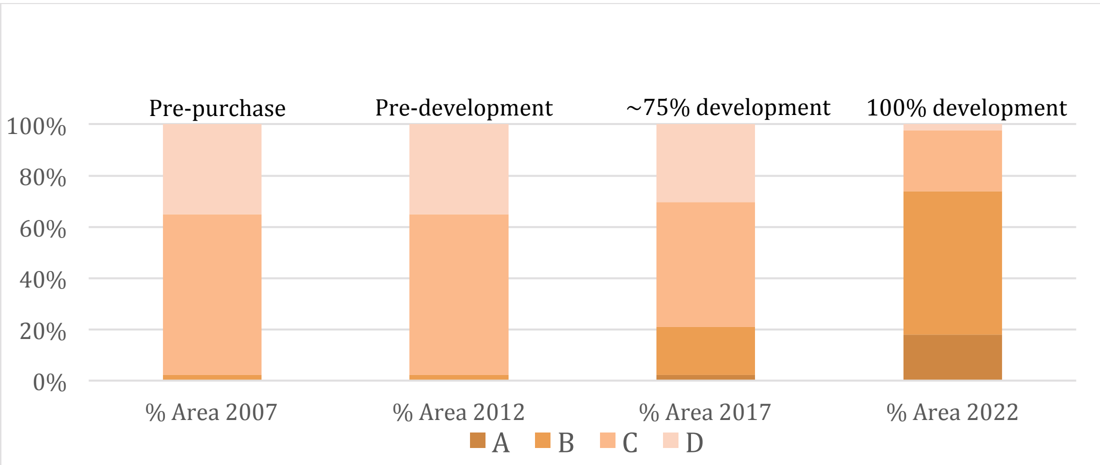

Figure 1. Relative areas of FFL Winlaton over time, 2007-2022 using four soil condition classes across all three-broad soil-landscape types, including agricultural and ecological lands

Assessment of ecological and biodiversity outcomes

Managing soil-landscape types to minimise effects of extreme climatic events

The most common extreme climate-related event in the region is riverine flooding associated with major rainfall events in the upper catchments of the central Victorian uplands. A major inundation event can leave the cropping land unsuitable for agricultural production for extended periods of time.

Since FFL Winlaton was established in 2007, Kilter Rural has worked on minimising the effects of flood inundation events. Much of the “intensive use” land use zone is situated upon lower lying soil-landscapes, where the risk of flooding is greatest. Paddocks have been laser levelled and drainage sumps installed to assist with shedding flood water particularly associated with flash flood storms. In addition, heavy-duty movable water pumps can be mobilised to reduce periods of inundation when flooding inevitably occurs. The need for this level of planning and design was demonstrated in January 2011 when a >1:100 yr flood event (refer to the Supplementary Ecological Report) impacted the region.

Despite these management strategies, major flood events and prolonged inundation remain a material risk to agricultural production in a floodplain environment. The consequences of flooding if it were to occur is obviously greater in a higher value agricultural (intensive) setting.

It is worth noting that during major flood and prolonged inundation events the “extensive use” and “minimal use” land use zones can still be adversely affected but the consequences are not as critical as the “intensive use” land use zones.

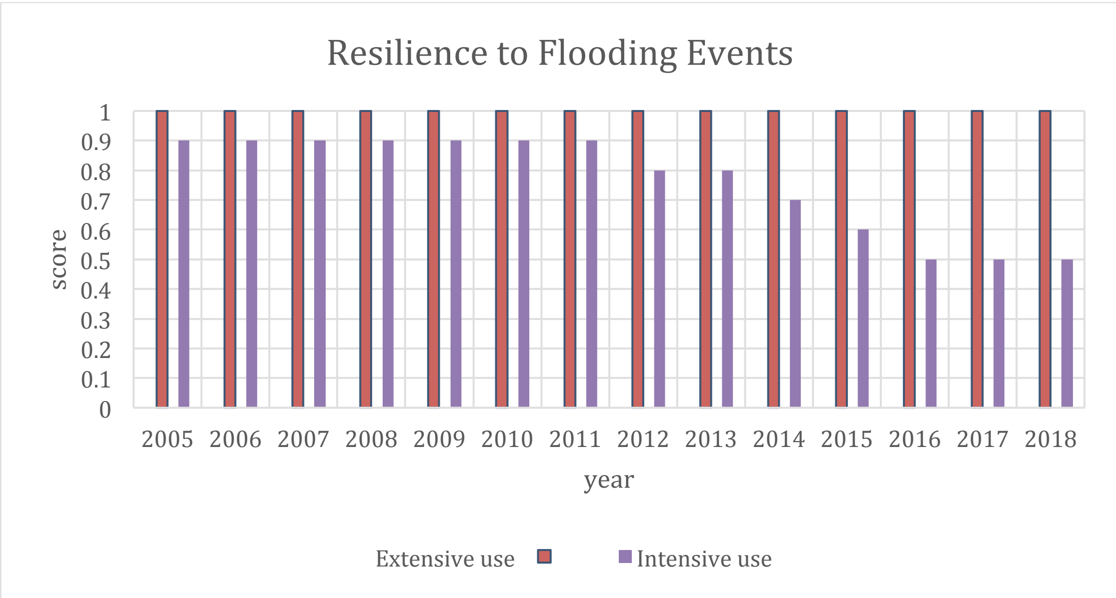

Figure 2. Depicts the ability of the “extensive use” and “intensive use” land management units within FFL Winlaton to recover from flooding events over time.

Managing soils to prevent erosion, restore eroded areas and to maintain ecological health, productive capacity and water quality

Kilter Rural has progressively introduced, tested and adopted a range of ‘active’ measures to improve key soil indicators (Figure 3.) across FFL Winlaton. The focus of these active measures has been on the intensively farmed land.

An initial step is to reduce high levels of salinity within the crop root zone, which also allows the status of other soil indicators to be more easily addressed. Large quantities of compost and gypsum have been applied throughout much of the redeveloped “intensive use” land, and soil conditioning crops such as lucerne chosen for their economic return in addition to their ability to improve soil capability.

Lucerne has a deep-root system, which has helped to mobilise salt deeper into the soil profile. Tomatoes have the ability to draw salt from the soil and hold it within the plant. In general, an orderly rotation between lucerne, tomatoes and cotton (and occasional fallow) has allowed the positive progression of soil condition, further enhanced by irrigation techniques that provide a level of match to natural soil behaviour (wetting and drying characteristics of floodplain clays). Soil indicators are also assumed to have also improved within the “minimal use” land (Figure 3.).

The removal of livestock from these areas has assisted the passive regeneration of groundcover as well as allowing active methods of revegetation with native grasses, shrubs and trees. Increased groundcover has also aided in the prevention of erosion.

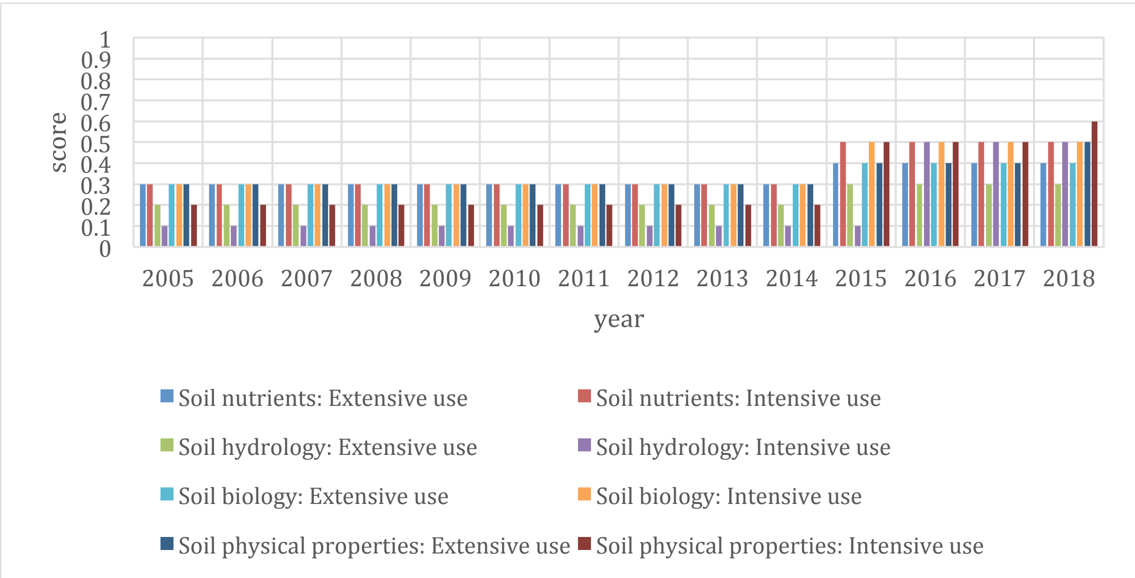

Figure 3. Status of soil indicators over time within the “minimal use” and “intensive use” land at FFL Winlaton.

Managing native groundcover for production and to maintain ecological health

Within FFL Winlaton, the “extensive use” land use zone is managed to allow light grazing (sheep) and the “minimal use” land use zone is managed to specifically improve and maintain ecological health. Within both these zones, grasses and herbs have been passively regenerated or actively planted to improve ground cover levels as well as structure and composition of these otherwise highly modified plant communities. Livestock (sheep) are rotationally grazed within the “extensive use” land to minimise groundcover loss but also to attempt to promote the desired structure and composition of the grasses and herbs in the ground layer. (Figure 4).

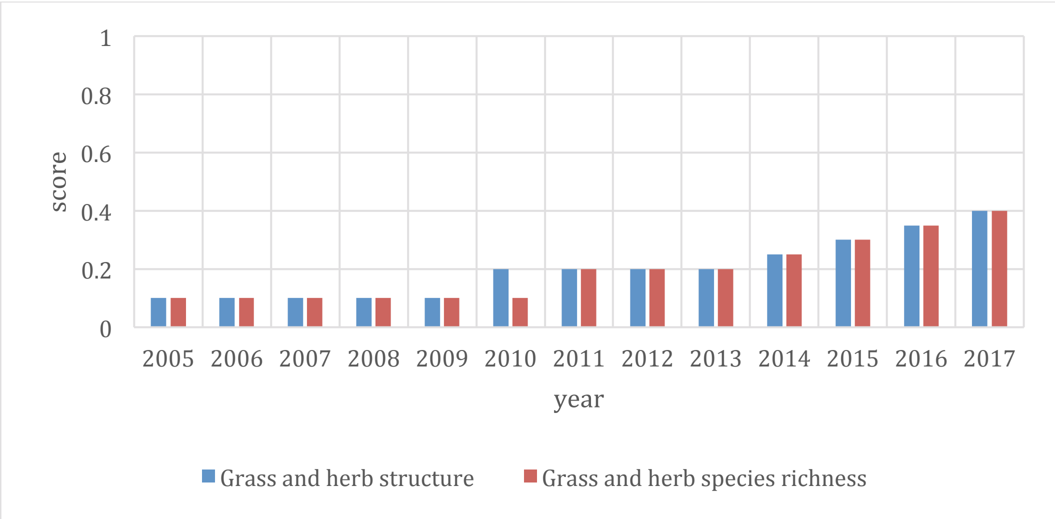

Figure 4. Status of grass and herb indicators overtime at FFL Winlaton.

Managing trees and shrubs for production and to maintain ecological health of the property and watershed

The extent and condition status of trees and shrubs across FFL Winlaton at the time of purchase was relatively poor, with much of this subsumed by historical agricultural layout (irrigation). Over subsequent years, the status of trees and shrub indicators gradually improved due to slow natural regrowth following permanent abandonment of irrigation, but also by active planting/direct seeding of trees and shrubs throughout the “minimal use” and “extensive use” land.

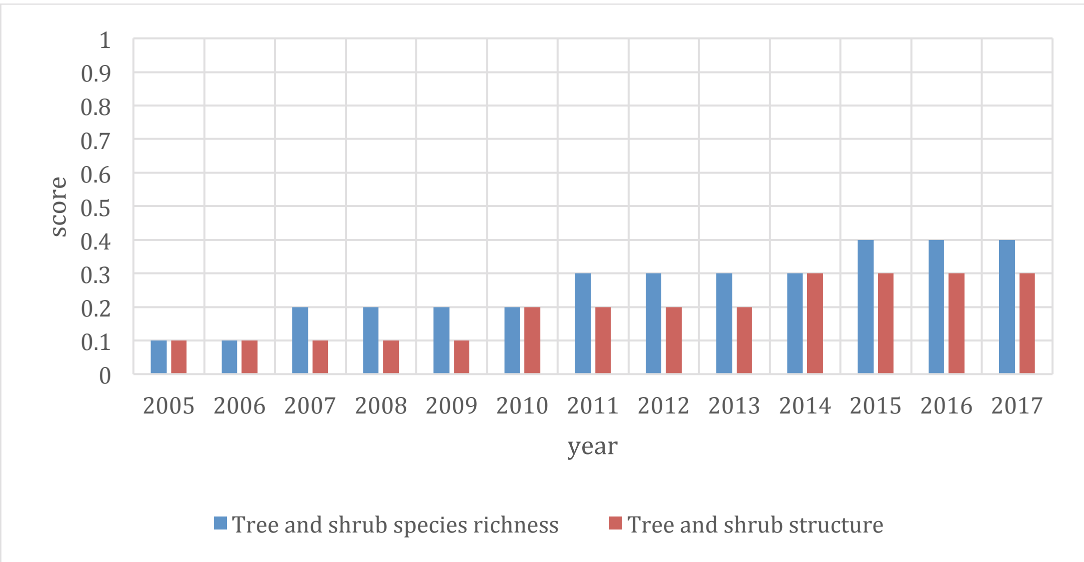

Figure 5. Status of tree and shrub indicators overtime at FFL Winlaton

Managing natural watercourses, riparian areas, natural lakes and wetlands, to protect ecosystems that are sensitive to agricultural land management.

Kilter Rural has fenced off livestock access to watercourses throughout FFL Winlaton.

Connected remnant and regrowth vegetation that is superfluous to the agricultural footprint (previously intensive use) has, in many instances been added to, and therefore expanded the area of "minimal use" land. Fencing demarcates the agricultural from non-agricultural zones, so that riparian and related waterway frontage is protected from agricultural activity.

For more detail, see the Ecological Supplementary Report

Case Study

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FFL WINLATON CASE STUDY: ECOLOGICAL SUPPLEMENTARY REPORT

Prepared by

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Planting native shrubs such as salt bush may have helped reduce salinity levels in the soil, resulting in an improvement in the level of soil nutrients

Key findings

Prior to 2007, and before to the purchase of the 35 properties, each of the land parcels were independently managed freehold land parcels.

Riverine flooding is arguably the greatest climatic-related risk to the region. New Infrastructure built by Kilter Rural is designed and located in the context of physical flood risk, but also from a perspective of future floodplain management opportunity (e.g. flood mitigation services).

The floodplains were primarily managed for dairy production using flood irrigation of lucerne pastures. The gently rolling low sandy hills and the lunette sand dunes were managed for relatively intensive grazing of cattle and sheep. Most of the native plant communities across the three land types have been cleared, converted and managed to agricultural vegetation. Small areas of remnant native vegetation remain, as does a native and exotic mosaic within minimally used paddocks, where grazing has been totally removed or intermittently rested from grazing for long periods.

Knowledge of historic production systems and detailed soil analyses have been used to establish a four-class 'state and transition model' of soil condition and function across all FFL Winlaton's land types. Where soil was identified as not adversely affected by prior land management regimes, these land management units are delimited and managed as prime agricultural land. Varying degrees of impairment for agricultural production have been delimited into the remining three classes depending on the degree of impediments.

Assessing responses to land management regimes according to the ecological criteria

A field visit to FFL Winlaton was made on 28-29 November 2017. Kilter Rural was asked to document the production system's history and land management regimes leading up to the current regenerative land management regimes (Attachment A). This included a collation of all available published and unpublished relevant ecological data and information about the farm and how it was managed. Information available in that interview included whole of farm aerial photographs, fertiliser history, and paddock-based management histories.

This section describes how the property has been managed over the four phases over the period 1900-2017:

Phase 1: 1900-2006	Conventional non-regenerative regimes and practices
Phase 2/3: 2007-2011	Phase 2: Conventional non-regenerative regimes and small-scale demonstrations. Phase 3: Transition to broader scale regenerative regimes
Phase 4: 2012-2017	Broad scale regenerative management regimes

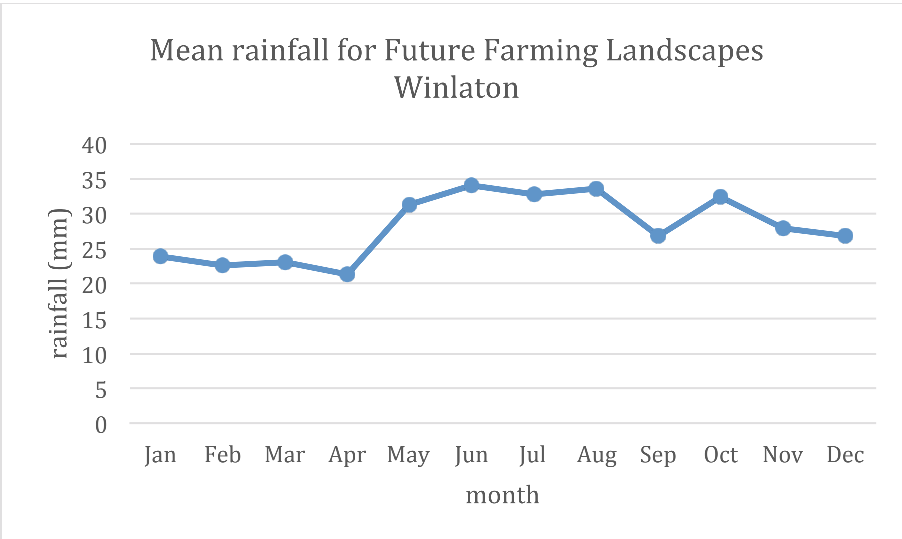
Where quantitative data had been collected over time by the land manager, these were used to populate the respective ecological response. Expert elicitation was used to assist the land manager to assess the ecological responses of implementing the production systems on ecological criteria associated with ecosystem function, structure and composition over time.

The land manager was asked to self-assess how his goals or lifestyle intentions affected his landscape management regimes (i.e. production systems) and what effects he observed on a scale of 0-1 for each ecological response criteria. Change was assessed graphically, relative to the baseline, which was defined by the land manager as conventional non-regenerative land management.

In the following section, the ten ecological response criteria are assessed and shown graphically over four phases (i.e. Landscape Management Regimes). Each phase is described by an aggregate of land management practices, which correspond to the goals or ideals of the land manager (Attachment A).

This Ecological Assessment acknowledges that climate variability plays a major role in influencing the land manager's decision-making process and his capacity to implement his plans for production. In turn, the effects of climate variability have major impacts on ecological, economic and social wellbeing. The highest rainfall months at FFL Winlaton are between May and August, (Figure 1) which corresponds to a Mediterranean climate (Thackway and Freudenberger 2016, Figure 1). It should noted, that within this winter season, the rainfall at FFL Winlaton is highly variable (Appendix 2).

FFL Winlaton, like most agricultural land managers use rainfall to as a gauge of climate variability. A summary of the modelled seasonal rainfall from 1900 to 2015 for the property is presented in Attachment B.



Source: Bureau of Meteorology (BOM n.d)

Figure 1. Mean monthly rainfall for FFL Winlaton

The following 10 ecological response criteria are assessed[1] below:

A. Resilience to natural major disturbance/s (e.g. drought, fire, flood);
B. Status of soil nutrients including soil carbon, major and minor elements;
C. Status of soil hydrology including infiltration, percolation and water availability to plants;
D. Status of soil biology including bioturbators i.e. nutrient recyclers, fungi and bacteria ratios and soil organic matter;
E. Status of soil physical properties including bulk density and soil as a medium for plant development and growth;
F. Status of the reproductive potential of the plant species and plant community;
G. Status of tree and shrub structure;
H. Status of ground layer/ground cover/grass and herb structure;
I. Status of tree and shrub species richness and functional traits; and
J. Status of the ground layer/grass and herb species' richness and functional traits

[1] Ecological change and trend information presented in this report has been scored by the land manager relative to a baseline. This process involved considering relevant qualitative and quantitative data and information and expert elicitation and workshopping. The graphical summaries are scored using the VAST assessment framework.

To evaluate and validate the land manager's self-assessment, Soils For Life has engaged Farmmap4D, in a partnership agreement, whereby Farmmap4D will provide a satellite-based validation of two measures:

1. the observed responses of paddocks within FFL Winlaton over time
2. the observed responses of FFL Winlaton compared with the surrounding properties within a 2 kilometre radius over the study period.

These two measures are expected to show varying levels of correlation within FFL Winlaton to several response criteria including:

D. Status of soil biology - Soil surface condition

E. Status of soil physical properties – Landscape function

G. Status of tree and shrub structure - Extent of tree cover

H. Status of grass and herb structure – Year-round ground cover

J Status of grass and herb functional diversity - Grass and herb species richness

Assessment of Response Criteria

A. Resilience to extreme climate events

Wildfire (Intensive and Extensive land use zones)

Phase 1. (1900-2006)

Before 2007, prior to the purchase of the 35 properties (i.e. private land parcels) that now comprise FFL Winlaton, each of the land parcels was resilient to wildfire because:

- Many of the floodplain paddocks were cleared of native vegetation, cropped and periodically inundated using flood irrigation. Only small areas of remnant native woody overstorey have been retained;
- There was ready access to large quantities of water;
- Other non-floodplain sand plain and lunette paddocks were conventionally grazed resulting in a native and exotic pasture mosaic, which was minimally flammable.

Even if the land were to be burnt by wildfire it would have returned to productivity quickly due to the abundance of water, and the utilisation of the landscape through livestock or crops.

Phase 2/3. (2007-2011)

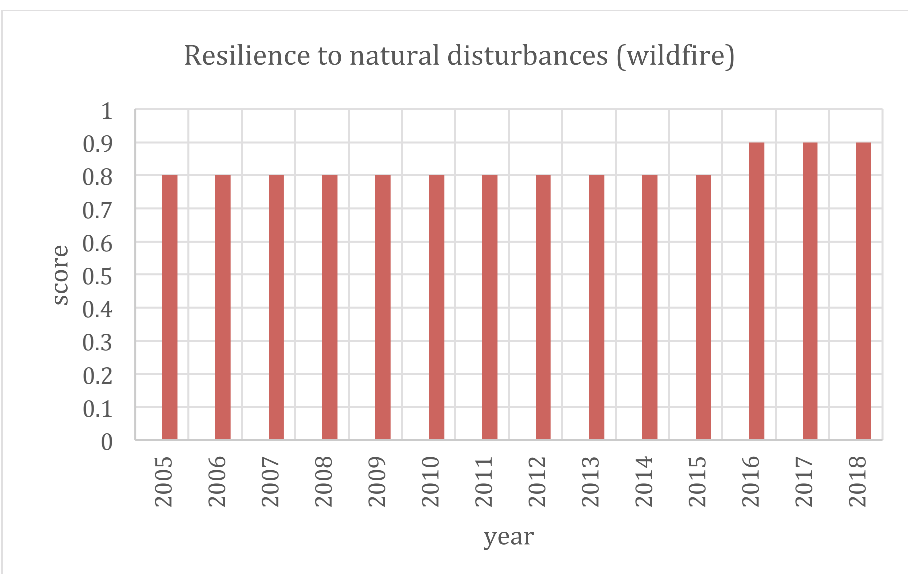
The resilience of the land parcels found on the floodplains, sand sheets and lunettes to wildfire did not alter during this phase. Improvements were not made across the land and the continued use of irrigation kept the risk of wildfire low, while recovery to productivity following fire would have been quick.

Phase 4. (2012-2017)

The resilience of FFL Winlaton to wildfire increased during this phase. The improvements provided by Kilter Rural throughout the landscape, particularly with water wastage, resulted in the increase in resilience to wildfire. The infrastructure added to the properties also helped increase their resilience to wildfire.

Other infrastructure, including formed all-weather road access contribute to the resilience of the landscape to wildfire.

40% of FFL Winlaton is deemed as native vegetation and managed accordingly.



Flood (Intensive land use zone)

Phase 1. (1900-2006)

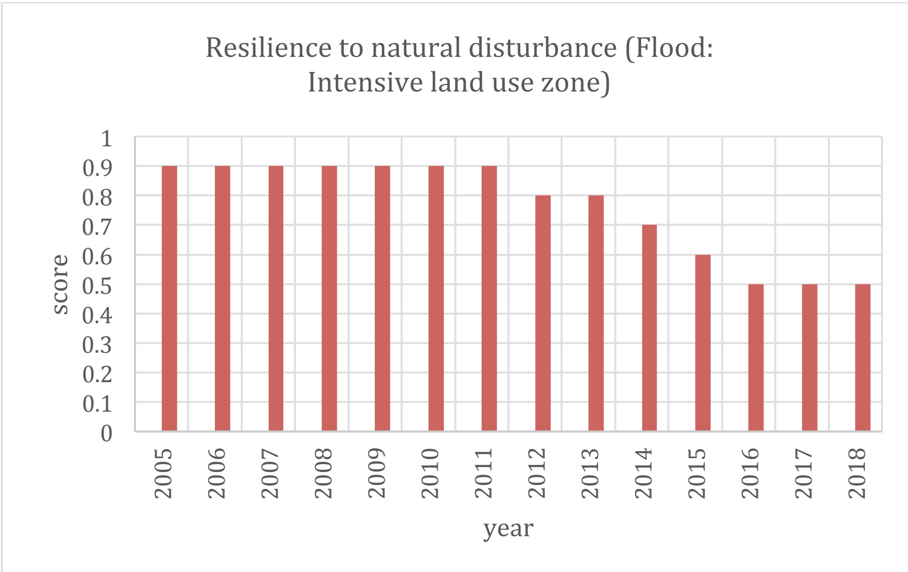
The resilience of individual properties to flood on the intensive land use zone would have changed throughout this phase. At times of higher production, the land's resilience to flood would have been low and, at times of low production, the resilience would have been higher.

Phase 2/3. (2007-2011)

The resilience of individual properties to flood on the intensive land use zone would have been quite high due to the land management practices. The majority of the land was not in heavy production and a flood would not have dramatically affected the production occurring.

Phase 4. (2012-2017)

The Lake Boga region is highly susceptible to major flood events associated with the Murray River and can suffer from prolonged periods of inundation, impacting heavily on the land and knock it out of production for an extended period of time. Recently, as the agricultural activity increased across the intensive land use zone, its resilience to cope with a flood event declined until plateauing in 2016. Increased cropping and horticulture has resulted in attention to drainage to avoid loss of production from major floods. Nevertheless floods are considered the highest risk to productivity on the floodplain intensive land use zone.



Flood (Extensive land use zone)

Phase 1. (1900-2006)

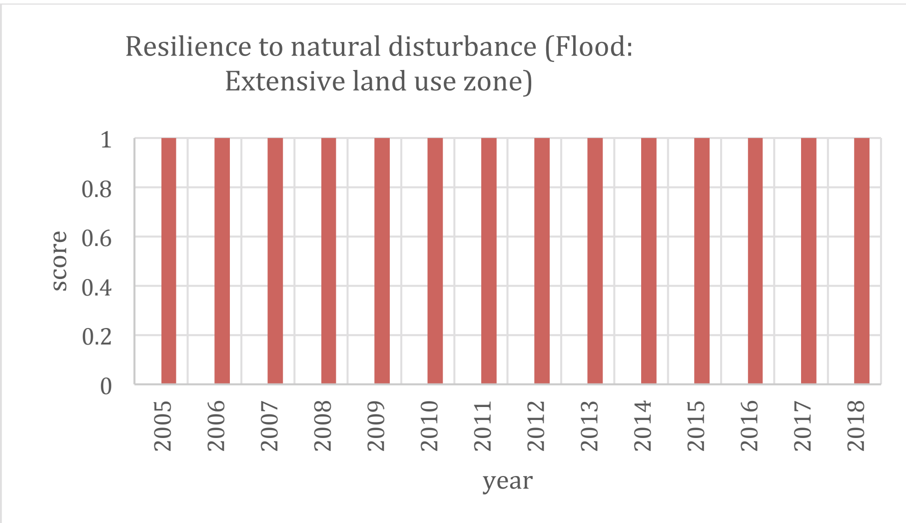
The extensive land use zone on the individual properties surrounding Lake Boga is generally not susceptible to major floods associated with the Murray River. The elevation of the land is somewhat higher and the production rates on the land are low due to the poor quality of the land. These factors combined to reduce its susceptibility to inundation and give it a high resilience to major flood events associated with the Murray River.

Phase 2/3. (2007-2011)

The ability of the extensive land use zone within the properties at Lake Boga to respond to major floods associated with the Murray River was excellent. The extensive land use zone was not heavily utilised for agriculture and floods had little effect on the land. Much of the native vegetation present in the region responds well to major flood events associated with the Murray River and is not adversely affected.

Phase 4. (2012-2017)

There has been little change in the capacity of the extensive land use zone to withstand major flood events associated with the Murray River during Kilter Rural’s ownership. Engineering works associated with laser levelling means the irrigated area now freely floods and the native vegetation responds well to occasional floods.



B. Status of soil nutrients

Soil carbon, major and minor elements (Extensive land use zone)

Phase 1. (1900-2006)

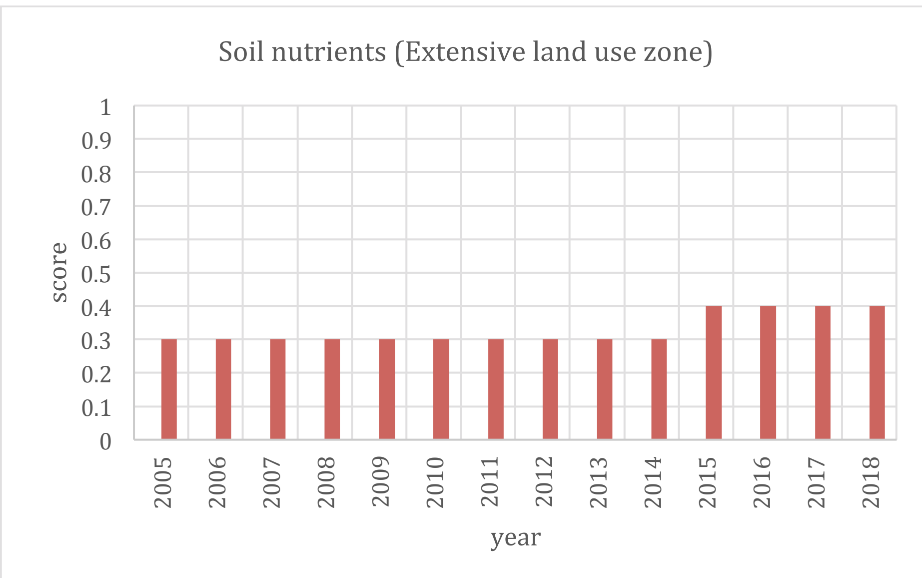
The status of soil nutrients is expected to have been quite low within the extensive land use zone throughout this phase. This area of land was not heavily utilised for agriculture except for opportunistic livestock grazing throughout this phase due to its low quality. While there was no testing of soil nutrients during this phase, it can be inferred that the status of soil nutrients would have been poor due to natural causes.

Phase 2/3. (2007-2011)

Land parcels that were deemed unsuitable for agriculture were set side for ecological purposes. Some of the extensive land use zone was deemed suitable for livestock grazing and utilised for sheep grazing in the summer of 2009. Direct seeding of old man saltbush occurred in certain paddocks in March 2010. The actions taken by the land manager during this phase did not improve the soil nutrient status within the extensive land use zone in this phase. However, it is possible that the soil was nutrient deficient due to natural causes.

Phase 4. (2012-2017)

The soil nutrient levels increased slightly within the extensive land use zone. This may have occurred due to the planting of native vegetation throughout the extensive land use zone and excluding the majority of it from agricultural practices. Planting native shrubs such as salt bush may have helped reduce salinity levels in the soil, resulting in an improvement in the level of soil nutrients. Where direct seeding or tube-stock planting was unsuccessful, it is now realised that natural regrowth was possibly more effective.



Soil carbon, major and minor elements (Intensive land use zone)

Phase 1. (1900-2006)

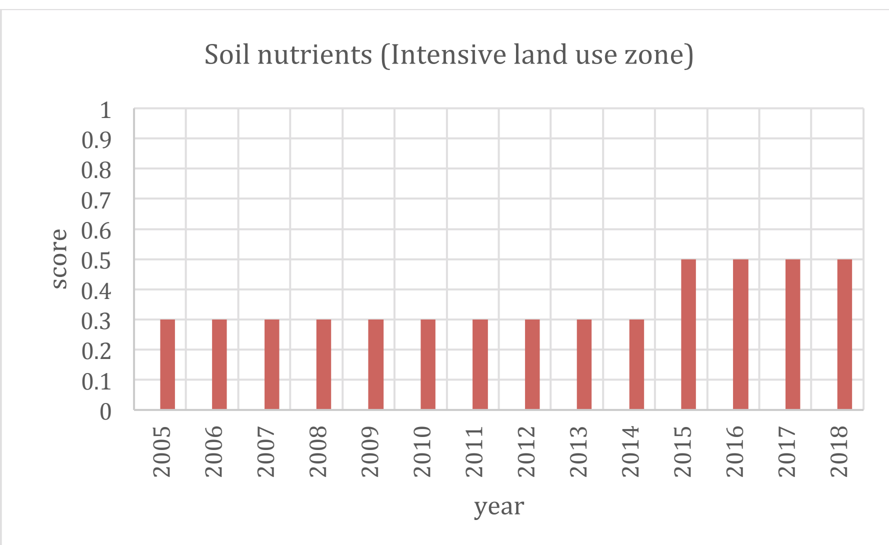
Extensive dairy farming occurred throughout the region for the majority of this phase. Opportunistic grazing for fat lamb, wool and vealer enterprises was also prevalent. Flood irrigation was utilised heavily throughout much of the land holding. Summer and winter cropping was conducted in non-drought years. By the turn of the century many paddocks were effectively abandoned from agricultural use due to the salt and soil impacts of past cultivation and inappropriate irrigation practices.

Phase 2. (2007-2011)

The land manager's focus during this phase was on improving the soil nutrient levels to enable the land to be utilised for agricultural production in the future. The actions the land manager took to achieve this included applying compost across the intensive land use zone as well as gypsum and other (unknown) fertilisers. Minimum till cropping was practiced as well as leaving the cereal stubble and root ball to stand and naturally mulch back into the soil. Some paddocks were sown with the deep-rooted crop lucerne in April 2010. Whilst the management actions of the land holder during this phase did not result in an improvement in soil nutrient levels, the management focus of the land holder changed to incorporate sustainable farming practices.

Phase 4. (2012-2017)

The effect of earlier top-dressing and continued applications gave rise to increased soil nutrient levels within the intensive land use zone areas during this phase.



C. Status of soil hydrology

Infiltration, percolation and water availability to plants; (Intensive land use zone)

Phase 1. (1900-2006)

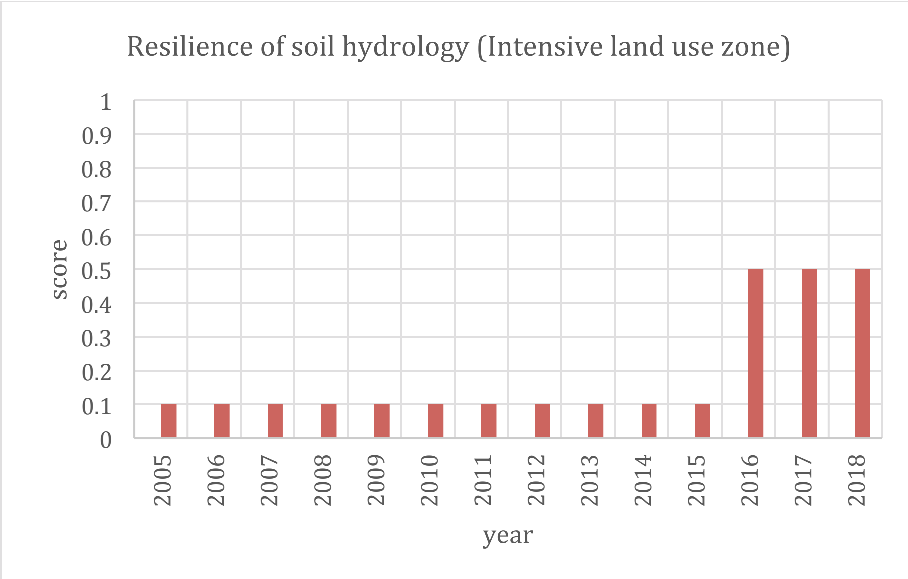
Throughout this phase the land was subjected to irrigation practices which would have raised the salinity of the soil and affected its physical structure reducing the soil's ability to retain and hold water. These factors may have kept the soil hydrology at the level that was found after Kilter Rural begun purchasing properties from 2007.

Phase 2/3. (2007-2011)

At the time of purchasing the land parcels, the status of soil hydrology was poor due to the management actions undertaken in the previous phase. The land holder undertook specific actions to improve the status of soil hydrology within the intensive land use zone of the land parcels. Crops such as lucerne were sown in 2010 in certain paddocks to improve root depth and infiltration capability of water. The land holder also improved the irrigation infrastructure on the land holdings installing high gradient gravity subsurface drip and centre pivot irrigation systems.

Phase 4. (2012-2017)

The status of soil hydrology within the intensive land use zone increased during this phase. , The improvement in the physical structure of the soil caused by specific cropping regimes was a major factor in improving the soil's ability to retain water.



Infiltration, percolation and water availability to plants; (Extensive land use zone)

Phase 1. (1900-2006)

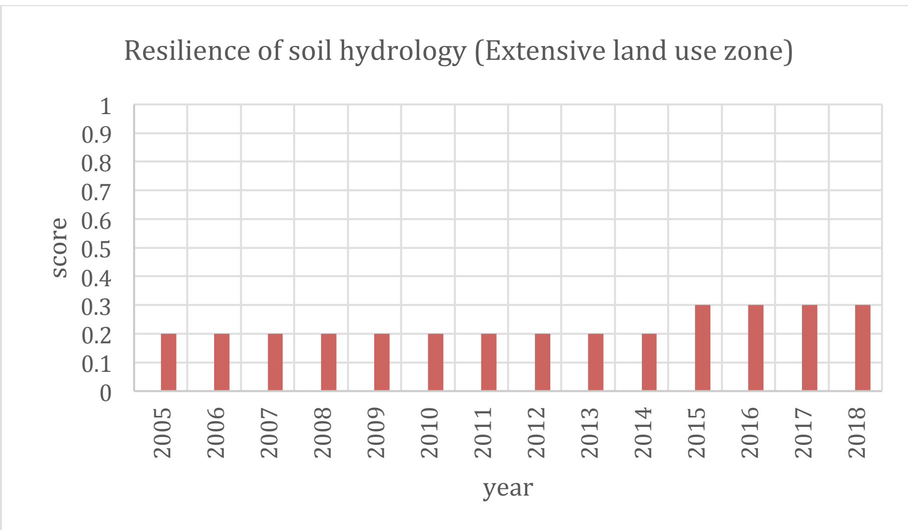
The status of soil hydrology within the extensive land use zone for this phase may have been relatively similar to the status seen post 2007. The extensive land use zone was left largely untouched by agriculture except for opportunistic livestock grazing due to its poor soils. This factor indicates that the soil hydrology level pre-2005 would have been similar to that of post-2007.

Phase 2/3. (2007-2011)

When the land was purchased by Kilter Rural, it was decided that certain areas were unsuited to agriculture and they were set aside for ecological purposes. Other areas within the extensive land use zone were lightly grazed with sheep in the summer of 2009. Much of the extensive land use zone was planted with native trees and shrubs throughout the phase, but many of the plantings failed. The management actions undertaken in the phase did not immediately improve the status of soil hydrology within the extensive land use zone but may have paved the way for future improvements.

Phase 4. (2012-2017)

Tree and shrub planting continued throughout the extensive land use zone. Much of the extensive land use zone was also locked away from agricultural use under legal covenant (BushTender). Although the plantings continued to fail in this phase, natural regrowth occurred in areas of the extensive land use zone and the growth of deep rooted plants helped improve the status of soil hydrology.



D. Status of soil biology

Nutrient recyclers, fungi and bacteria ratios and soil organic matter; (Extensive land use zone)

Phase 1. (1900-2006)

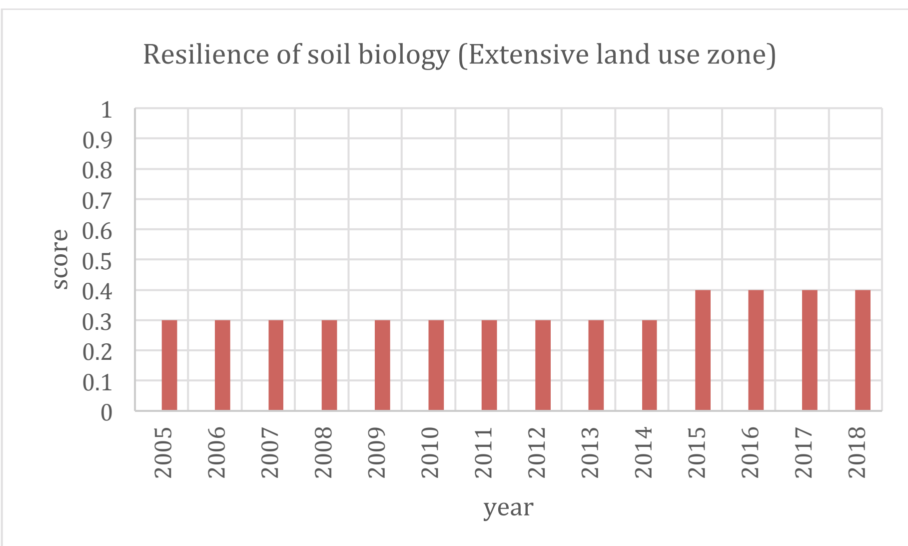
Throughout this phase the extensive land use zone within the land holdings was utilised for opportunistic livestock grazing. The land was not suitable for cropping or intensive farming due to its poor soils, and there were areas of surviving native vegetation. The areas where native vegetation was present would have had a better status of soil biology due to fungi and bacteria requiring a 'host' to provide sugars. Likewise, vegetation couldn't survive without the nutrients provided by the fungi and bacteria. The clearing of native vegetation which may have occurred throughout this phase would have reduced the status of soil biology within the extensive land use zone.

Phase 2/3. (2007-2011)

The status of soil biology is directly linked with the presence of vegetation. The land holders during this phase attempted to increase vegetation density across the extensive land use zone. They aimed to achieve this by planting trees and shrubs and setting aside paddocks from agricultural use. The trees and shrubs planted during this time largely failed and did not survive.

Phase 4. (2012-2017)

Native regrowth of vegetation occurred in this phase in the paddocks set aside from agricultural production. The increase in vegetation density caused by the native regrowth and partially due to the tree and shrub plantings undertaken by the land holder caused an improvement in the status of soil biology. The status of soil biology improved due to the increase in 'host' plants providing sugars for the fungi and bacteria to survive off.



Nutrient recyclers, fungi and bacteria ratios and soil organic matter; (Intensive land use zone)

Phase 1. (1900-2006)

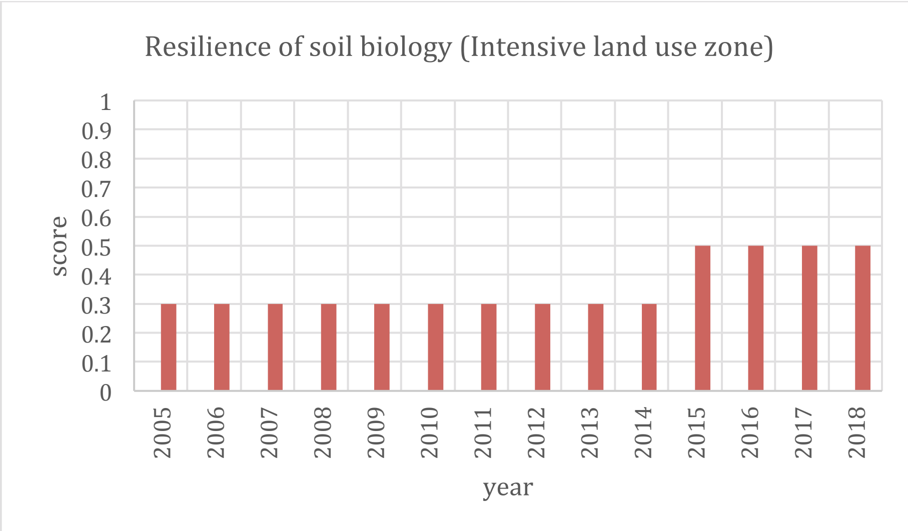
The management actions undertaken by the land holder during this phase would have caused a reduction in the status of soil biology. Much of the landscape was intensively farmed for dairy production for long periods of time. Cropping, fat lamb, wool and vealer enterprises were also conducted when weather conditions allowed. The management ideal of producing as much as possible with little regard for the environment led to soil degradation across the land holdings. By the turn of the century much of the land holding was denuded of vegetation with bare ground throughout. This resulted in the poor status of soil biology due to fungi and bacteria requiring 'host' vegetation to provide the necessary sugars for survival.

Phase 2/3. (2007-2011)

Throughout this phase the land manager focused on reducing the salinity levels of the soil and improving the status of soil biology. A major focus was placed on ensuring bare ground on the land holdings was reduced as much as possible. Wallaby grass, lucerne, chenopods and other native grasses were planted throughout 2010. The aim of the plantings was to ensure paddock coverage within the intensive land use zone. Large quantities of compost were applied strategically across the land holdings to increase biological activity within the soil. Gypsum and other fertilisers were also applied across the land holding to improve soil health. While the status of soil biology did not improve during this phase, the management ideals of protecting and caring for the soil would lead to future improvements.

Phase 4. (2012-2017)

The status of soil biology within the intensive land use zone increased during this phase. The management practices begun in the previous phase were continued, leading to improvement. Crop rotations were conducted across much of the intensive land use zone with the aim of reducing the time a paddock lay 'fallow'. By reducing the 'fallow' time, fungi and bacteria within the soil would have a greater chance of surviving between cropping rotations. Large quantities of compost continued to be applied strategically throughout this phase. The result of the management actions was an increase in the status of soil biology within the intensive land use zone during this phase.



E. Status of soil physical properties

Bulk density and soil as a medium for plant development and growth: (Intensive land use zone)

Phase 1. (1900-2006)

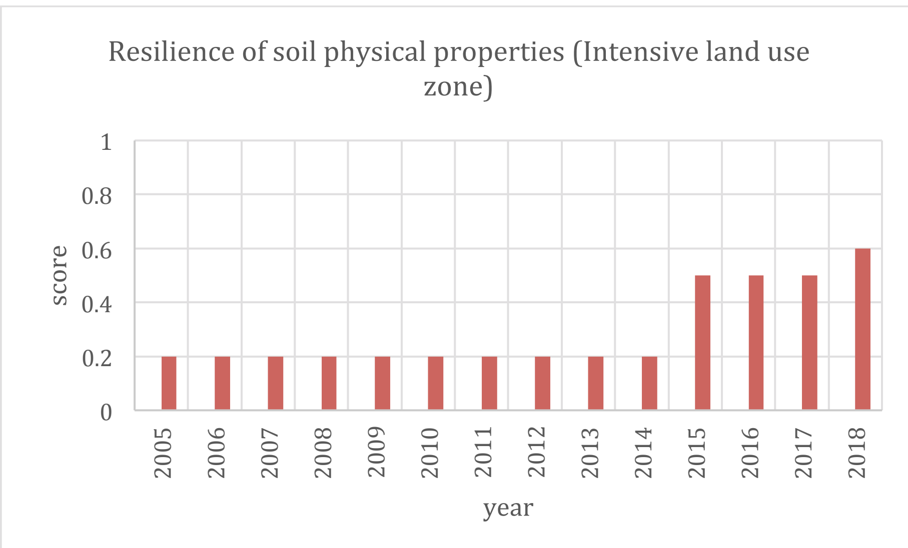
The production systems utilised throughout this phase such as dairy farming, fat lamb, wool and vealers, with the occasional crop, would have lowered the physical structure of the soil due to their intensity and the focus of land holder on ‘production’. The widespread prevalence of bare ground and salt affected soil across the land holdings seen at the end of the phase suggest that the physical structure of the soil was relatively poor. The low amount of vegetation within the intensive land use zone would also have adversely affected the structure of the soil due to poor root depth.

Phase 2/3. (2007-2011)

The management actions undertaken by the landholder during this phase were focused on improving the productivity of the intensive land use zone by improving the health of the soil. Crops such as lucerne were sown due to their deep root structure. An aim of the land holder was to ensure a vegetation layer existed over the soil, reducing the amount of bare ground. Minimum till cropping was practised as well as leaving cereal stubbles and the root ball in place to naturally mulch back into the soil. The changes in production systems did not improve the physical structure of the soil during this phase but they paved the way for future improvements.

Phase 4. (2012-2017)

The landholder continued to implement the production systems utilised in the previous phase throughout the current phase. Crop rotations were planned for each paddock to minimise the amount of time each paddock lay ‘fallow’. Crops such as lucerne continued to be planted to improve the root depth within the soil. Tomato crops were utilised heavily for their ability to remove salt from the soil and their high production value. The management action undertaken by the land holder throughout the current and previous phase successfully improved the physical structure of the soil within the intensive land use zone.



Bulk density and soil as a medium for plant development and growth; (Extensive land use zone)

Phase 1. (1900-2006)

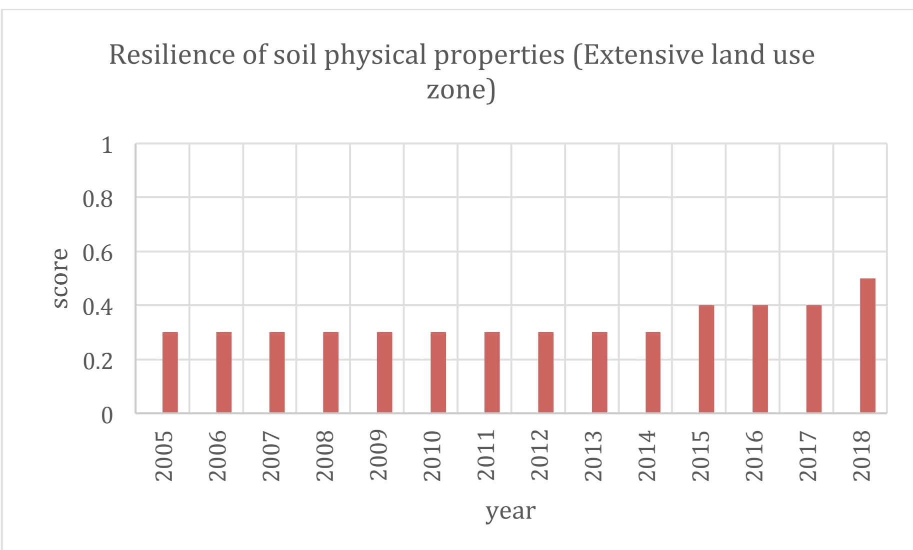
The physical structure of the soil within the extensive land use zone may not have been as degraded as the soil in the intensive land use zone during phase 1, due to it not having been subjected to intensive farming over many years. The poor, low nutrient soil found in the extensive land use zone would not have been as productive as the soil found in the intensive land use zone. This would have contributed to it not being utilised as heavily for agriculture as the intensive land use zone. These factors may potentially have aided in keeping the physical status of the soil in a better condition within the extensive land use zone than the intensive land use zone towards the end of phase 1. The increased density of vegetation within the extensive land use zone would also have aided in improving the structure of the soil due to the deeper root depths.

Phase 2/3. (2007-2011)

Land parcels deemed unsuitable for intensive agriculture were set aside as the extensive land use zone, and were managed for ecological purposes. Trees and shrubs were planted or, where possible, regrowth protected. While this did not immediately improve the soil biology of the extensive land use zone, the presence of more vegetation with increasing root depths would lead to future improvements.

Phase 4. (2012-2017)

The physical structure of the soil improved in the extensive land use zone, as a result of ecological management during this and the previous phase. The increased presence of vegetation in the form of plantings and natural regrowth provided a deeper root base which improved the physical structure of the soil within the extensive land use zone.



F. Status of the reproductive potential

Plant species and plant community; (Intensive and Extensive land use zones)

Phase 1. (1900-2006)

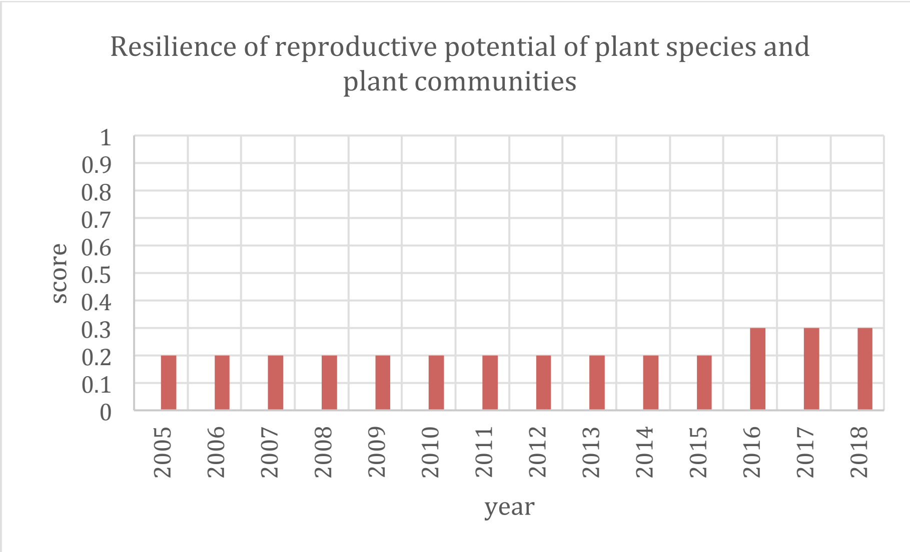
The reproductive potential of plant species and communities across the property may have been limited during this phase. Clearing of native vegetation for agriculture would also have reduced the ability of the plant species to reproduce. Opportunistic livestock grazing was also conducted throughout this phase by the landholders, and this would have impacted on vegetation due to livestock browsing. The production systems utilised throughout this period reduced the reproductive potential of plant species and communities across the land holdings.

Phase 2/3. (2007-2011)

The land holder altered production systems in this phase, including locking away up to 30% of the entire land holding from agricultural use under BushTender status and planting native trees and shrubs in paddocks to return vegetation to the landscape. The actions taken by the land holder enabled areas of the land holding to rest and begin to recover from agricultural use during this phase.

Phase 4. (2012-2017)

The management actions taken in the previous phase to improve the reproductive potential of plant species and communities began to take effect in this phase. Within areas locked away from agricultural use, native regrowth of vegetation began to occur. While tree and shrub plantings still continued into this phase, they had limited success. The reproductive potential of plant species and communities improved during this phase due to the land holder resting areas of the landholding from agricultural use.



G. Status of tree and shrub cover and structure (Intensive and Extensive land use zones)

Phase 1. (1900-2006)

Throughout much of this phase the landholders managed the land with a mindset focused on 'production'. Areas of the land holding were subjected to opportunistic livestock grazing which would have reduced the amount of regrowth produced naturally by trees and shrubs. Paddocks would also have been cleared of vegetation to make space for crops and dairy cows. The impact of the production systems utilised throughout this period was to severely reduce the status of the tree and shrub structure across the land holdings.

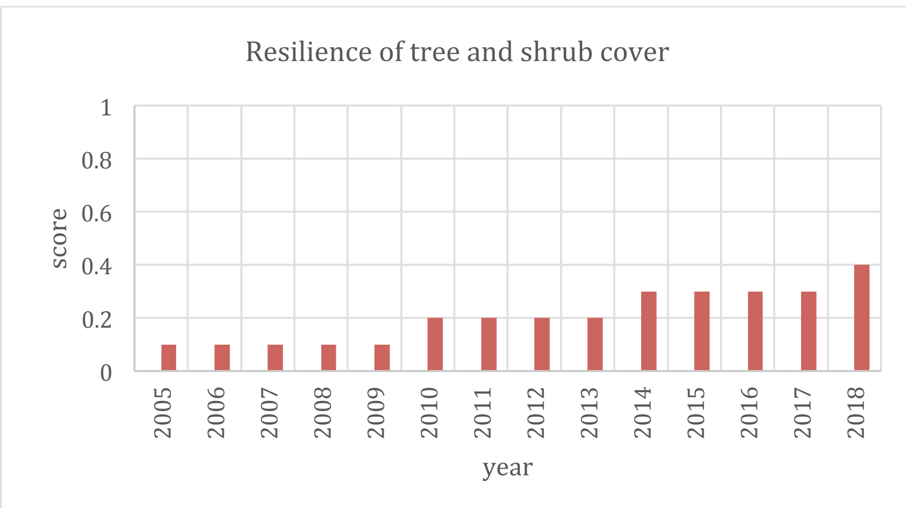
Phase 2/3. (2007-2011)

During this phase the production systems utilised by the land managers changed. Land was locked way from agricultural use under legal covenant (BushTender), trees and shrubs were also planted across the land holdings. Whilst the tree and shrub plantings had limited success, within the areas locked away from agricultural use natural regrowth of vegetation occurred. The status of the tree and shrub structure improved marginally due to the regrowth of vegetation.

Phase 4. (2012-2017)

The landholder continued to plant trees and shrubs throughout this period and monitored the progress of the natural regrowth occurring across the land holdings. The aim of the land managers during this phase was to enhance vegetation complexity in certain areas of the property. To assess if this was being achieved, vegetation assessments were conducted during 2013 and 2014 within trial paddocks across the property. The results of the study found that the status of the tree and shrub structure improved between 2013 and 2014. The results of the study can be found here:

http://www.nccma.vic.gov.au/sites/default/files/publications/sequesting_soil_carbon_in_irrigated_landscape_turned_dry_ecological_grazing_2014.pdf



H. Status of ground layer/ground cover/grass and herb cover and structure (Intensive and Extensive land use zones)

Phase 1. (1900-2006)

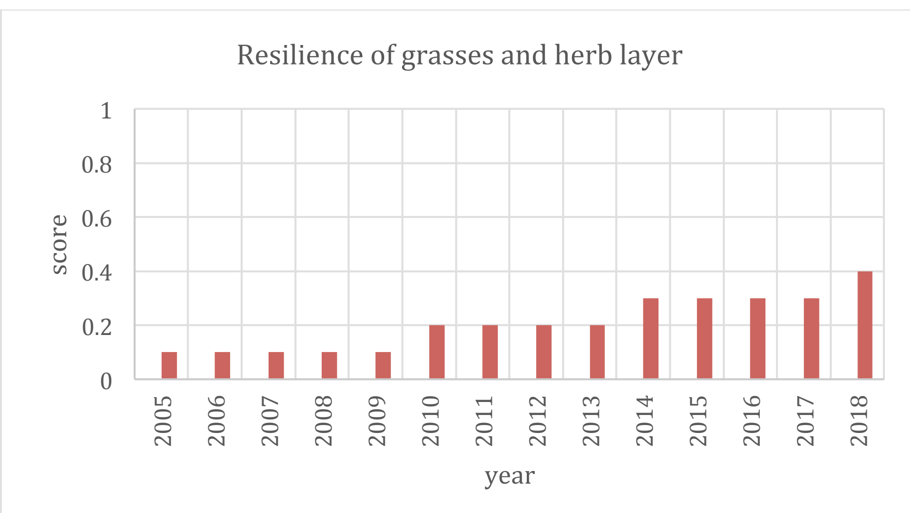
Landholders farmed the area intensively from the beginning of the phase up till the end of the century. The main enterprises consisted of dairy farms, cropping when weather conditions allowed and opportunistic grazing of livestock. Dairying was focussed on the floodplains. Intensive production systems would have dramatically affected the grass and herb cover and structure due to the land rarely being rested from agricultural use. Decreasing soil health over time (saline water tables) would have been evident on the floodplain soils, which would have reduced the capacity of the grass and herb cover to grow and produce healthy grasses and herbs.

Phase 2/3. (2007-2011)

The management ideals of the landholder changed during this phase. Much of the land was managed with the aim of repairing the health of the soil and bringing it back into production. Areas of the land holding were sown with perennial lucerne in 2010 in place of annual grass species. Wallaby grass, chenopods and other native grasses were also sown throughout 2010. This reduced the amount of bare ground across the land holding and improved the status of the grass and herb layer.

Phase 4. (2012-2017)

The status of the grass and herb layer improved due to actions taken by the land managers. Much of the property was locked away from agricultural use under legal covenant (BushTender) and strategic cell grazing of livestock was conducted. Vegetation surveys were conducted in 2013 and 2017 which found that the grass and herb layer was improving within certain paddocks. The results of the 2013 study can be found here:
http://www.nccma.vic.gov.au/sites/default/files/publications/sequesting_soil_carbon_in_irrigated_landscape_turned_dry_ecological_grazing_2014.pdf



I. Status of tree and shrub species richness and functional traits; (Intensive and Extensive land use zones)

Phase 1. (1900-2006)

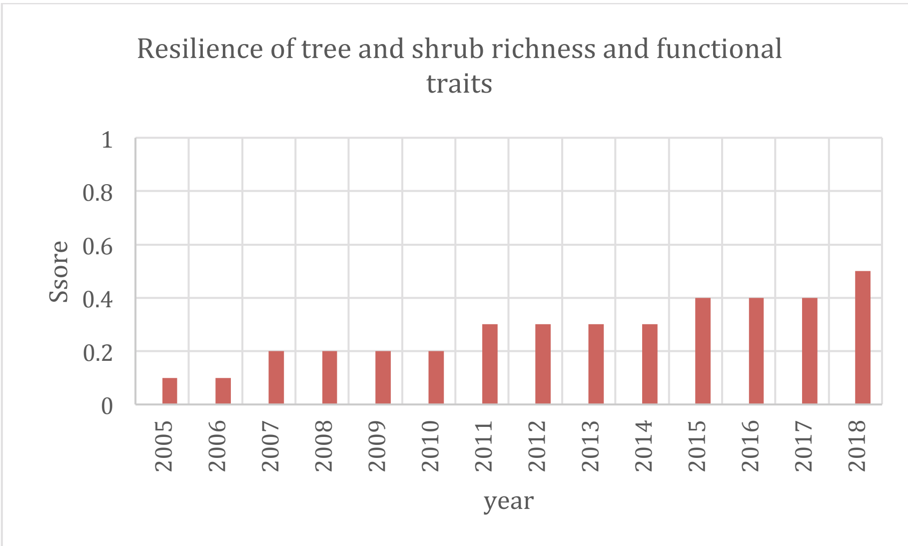
Like most land in the intensive land use zone i.e. non-rangelands, each of the former land holdings now part of FFL Winlaton were managed for asset intensification during this period. Early in this phase, large, mature paddock trees were harvested and used for strainer posts, building materials or firewood. Only the poor specimens or immature trees were retained. This would have caused a reduction in tree species richness across the individual properties. Shrubs would have been removed to make way for pastures and crops, again negatively affecting species richness.

Phase 2/3. (2007-2011)

Tree and shrub species richness began to increase during this phase. This was due to the land managers planting varying species of trees and shrubs in appropriate areas across the properties.

Phase 4. (2012-2017)

Tree and shrub species richness increased further due to increases in tree and shrub plantings, introducing more species to the property. 30% of the property was also set aside from agricultural use for ecological purposes under legal covenant. This allowed tree and shrub species to grow unhindered by livestock and feral animal grazing. Site-based vegetation surveys were conducted in 2013 and 2014 which indicated that tree and shrub species richness was improving. The results of the study can be found here:
http://www.nccma.vic.gov.au/sites/default/files/publications/sequesting_soil_carbon_in_irrigated_landscape_turned_dry_ecological_grazing_2014.pdf



J. Status of the ground layer/grass and herb species richness and functional traits (Intensive land use zone)

Phase 1. (1900-2006)

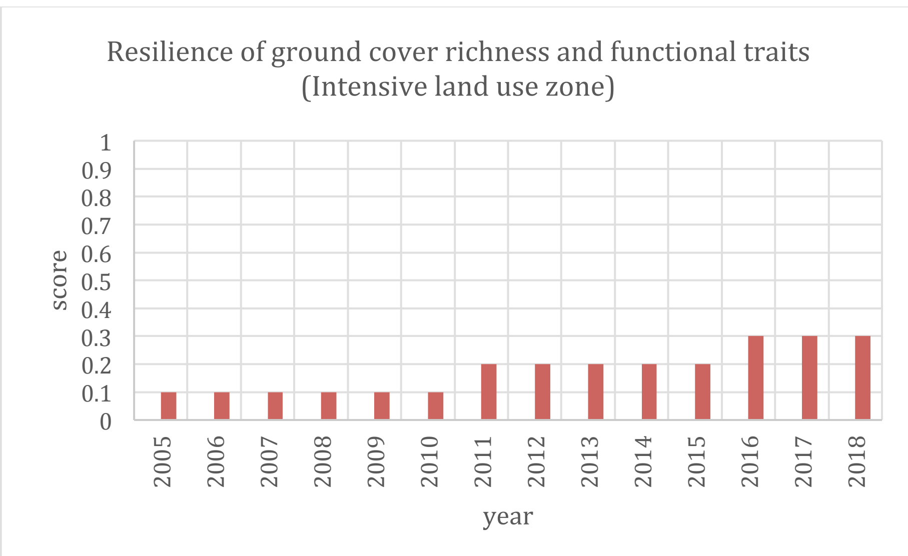
Ground cover species richness would have suffered during this phase due to the ‘traditional’ farming techniques utilised within the intensive land use zone. Overgrazing from livestock and planting monocultural winter fodder crops would have occurred throughout much of the phase.

Phase 2/3. (2007-2011)

The ground cover species richness within the intensive land use zone may not have improved pre-2010, partly because of the Millennium Drought and partly because it required time to recover from the decades of conventional farming. However, ground cover species richness improved in 2011 after plantings of lucerne, wallaby grass, chenopods and other native grasses occurred throughout 2010.

Phase 4. (2012-2017)

Ground cover species richness improved within the intensive land use zone during this phase. The improvement is due to the changes in farming techniques applied across the intensive land use zone. The land managers focused on growing diverse, healthy pastures during this stage as well as trialling new species of forage within the pastures. These methods, combined with managing livestock through rotational movements across grazing cells, helped to improve the ground cover species richness during this phase. Site-based vegetation surveys was conducted in 2013 and 2014, and repeated in 2017,found ground cover species richness was improving. The results of the study can be found here: http://www.nccma.vic.gov.au/sites/default/files/publications/sequesting_soil_carbon_in_irrigated_landscape_turned_dry_ecological_grazing_2014.pdf



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Attachment A: Production Systems – Land management regimes over time

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

Phase 1 (1900-2006)

Years:

- 1900-2006

Land area:

- 8900 acres

Management ideals:

- The land was managed from an economic perspective with little regard for the environment during this phase. (Kilter_PaddockHistories)

Animal management and production:

- Fat lamb and wool. (Kilter_PaddockHistories)
- Vealer enterprises. (Kilter_PaddockHistories)
- Extensive dairy farming across the land holding for the early part of the 1900's, continued in some areas till the 1990's. (SFL_EOI)
- Opportunistic grazing with little attention provided to strategic (sustainable) grazing management. (SFL_EOI)

Crop and pasture management:

- Flood irrigation occurred throughout much of the land holding. (Kilter_PaddockHistories)

- Summer cropping occurred in non-drought years. (Kilter_PaddockHistories)
- Winter cropping believed to be wheat during drought years (2000's). (Kilter_PaddockHistories)
- Some paddocks consisted of 'sub & rye' annual pasture – predominantly Trefoil and Ryegrass boosted by Barley Grass. (Kilter_PaddockHistories)
- Annual pastures were prevalent in conjunction with dairy operations. (SFL_EOI)

Monitoring and observations:

- Generally denuded soils. Nutrient deficient and salt affected land widespread. (SFL_EOI)
- Many paddocks effectively abandoned due to salt and soil impacts of past cultivation, and inappropriate irrigation practices. (SFL_EOI)
- Generally poor attention to weed management in line with loss of land production value. (SFL_EOI)
- Much of the landscape was in a highly modified state from land clearing activities, with natural regrowth on stranded irrigation land typically of low quality (dominated by halophytes on salt affected ground). (SFL_EOI)

Evaluation:

- Substantial soil structure damage with bare ground and salt scalds throughout the land holding. (SFL_EOI)

Improvements:

- None recorded

Phase 2/3 (2007-2011)

Years:

- 2007-2011

Land area:

- 8900 acres

Management ideals:

- The Land holder's focus was on preparing for and implementing their desired management regime of environmentally sustainable farming.

Animal management and production:

- Sheep grazed lightly over the summer period (2009). (Kilter_PaddockHistories)

Crop and pasture management:

- Export quality oaten hay crop grown in some paddocks in 2009 utilising Autumn watering, produced 3 tonnes/ acre. (Kilter_PaddockHistories)
- During this phase minimum till was practiced as well as leaving the oat stubble and root ball to stand and naturally mulch back into the soil. (Kilter_PaddockHistories)

- Some paddocks were ‘air seeded’ with Wallaby grass in April 2010. (Kilter_PaddockHistories)
- Paddocks were sown with native grasses and chenopods by ‘air seeding’ in June 2010. (Kilter_PaddockHistories)
- A few paddocks were sown with lucerne and then oversown with a barley crop in April 2010. (Kilter_PaddockHistories)
- Direct seeding of native species including Old Man Saltbush was utilized in certain paddocks in March 2010. (Kilter_PaddockHistories)
- Gypsum and fertilisers applied throughout this phase. (SFL_EOI)
- Large quantities of compost sourced from Melbourne and applied strategically to support improvement in soil structure and biological activity. (SFL_EOI)
- Utilised irrigation to exploit the natural cracking property of the soils to assist with flushing of salts deeper into the soil profile. (SFL_EOI)

Monitoring and observations:

- Large areas of the land holding were inundated for extended periods of time due to the flooding of the Lower Loddon in January 2011. (Kilter_PaddockHistories)
- BushBroker status was granted to certain trees on the Land holding in 2011. (Kilter_PaddockHistories)
- Detailed soil surveys were carried out to quantify soil constraints to production. (SFL_EOI)

Evaluation:

- The management regimes utilised during this phase have assisted in bringing the soil back into a productive state.

Improvements:

- Efficient forms of irrigation being implemented include, high gradient gravity with reuse, sub-surface drip (SDI) and centre pivot. (SFL_EOI)
- Approximately 40% of the landscape protected (voluntarily and under legal covenant) and enhanced for its native vegetation value to provide ecological services, physical buffering and offsetting of agricultural impacts. (SFL_EOI)
- Pest and weed management programs conducted on both agricultural and ecological lands. (SFL_EOI)

Phase 4 (2012-2017)

Years:

- 2012-2017

Land area:

- 8900 acres

Management ideals:

- To strategically manage the landscape using an environmentally sustainable land management regime. Low input dryland cell grazing is the dominant land use planned for the Kilter landscape where irrigation is being removed.

Animal management and production:

- 4000 strong flock of merino cross ewes (wool and fat lambs) cell grazed on native vegetation and seasonally on Lucerne and cropping residues. (SFL_EOI)

Crop and pasture management:

- Currently 30% (building to 50%) of landscape developed for summer cropping (cotton, tomatoes, Lucerne), horticulture (stone fruit, plums) and winter cereals. (SFL_EOI)
- Rotations of trial crops conducted intermittently across the irrigated section of the land holding. (SFL_EOI)
- An experimental crop of cotton grown in 2014? (Gray 2014)

Monitoring and observations:

- Soil surveys conducted by hired scientists monitoring and planning for changes in soil health and structure. (SFL_EOI)
- Soil carbon surveys conducted in October 2012. (FACT SHEET NO. 2)
- Post purchase and redevelopment Kilter Rural seeks to deliver total return of 8% p.a. (SFL_EOI)

Evaluation:

- Nil recorded

Improvements:

- Investment to date of approximately $40M for purchase and redevelopment of 35 Soldier Settlement scaled farms. (SFL_EOI)
- Kilter invests heavily in the training of staff (farmer managers). (SFL_EOI)
- Areas of the land holding were fenced and protected from stock incursion in Autumn 2012. (Kilter_PaddockHistories)