LANDCARE VICTORIA

Pasture Cropping

Trials by the Gecko CLaN in the Goulburn Broken and North East Catchments of Victoria

gecko CLaN
(Catchment Landcare Network)

CARING FOR OUR COUNTRY

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This publication is intended for general interest, to assist public knowledge and discussion about Pasture Cropping methods. It may be of assistance to you, but the steering committee does not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequences which may arise from you relying on information in this publication.

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Meredith Mitchell: DPI, Vic

Foreword

This booklet and the accompanying DVD document the adaptation of pasture cropping to farms in the northeast of Victoria. The level of interest in the technique has been extraordinary. From first hearing about it, there has been strong interest in using the approach, both from relatively inexperienced farmers and others with a lifetime's experience in managing their farms. Farmers have attended courses, and have generally gone straight out to the paddock and started to use the ideas in one way or another. They have continued to come back to group meetings and field days to discuss and contribute their experience.

What has caused the interest? There are a number of reasons. Over the past very dry and difficult years, most farmers have gone through intense periods of feeding stock – a technique that provides additional summer feed is bound to create interest. There is the possibility of the technique being a 'lower input' approach, with less herbicide and less fertiliser. There is the means to maintain cover on the soil all year round, with decreased summer weed problems.

Also, there is the prospect of maintaining a healthy soil ecosystem, with the benefits of longer shoulder seasons of growth (later in spring and earlier in autumn) due to the additional water holding capacity of the soil. Significantly, there is also real optimism that an approach such as pasture cropping can substantially increase levels of soil carbon storage.

Much remains to be tested and proven, and the case studies presented here do not attempt to do this.
Rather they aim to show how a number of farmers have started to apply pasture cropping on their own farms, hopefully triggering ideas for other farmers.

We look forward to continuing to develop pasture cropping for our own situations and invite others to come and have a look at the approach.

David Dore
Chair, Pasture Cropping steering committee
Gecko CLaN

Contents

Introduction

The Pasture Cropping Project was run by the Gecko CLaN Catchment Landcare Network during 2008-2009. The objectives of this project were to:

1. Use demonstration sites to illustrate the performance of Pasture Cropping methods in a variety of grazing and cropping enterprises
2. Improve participants' skills and knowledge to assist in selection and implementation of alternative methods for farming profitably and sustainably under low input systems
3. Communicate the progress and outcomes of the project to farming communities, and broaden the rural communities' knowledge of and engagement with these farming principles.

Six demonstration sites were used to trial Pasture Cropping. Four of these sites were in the Mid Goulburn Broken Catchment (MGBC), and two sites were in the North East Catchment (NEC). These producers Pasture Cropped the trial paddocks in the 2008 and 2009 seasons.

1. David Dore	Benalla
2. Russell, Helen and Andrew Ellis	Chesney Vale
3. Doug, Jan, Steve and Mardi James	Bungeet
4. Kevin and Pat Mitchell	Devenish
5. Bob and Marj Falconer	Meadow Creek
6. Alan Wood	Markwood

Gecko CLaN funded a presentation by Colin Seis and Meredith Mitchell in Benalla in August 2008, followed by a bus tour in October of that year to several properties, including Colin Seis' property at Gulgong, NSW. The interest in both these events was the catalyst for initiating this project. Activities during the course of the Pasture Cropping project include:

1. Farm Walk: Opportunity for participants to visit a trial site. February 2009
2. Newsletters: Four newsletters produced in 2009
3. Soil Testing on Trial Sites in December 2008
4. Soil Food Web test and site inspection by Gerhard Grasser of Agrisolutions in August 2009
5. Two Advanced Pasture Cropping and No Kill Cropping Courses: These two day courses were held in Warrenbayne and Thoona.
6. Bus Trip: A visit to "KoWarra Seeds', near Echuca to discuss the production of native pastures.
7. Discussion Forum: Trial participants participated in this forum held in Benalla.
8. Field Day: 'Soil Health and Monitoring Pasture' Guest speakers: Sonia Lee and Graeme Hand
9. Field Day: 'Improving Biodiversity and Monitoring Soils' Guest speakers: Christine Jones and Colin Seis. This day also included field walks and trial participant presentations.
10. Production of a 'Pasture Cropping" CD (enclosed with this booklet).

What is Pasture Cropping?

Pasture Cropping is a technique of sowing zero-till annual crops directly into living perennial pastures. Generally winter cereal crops are sown into summer-growing native perennial pastures. The pasture can be grazed right up to the point of sowing and the stock can be put back on the pasture after harvest to graze stubble and green perennial grasses. Using this technique, cropping and grazing are combined into one land management system and each enterprise enhances the other both economically and environmentally.

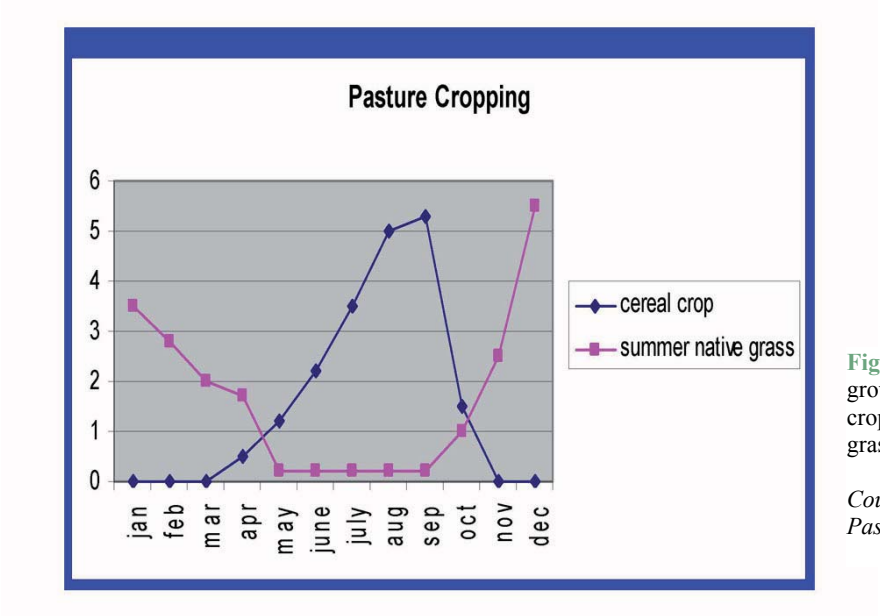

Figure 1: Comparative growing season of a cereal crop and summer native grasses

Courtesy of the Advanced Pasture Cropping Company

The guidelines for Pasture Cropping are:

- Never plough!
- Never kill perennial species.
- Perennial pastures can be native or introduced - better results are achieved from native grass species.
- Weeds are controlled by creating large quantities of thick litter and by correct grazing management of livestock.
- Weeds can also be controlled with very careful herbicide use.

Colin Seis and Daryl Cluff are the pioneers of Pasture Cropping in Australia. Studies of Pasture Cropping on Colin's property have shown that sowing a crop into native perennial pastures actually stimulates the native seedlings to grow. The consequent greater tonnes/hectare of plant growth provides more stock feed after the crop is harvested. Up to six months extra grazing can be achieved in comparison to traditional cropping methods where there is loss of grazing due to ground preparation and weed control. A three year trial was conducted by the CSIRO on Colin Seis' property which showed positive outcomes for water use efficiency, weed control, nitrogen use efficiency and soil health.

Pasture Cropping is now being practiced throughout Australia as well as in USA and Scandinavia with good results.

Trials in North East Victoria

Six properties participated in the Pasture Cropping trial within the Mid Goulburn Broken and North East Catchments in Victoria.

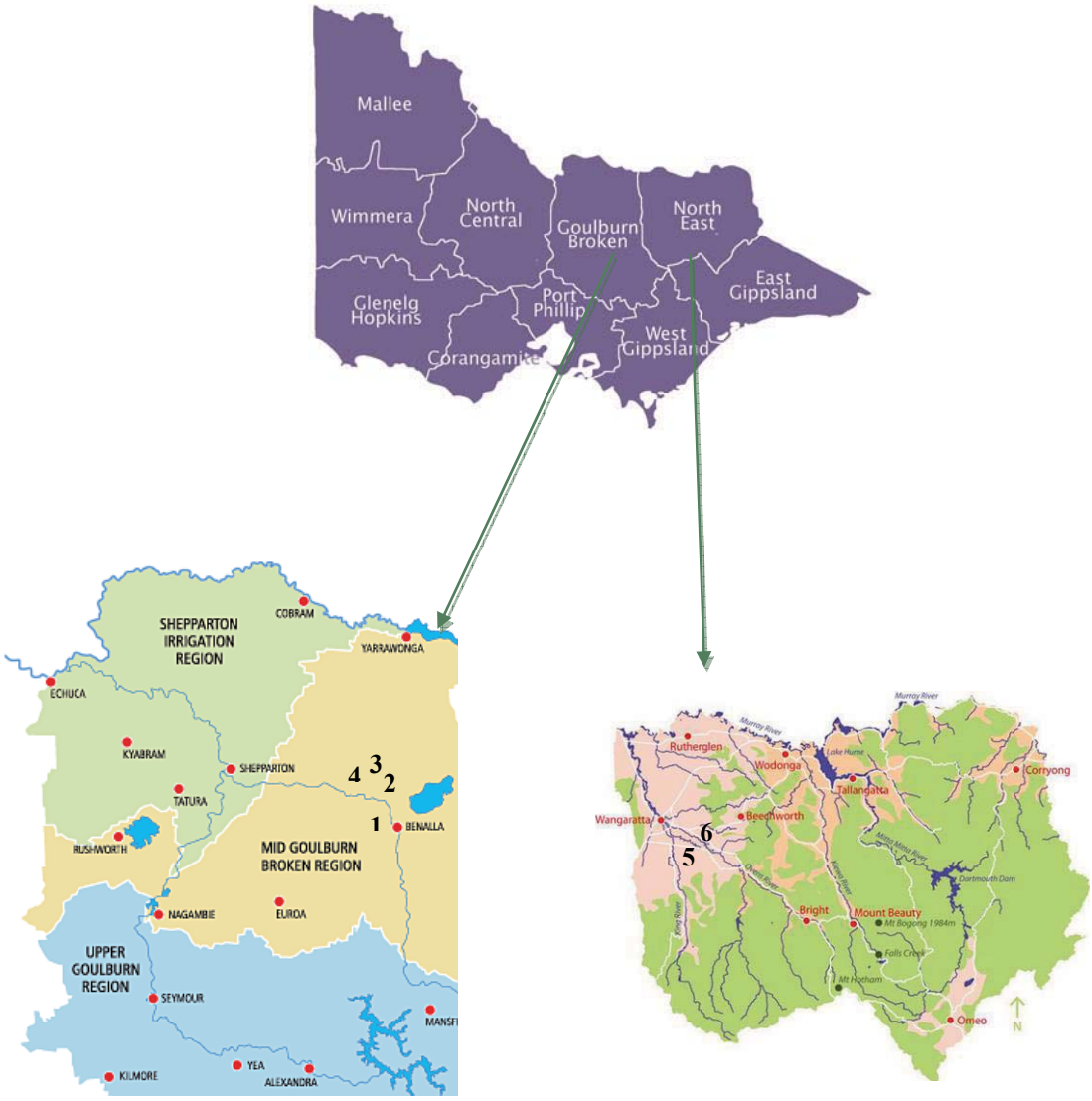

Figure 2: Location of trial participant properties

1. David Dore – Benalla
2. Ellis Family – Chesney Vale
3. James Family – Bungeet
4. Kevin Mitchell – Devenish
5: Bob and Marj Falconer – Meadow Creek
6. Alan Wood - Everton

The trial properties include a variety of enterprises - cropping, cattle, prime lamb and horses. Native seed was purchased and also collected from the local areas and hand broadcast or incorporated around sowing time. Some crops were harvested, whilst others were used as fodder.
Soil tests were taken from each site and producers monitored their own sites to gain insights into the use of Pasture Cropping for their particular enterprise.

NAME:
David Dore

PROPERTY:
'Marangan'
283 ha

AVERAGE RAINFALL: 668 mm
2008: 354 mm
2009 to Nov. 398.8 mm
ENTERPRISE:
Beef Cattle

TRIAL PADDOCK
Name: R1
Size: 15 ha

HISTORY:
This paddock was predominantly a pasture paddock (rye and clover) and has been cropped that past few years with oats.
It has had maintenance rates of super and lime since 2002.

PASTURE COMPOSITION:
Perennial Rye/Clover
Weeds: Capeweed, Erodium, Heliotrope

Case Study One

Pasture Cropping to increase groundcover throughout the year

The Problem

David found that he did not have feed for his stock over the summer months, especially over the tougher seasons of the past few years. He hopes that he will increase summer growing perennials to fill this feed gap, and also decrease his weeds through Pasture Cropping. He is also very aware that to increase soil carbon on his property the first step is to have 100 percent cover 100 percent of the time.

Method

Year One: David direct drilled 40kg/ha of Targa Oats with a Connor Shea seeder (12 inch spacings/baker boots) into fairly heavy trash in late April 2008. In early June 12 kg/ha Vic Rye and 2 kg/ha of Trikkala clover and 2 kg/ha of Goulburn clover were spread while fertilizing the paddock with 150 kg/ha of single super. Forty cows and calves were crash grazed in July, and again in September and October. The paddock was not harvested, but was grazed during December for 2 days/week for several weeks.

Pasture Cropping oats into rye and clover

Year Two: Rather than undertake further sowing, the paddock was left to allow the rye and clover to establish. As there were very few native grasses naturally occurring in this paddock Red Grass and Weeping Grass was sown by strip sowing these seeds in May using a converted vegetable seeder. The awns on the Red Grass seeds did not move through the seed freely and were therefore hand sown at the same time from the back of the tractor. It is intended that these species will disperse naturally and spread across the paddock.
The paddock was not grazed until grasses had developed strongly in August.

Results:

In the first year the paddock has provided cattle with regular feed of forage oats and the underlying pastures for several months.
Very few native species existed in this paddock prior to the commencement of this trial. There was some couch grass and wallaby grass noted in the first year, but only a small percentage. The establishment of perennial native species was therefore a priority in the second year. At the beginning of December 09 the sown weeping grass and red grass are not visible. Other native species are still largely absent.

Good ground cover in December 08 – Aiming for 100% ground cover 100% of the time.

Pasture Cropping has been a very low cost way of ensuring that there is additional forage in paddocks. By lowering input costs through lowering sowing rates to 40kg/ha and not spraying prior to sowing, David has been able to Pasture Crop other areas of his farm.

The Future

Dry sowing seems to be the safest way of ensuring that the oats can compete with existing grasses, thus avoiding the need to spray out grasses.
Although the Connor Shea seeder with the narrow points worked reasonably well David hopes to upgrade soon to obtain more even establishment.

Grazing management has been a challenge during the trial, and plans are to divide the farm more appropriately for rotational grazing so that Pasture Cropping paddocks can be more strategically grazed.

Although Targa Oats is a good forage oat, in the Pasture Cropping situation it was slow to establish, and therefore there was competition with the barley and rye grasses. David plans to trial an older variety of oats next year that may have more vigorous early growth, even if that comes at the expense of palatability.

NAME:
Russell, Helen and Andrew Ellis

PROPERTY:
"Hawkhill"
Chesney Vale, Victoria
800 ha

AVERAGE RAINFALL: 550 mm
2008: 420 mm
2009 to December: 360 mm

ENTERPRISES:
Prime Lamb
Cropping

TRIAL PADDOCK
Vineyard Hill Nearside 18 ha
Vineyard Hill Front 15 ha

HISTORY:
These have been a pasture paddock for 20 years.

PASTURE COMPOSITION:
Mixture of annuals – rye, barley grass and clover
Vineyard front had a base of wallaby grass, patches of red grass, windmill grass and some other natives.
Weeds: capeweed, erodium, onion grass

Case Study Two

Pasture Cropping to Increase Biodiversity

The Ellis family like the flexibility that Pasture Cropping provides. They can grow a crop if the season is good, or have winter feed for their stock in the years of lower rainfall.

The Problem

With only annual grasses grown on this property there was no feed and bare paddocks over the autumn period. This also led to weed infestation of opportunity weeds such as capeweed and erodium. Summer rainfall was also not being utilised. Russell could see the advantage of having more C4 perennial plants in his pastures for this purpose.

Method

Year One: The pasture in Vineyard Hill nearside was grazed until directed drilling of 75 kg/ha each of Bulban Oats and guano fertiliser into the pasture in March, using a converted International combine (knife points and 30cm spacings.)
Prior to sowing, a variety of native seed, some of which had been collected in the district, was hand broadcast. This included early Spring Grass, Arm Grass Millet, Weeping Grass, Kangaroo Grass, Red Grass and Silky Blue Grass.
The paddock was harvested for seed. 1200 ewes were grazed for three days after harvest and then it was rested up until lambing.

Vineyard Hill Front was also direct drilled with 75kg of Bulban Oats. This paddock was sprayed in August with 20g/ha Glean and 0.5lts/ha MCPA to control the onion weed and other broad leafed weeds. Due to the continued drought conditions the paddock was heavily stocked and eaten out by end of November.

Year Two:
Russell continued to graze both paddocks in May and June, stocking with around 1100 ewes and lambs for a week in May and again for 3 days in June.
He decided to rest Vineyard Hill Nearside for 2009 to allow some natural recruitment and to Pasture Crop Vineyard Hill Front.
In early June, just after the first rains 4 kg each of Blue Grass and

Pasture Cropping: Bulban oats sown into an annual and perennial grass base

Red Grass and 5 kg each of Weeping Grass, Windmill Grass and Kangaroo Grass were hand broadcast behind the motorbike and then Bulban Oats was sown the next day.

Results:

In the first year Vineyard Hill Nearside showed impressive results in natural recruitment of a variety of native perennial grasses, in particular increases in wallaby grasses.
There was a high percentage of erodium, onion grass and broadleaf such as capeweed in the crop and Russell was concerned that the onion grass was taking Nitrogen out of the soil. The final harvest produced on 0.55 t/ha, which was quite disappointing. Russell had Pasture Cropped another paddock on his property that year and had achieved 1.23 t/ha.

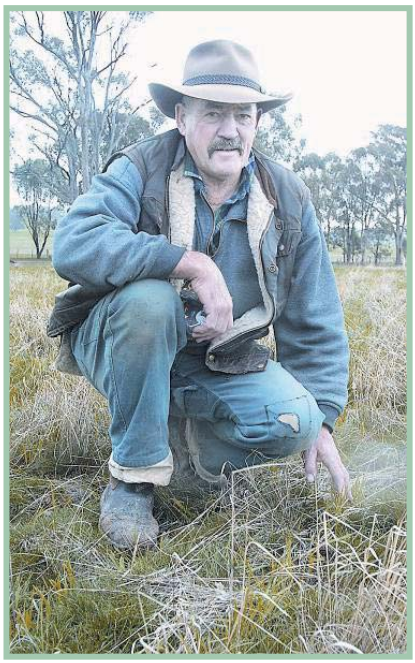

Photo courtesy of Wangaratta Chronicle

In the second year strategic spraying prior to sowing assisted in the control of weeds. Russell expects that Vineyard Hill Front will produce about 0.8 t/ha this year. This is an increase on last year, even though both seasons have been very dry.

Further increase in the wallaby grass plants was noted in the second year. (50% increase from the commencement of the trial). Russell believes that the combination of strategic spraying and the overall increase of plants on the paddocks also saw a 70% reduction in capeweed and erodium. Overall groundcover increased from 60% at the commencement of the trial to 85%.

Vineyard Hill Nearside was noted as one of the best pasture paddocks this year. 140 ewes and lambs were set stocked on the paddock over the lambing period and 360 ewes and lambs from Mid September to Mid November.

The Future

The Ellis family believe strongly in the concepts of Pasture Cropping and plan to continue expanding into other pasture paddocks on the farm.

Strategic spraying will be trialled in some of their paddocks which have had increases in silver grass and barley grass this year, using a chemical which will only inhibit the wallaby grasses and other C3 perennial natives in the paddock.

Stipa grasses have established well in other paddocks which have been Pasture Cropped. Although this is not a problem yet and only exists in small numbers on the trial paddock, the Ellis family will be monitoring this carefully as they do not want a problem of grass seeds in the fleece down the track. In the trial paddock other plants have established and it is hoped that this less desirable perennial will be out-competed. It is also expected that strategic grazing practices will assist this process.

More desirable varieties of wallaby grass which are more palatable than those which have recruited first are also being sought and will be hand broadcast onto the trial paddocks.

Case Study Three

Pasture Cropping to increase long term sustainability.

NAME: Steve & Mardi, Doug & Jan James

PROPERTY:
'Viewbank'
Bungeet, Victoria
1100 ha

AVERAGE RAINFALL: 520 mm
2008: 400 mm
2009 to November. 350 mm

ENTERPRISES:
Prime Lamb
Cropping

TRIAL PADDOCK
Smiths No. 1
26 ha

HISTORY:
This has been a pasture paddock, used for grazing sheep. It was last cropped in 1975. It has had regular application of 100 kg/ha single super for the last 10 years

PASTURE COMPOSITION:
Barley Grass, Rye Grass
Some clover and native corkscrew

Increasing costs in their cropping system were the main drive for this family business to consider new methods of farming. They expect that Pasture Cropping will reduce costs, improve pastures and soils and improve the bottom line.
The James family has been farming on Viewbank for five generations. Doug, Jan and their son Steven made a conscious decision several years ago to stop using insecticides. They wanted to begin working with nature rather than constantly battling with it.

The Problem

The James' were concerned with the escalating fertiliser and chemical costs of their cropping enterprise. They have also noted the changes in seasons over the past few years. Having farming records of their property that go back 140 years, they were able to see that the last four consecutive years have been the toughest. They wanted a system that would be more sustainable and more viable in the longer term, and would provide a more reliable and ongoing feed source for their livestock throughout the year. They knew the first step towards this was to reduce their costs and improve their soil, so they decided to trial Pasture Cropping.
The paddock chosen for the trial had been fertilised regularly with 100 kg/ha single super for the past 10 years and was used as a grazing paddock for ewes and lambs. It had been overstocked, especially over the past few years as a result of the drought.

Method

Year One: 70 kg/ha of Echidna oats was sown in Mid April using a converted John Shearer (knife points and 25 cm spacings). The high content of capeweed and erodium was sprayed with a low dose of Diuron and MCPA in July. This was followed up with a light grazing.
Due to the continuing drought conditions, this paddock was not harvested and about 400 lambs were provided with light grazing on and off from October through to March. Doug and Steve attempted not to overgraze to allow some recruitment of native grasses which were in the paddock.

Smiths No. 1: November 08

Year Two: 5 kg each of Arm Grass Millet, Warrego and Cotton Panic were hand broadcast off the back of a motorbike, and the paddock was dry sown with Triticale in the third week in May. Erodium and capeweed were controlled by a low dose of Spray Seed prior to sowing. 300 ewes were also placed on the paddock six weeks after sowing for a week.

Results

Although the drought conditions in the first year did not assist with recruitment of native grasses, some spear grass, wallaby grass, native clover and windmill grass were noted. The extra feed from the stubble and grasses underneath was a bonus to the lamb enterprise. In the second year the paddock was used for feed prior to sowing. Doug chose to harvest the crop this year. The rain events in November were too late for the crop, however, it is expected that this will favour further recruitment of C4 native grasses and provide good groundcover and feed for the stock over the summer months.

The Future

Since commencing the Pasture Cropping trial on 'Viewbank' the James family have decided to incorporate this system into the enterprise. They are so sure that they are 'on the right track' that they plan to utilize Pasture Cropping in their entire cropping program.

Doug believes that it has been very difficult to really 'test the system' with the lower rainfall figures over the past few years. He has noted some benefits of Pasture Cropping which include:

- Better feed value out of stubbles over the summer when there is usually a shortage
- Having more ground cover over summer to assist in creating healthier soils
- The ability to still be able to grow useful crops without large input costs

Doug and Steve plan to start dry sowing earlier next year (March), to allow quick germination for early sheep feed, better ground cover, better weed competition and the ability to pace themselves and still cover the area required.

Above: Gerhard Grasser & Steve James inspect the soil.
Left: Doug standing in the trial paddock.

Case Study Four

NAME:
Kevin and Pat Mitchell

PROPERTY:
'Muttaburra Sth"
Devenish, Victoria
380 ha
AVERAGE RAINFALL: 525 mm
2008: 340 mm
2009 to November: 247 mm

ENTERPRISES:
Prime Lamb
Cropping

TRIAL PADDOCK
Kangaroo Pad
16 ha

HISTORY:
Cropped in the early 2000s, and sown out to Wimmera Ryegrass and grazed until 2007. Cropped again in 2007 (Oats/Triticale)
Identified as very acidic (CACl2 4.1 in 2001) and yearly application of Lime and Dolomite since that time.
16 ha

PASTURE COMPOSITION:
Wimmera Ryegrass.
Some Clover
Weeds: Capeweed and wild radish

Pasture Cropping as a management tool to improve the whole system

Kevin and Pat have made some major changes on their property over the past few years as they move towards a more biologically healthy farming operation. Pasture Cropping is seen as a versatile low cost system which works well with their Prime Lamb and Cropping enterprise.

The Problem

Kevin and Pat had noticed that the pastures were slipping with the system they had been using in the past. Soils were gradually being mined through the growing of pastures such as Lucerne for hay production and paddocks were being overgrazed, especially during the drier seasons. Also, with the increasing use of herbicides they were seeing an increase in weeds. They made a decision several years ago not to use insecticides at all and to minimize the use of herbicides and were looking for methods which suited this type of farming.

Method

Year One:
300 kg/ha Eco-min was spread in May and the paddock was sprayed with 1.6 l/ha Roundup prior to sowing. (It is not advised to use Roundup as this chemical is extremely harsh on natives.) This paddock however did not have any natives left and therefore a new start was recommended.
18 kg/ha of echidna oats was direct drilled using a combine modified with a 'John's conversion' in August, together with mix of 3 kg/ha Atom Prairie Grass, 1 kg/ha Wallaby Grass and 0.3 kg/ha Plantain.
Local wallaby grass, Red Grass and Kangaroo Grass, 3kg Weeping Grass and 1kg Windmill Grass was also hand broadcast.

The paddock was not grazed after sowing to allow for this pasture cropping mix to seed and establish.

Year Two: 50 kg/ha oats were sown in mid May. Directly after this 5 kg of wallaby grass and 1 kg of Tall Windmill Grass were hand broadcast from a motorbike. These seeds spread well, with the wheels of the motorbike assisting to press them into the ground. With some rain occurring in May and June this year (89 mm), it was decided to lightly graze the paddock a couple of times (400 lambs for 7 days) to keep the pasture down.
5kg Warrego and 2kg Arm Grass Millet were sown at the end of November with sod seeder.

Results:

The modified combine worked well for direct drilling oats into the existing pastures, with very little disturbance of existing plants due to the narrow points and wider spacings.

With the extremely low rainfall in the last year the results were disappointing. The Weeping Grass emerged but did not survive the heat. The Wallaby Grass also struggled. Prairie Grass did well and set useful seed.

The second year saw limited rain events and there was good establishment of Prairie Grass but only a few of the perennial native plants could be found. Kevin and Pat were pleased however with the added benefit of having extra feed to be able to keep their sheep enterprise going during these two quite dry seasons. The potential benefit of extra feed during the wetter summer months is also a bonus. They are hoping this could well occur this year as the November rain (60 mm) may well inspire some seeds into action.

The Future

Despite the paddock not doing well in the first year of the trial, Kevin and Pat are still confident that Pasture Cropping techniques, in particular the diversification of pastures, will assist them to work in the 'right direction.' Consequently they have continued to trial Pasture Cropping on other parts of the property and are pleased with the results. This has included trialling other plants such as Lab Lab and harvesting seed from other Pasture Cropped paddocks for use as stock feed.

Trial Paddock: (Photo K. Mitchell)

The farm layout is well suited to move stock around and rest paddocks more frequently and for longer periods of time. This will assist them to achieve 100% groundcover for 100% of the time and thus enhance their pastures and improve their soils.

Taking penetrometer readings to gain some base figures on the trial paddocks

One of the main differences seen since commencing Pasture Cropping is the different mindset on plants that were once seen as a problem. They believe that the concept of accepting these species as a part of a diverse mixture of plants, and using grazing management principles to encourage the more desirable species is a change in a positive direction.

Kevin and Pat were happy with seeing Ladybirds on their boomspray this year. They are confident that the whole pasture and soil system on their property is improving.

Case Study Five

NAME:
Bob and Marj Falconer

PROPERTY:
'Kalimna'
Meadow Creek, Victoria
200 ha

AVERAGE RAINFALL: 700 mm
2008: 440 mm
2009 to November: 555 mm

ENTERPRISES:
Self-replacing Breeding Herd
Arabian Horse stud

TRIAL PADDOCK
Bore Paddock
2.6 ha

HISTORY:
This paddock was previously used as a fire break for the house nearby. It was grazed heavily for many years. The pasture was degraded and the soil compacted badly

Pasture Cropping for paddock restoration and renovation

Bob and Marj Falconer are making significant environmental improvements on their property in Meadow Creek. They became interested in Pasture Cropping after a workshop in Benalla and decided to trial this method on their 'bore paddock' which had been severely degraded during years of drought and continuous grazing. They have been so pleased with the results that they have adopted Pasture Cropping methods on many other paddocks on their property.

The Problem

The major concern in this paddock was the large percentage of bare ground and the dominance of capeweed following the autumn break. Other opportunistic species included sorrel, couch and pigeon grass. With the soil being so compacted from heavy grazing over many years, even the capeweed was stunted in growth.
Clover, phalaris and perennial rye had been sown in 1999 and a few struggling plants still persisted in spring. The only native perennials were a few wallaby grass clumps.

Method

First year - Due to the heavy compaction Bob and Marj felt that the first step was to aerate the soil. Aeration was done on the contour. The areas between the riplines provided a handy comparison during the trial. Cattle were used to trample the soil clods after aeration. Using a 'Connor Shea' Seeder, 40 kg/ha Saia Oats, inoculated with Nutrisol and Seasol, were sown into the roughly broken-up paddock in March 2008.

Second Year -The paddock was dry sown in March 2009 with 40 kg/ha of inoculated Triticale. Warrego Grass (9kg) and Arm Grass Millet (4kg) were placed in the seedbox and successfully sown with the Tritacale. A small amount of Weeping Grass (2 kg) Silky Blue Grass (1.9 kg) and Cotton Panic (2 kg) was hand broadcast to increase the native grasses in this paddock.

Pasture Cropping into a degraded paddock
Photo: M. Falconer

Results:

Four good grazings were achieved off the paddock in 2008. In a year when the area was affected by severe drought conditions, and feed was scarce, this was invaluable. By the second grazing in August

2008 the Falconers noticed that the capeweed was showing signs of stress from the competition from the crop. This may possibly be due to the oats using up the available nitrogen, as well as the effects of shading on the plants. Even though the crop would have yielded well, they chose to use this as a grazing crop for their cattle and took the opportunity to trample a substantial amount of plant matter into the paddock during the last graze in December '08.

A heavy infestation of red-legged earthmite was noticed in September 08 in the areas of heavy capeweed (creek bed and laneway) and about 0.5m into the oat crop. It appeared as though the greater biodiversity further into the crop provided a buffer and the earthmite attack was inconsequential.

Bob and Marj were also interested to see the difference in the growth of plants in the rip-lines in the first year. The Saia was certainly growing much better in the aerated strips with greatly superior root development. The cattle also appeared to have a preference for these sections of feed.

In the second year the triticale started well. By about mid June other plants also came away, resulting in a very handy pasture mix which also included annual rye, perennial rye, phalaris, clovers, self-sown saia oats, some brome and only small amounts of capeweed and silvergrass. Bob and Marj feel that the combination of a better season and the substantial improvement in the fertility of the paddock as a result of the Pasture Cropping trial of 2008 contributed to this result.

Oats outcompeting capeweed
Photo M. Falconer

The paddock provided three good grazings by October 2009 and had a substantial amount of biomass for another feed and plenty to trample for cover over summer.
There was a notable decrease in the percentage of capeweed in the second year, (95 % to10 %), with most prevalent areas being in the creek bed and laneway areas that had not been Pasture Cropped. Neighbouring paddocks which were not Pasture Cropped still had high percentages of capeweed.

Bob and Marj believe the most striking result of this Pasture Cropping experiment over two seasons was the way the cereal plants encouraged the growth of the other desirable plants in the paddock at the same time as producing a very handy oat crop in 2008.

A very pleasing outcome was the increase in the percentage of perennials – at this stage phalaris is about 15% of the pasture, up from about 1% in 2008. Bob and Marj hope that more summer active native perennials will become evident during this summer.

The Future

- Oats seem to offer greater potential when beginning pasture cropping.
- As fertility improves Triticale, Barley and Cereal Rye will be trialled.
- Emphasis in the future will be to manage grazing to promote C4 grasses.
- Grazing of the cereals will be monitored and adjusted, possibly with longer and more strategic grazing.
- Seed /soil contact is another area to be improved.
- Research the pre-requisite of soil disturbance for native perennial seed strike needs
- Aeration depth is still being adjusted – maybe as deep as 700 mm from 300 mm at present.

Case Study Six

Pasture Cropping to improve pasture composition and dry matter production

Alan Wood, a cattle farmer from Markwood, has not used Roundup on his property for several years. He plans to use Pasture Cropping and No-Kill techniques to grow organic crops in the future.

NAME:
Alan Wood

PROPERTY:
"Phil Greens" Markwood

AVERAGE RAINFALL: 611 mm
2008: 440 mm
2009 to November 555 mm
ENTERPRISES: Cattle

TRIAL PADDOCK
Paddock 'No 1'
4 ha

HISTORY:
This paddock was disc ploughed since the 1970's It has been predominantly a hay and grazing paddock. It was aerwayed twice in 2005.
It had an application of lime in 2007 at 1t/ha. Round up has not been used in this paddock for many years.
PASTURE COMPOSITION:
Phalaris, ryegrass, clover
Native clovers
Capeweed, onion grass

The Problem

Alan has noted increased weed invasion in his paddocks, with the main weeds being barley and thistles. He does not wish to use chemicals to control these problems. Pasture Cropping appeared to be a good way of improving the pasture composition of his paddocks without sacrificing production.

Method

Year One: Alan sowed 45 kg/ha of fodder oats with 65 kg/ha Nutrismart and 30% MAP using a John Deere disc drill in late May.
The paddock was grazed fairly hard until September.
50 heifers grazed the paddock each second week from November through until April.

Fodder oats cropped into Phalaris, ryegrass and clovers.

Year Two: Alan wished to plant weeping grass into Paddock 'no1', however prior to sowing there was a high percentage of rye and phalaris and it was thought that the competition may be too great to establish this native grass. Consequently Alan chose to sow into a nearby paddock and rest 'no 1' for 2009. 10 kg of weeping grass was sown into this paddock in May using a converted vegetable seeder. Gramoxone was applied prior to sowing to attempt to control the capeweed.

To provide the best opportunity for establishment a compost tea was applied after the first rain in May and it was decided also not to sow a crop this year.

Results:

Alan was happy with volunteer recruitment of couch and wallaby grass he noted emerging through the heavy clover mat during the summer months during the first year of the trial. He believes that the symbiotic relationship of the crop and the native species has assisted in this process.
This paddock was grazed very lightly in the second year to give further opportunity for recruitment. The resulting heavy crop of ryegrass and phalaris was grazed heavily to have a trampling effect and assist in providing good groundcover throughout the year. Plans are to Pasture Crop this paddock in 2010.

Use of the vegetable seeder was the best way Alan could see to sow the Weeping Grass in the second year. It did however provide quite a lot of disturbance to the paddock.

In the second year of the trial an early infestation of red-legged earth mite reduced the plant population of the emerging Weeping Grass. Alan is confident however that there are enough seedlings for improved production next year, when he plans to Pasture Crop this paddock.

The Future

Alan has also chosen several other paddocks on his property to implement Pasture Cropping principles. He has chosen some of his worst paddocks in the hope of controlling weeds such as onion grass, silver grass, capeweed and barley grass. He plans to use a no-kill approach in the future management of his property and sees the Pasture Cropping will work well in this scenario.

Several paddocks are now being pasture cropped on this property

Alan still sees the high growth rates of plants such as annual rye grass may be a problem for grain production, and hopes to explore ways of overcoming
this in his future trials.

With future expectations of more variable rainfall and rises in temperature Alan plans to Pasture Crop with compost tea injection.

Alan believes these concepts will retain native grasses and allow grain to be produced in Southern areas, provided that the sowing occurs early and the fungi:bacteria ratio is equal. He also believes that these techniques will be beneficial in the growth of humus and consequent holding of rainfall in the root zone.

Farm Walk

A farm walk was held to the properties of Doug James and Russell Ellis in February 2009. Farmers came together from across the district to discuss the methods of pasture cropping, equipment used by these farmers and to begin to develop skills in identifying a range of local native perennial grasses such as Red Grass, Wallaby Grass, Windmill Grass and other C4 (summer active) grasses found on the trial properties at Bungeet and Chesney Vale.

An International combine converted to narrow points and 30cm spacing for minimal disturbance

Participants were shown the International combine which has been converted for Pasture Cropping using a 'Johns' undercarriage.

There is minimal damage to the native pastures using this machine which has 6 mm points and 30 cm spacings. The little bit of disturbance that is created assists with recruitment of the natives already in the paddock.

The farm walks provide participants opportunity to view the trial sites and discuss the first hand experiences of the farmers who are trialling Pasture Cropping.

Farm Walk Discussions – a valuable learning tool

Newsletters

Four newsletters were produced by the Pasture Cropping Project Officer during 2009 and sent out to past course and field day participants, local Landcare groups and any other interested people to keep them informed on Pasture Cropping techniques, the case studies and future events. (See appendix 1.) Information was also provided on various sites on the internet.

Soil Tests

We expect that a further advantage of using Pasture Cropping techniques will be an increase in soil carbon levels. The increased biomass from having ground cover 100% of the time, and the use of perennial native pastures contribute to increased soil carbon levels.
This project aims to monitor these levels as well as soil nutrients. Samples were taken from each trial paddock in January and November 2009. An independent analysis laboratory was used to provide a total fertility and total carbon result for these samples. Even though no trends can be obtained in such a short period of time, these results will provide base figures for future monitoring. Soil test results are shown in Appendix 2.

Soil Testing on a Trial Site to monitor Carbon levels and other soil nutrient levels

Sampling for Soil Food Web analysis and penetrometer readings obtained on trial sites.

It was decided to also complete a Soil Food Web Analysis on each trial site so that we have some early data on the base levels of the health of the soil. These samples were taken in August. They give detail on bacterial and fungal activity, protozoa and nematode numbers and also Mycorrhizal colonization. These are beneficial micro-organisms which provide a range of important services that promote plant growth and vigour.

Consultant, Gerhard Grasser visited each property in August to assist farmers to take the samples for these tests. Penetrometer readings and visual analysis of the soil was also carried out.

Gerhard recommended a set of actions for each property that usually included in sequence: aeration, soil preparation techniques for crop sowing or pasture reseeding (where applicable), application of nutrients and/or biologicals in a timely way to coincide with predictable rainfall based on a normal growing season and grazing management. Gerhard emphasised the need to closely scrutinise grazing or cropping management so it can support efforts to rebuild the soil without greatly compromising the farm's production capacity.

Visual observations of root growth and soil structure

Pasture Cropping Courses

Two day Pasture Cropping courses in Warrenbayne and Thoona

Two Pasture Cropping courses have been provided by the Advanced Pasture Cropping and No Kill Cropping Company. The first course was held in Warrenbayne in December 2008 and the second was held in Thoona in April 09.

Topics covered in the course included:

· Pasture cropping principles
· No kill cropping (Advance sowing) principles
· Economic Analysis
· Cutting pasture establishment costs
· Improving grassland and soil health
· Grazing management and techniques
· Best management of native grasslands
· Farm planning for perennial profit
· Holistic integration of grazing/cropping and natural resources.

Presentation by Colin Seis and Bruce Maynard at the Pasture Cropping Course in Thoona

"A wonderful session explained competently and credibly by presenters who have runs on the board"

"A very helpful course"

"Every farmer should do this course"

"Very good and very helpful"

"Presentation was easily understood and extremely informative"

Twenty six participants attended these courses in total. Twenty three of the twenty four participants who completed the participant survey found the course to be 'very helpful' on the five point scale from 'very helpful' to 'poor'. One participant scored the course to be 'helpful'.
88% of the participants planned to implement aspects of the course on their property.

All comments provided by the participants were very positive and 67% expressed a desire to learn more about Pasture Cropping techniques.

Colin Seis, a presenter at each course, used the Bureau of Meteorology statistics to emphasize the distribution of rainfall in this area. This graph above shows mean rainfall for the 124 yr period from 1882 to 2006 in Benalla.

Benalla receives 40% of its rainfall during the 6 months from October – March. Many native perennials in this area (C4 varieties) are active during these months. Colin emphasized that by having active plants at all times of the year, especially during these summer months, all rainfall events are being utilized.

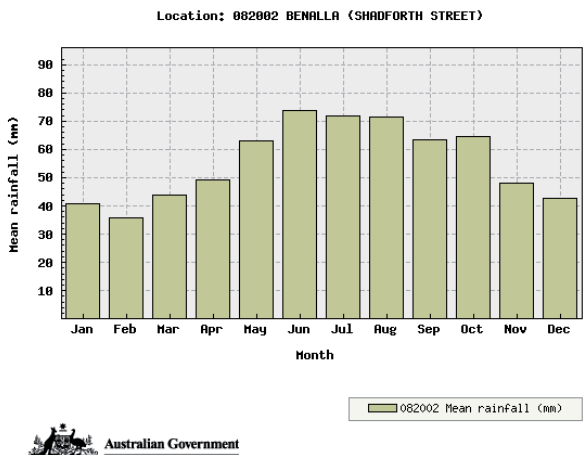

Figure 3: Bureau of Meteorology 124 year mean rainfall: Benalla

Colin Seis, Bruce Maynard and Russell Ellis on farm discussion at the Pasture Cropping Course in Thoona

Opportunity was also provided to visit two of the trial paddocks in the region. Participants learnt more about how to identify many native perennial grasses growing in the region and ask questions of both the presenters and trial participants present on some of the more practical aspects of Pasture Cropping.

Discussion Forum

A discussion forum was held at the Benalla Golf Club in April for thirteen participants, including those involved in the trial and committee members. This was an excellent opportunity to share results to date and plans for the future. Colin Seis kindly offered to participate in this forum, and participants were grateful of the opportunity to ask questions which were particularly relevant to Pasture Cropping in their farming enterprise.

Those attending found the evening to be very informative. Participants suggested that more of this type of informal forum would be beneficial to others in the area who had commenced or were about to commence Pasture Cropping on their properties.

Photo: K Mitchell

Bus Trip

Participants of the Pasture Cropping trial were provided with funding to purchase native seeds for the trial sites. A bus trip was organised to Ko-Warra Native Grasses in Mitiamo, near Echuca to learn more about native grass seeds which would be suitable for these sites. An invitation was also extended to those who had participated in previous Pasture Cropping Courses.

12 people boarded the bus in Benalla on the morning of April 2nd, and arrived at Ko-Warra Native Grasses in time for the morning tea, provided by the owner, Tim Barden. Tim had a display of photos and information for participants to peruse and gave tour of the site.

Tim showed us his seeder and harvester, both purpose built for his business. The seeder was adapted from a second hand vegetable seeder, and has different apertures for the different sized seeds which allow most native seeds can flow through.

Seeder used by Tim Barden at Ko-Warra.

One of the difficulties of sowing the native pasture seeds are their appendages. Australian native grass seeds have not been modified by years of selective breeding and usually come wrapped in awns or fluffy appendages. These appendages help to disperse the seed, and to bury the seed in the ground. They also assist in holding moisture around the seeds which aids germination. Unfortunately however they do not flow through conventional equipment easily.

One option for solving this problem is to coat the seeds. Pelletised seed flows more readily. It also has the potential advantage of inclusion of fungicides, insecticides or even specific plant nutrients into the pelletising material. The pelletising process does add considerable weight to the seed and therefore sowing rates need to be increased. According to Tim the weight of the seed can increase 3 fold or even more, depending on the processor.

Tim took participants to his production area to view sites of Weeping Grass - *Microlaena stipoides*, Silky Blue Grass - *Dichanthium sericeum,* Kangaroo Grass -*Themeda triandra* and Red Grass- *Bothriochloa macra.* There was much interest in the newly established site Weeping Grass developed in this area –*Lig.183 (pictured left)*

Tim was able to give some good advice on how to identify different species. Tim answered a field of questions relating to preferred soil and fertility conditions for different grasses, strategic timing of chemical application and grazing management practices to enhance establishment.

Field Day: "Soil Health and Monitoring Pastures"

A very successful and informative field day was held in February 2009 which explored a variety of topics on soil health and pasture management. These included:

- The chemical, physical and biological aspects of soil
- How to work with and support soil biology
- The value of Pasture Cropping to soil health and building soil carbon
- Soil structure, texture, compaction and water retention
- Managing animals to achieve grassland regeneration and performance
- Creating effective ecosystem function
- Grass plant physiology
- Need for biological decay
- Monitoring and corrective action.

Presenters for the day were Sonia Lee, who has researched and delivered training in regenerative soil management for many years, and Graeme Hand, the chairman of STIPA, who has extensive knowledge on grazing management of native pastures.

"Soil Health and Monitoring Pastures" Field Day

The twenty four participants of this field day commented favourably on many aspects of the course, particularly the presentation provided by Graeme Hand on Holistic Management.

Most useful parts of the program, as noted on the returned questionnaires included the discussion on creating ground cover/litter and also explanations on plant succession.

Participants had the opportunity to have a close look at several soil samples collected from trial paddocks. Signs of healthy soil were discussed such as the smell of a healthy soil and soil texture and aggregation .

Taking a closer look at Soil Health

Field Day: "Improving Biodiversity and Monitoring Soils"

Colin Seis, a pioneer of Pasture Cropping and Dr Christine Jones, well known for her work on soils and pasture management and a world leader in the field of soil carbon, were the keynote presenters of this very successful field day, which was held over 2 days in November 2009.

The 65 participants were from both local and nearby areas, and some also travelled several hours.
There were also many further enquiries from people throughout Victoria who were not able to attend, but wished to attend any future seminars on Pasture Cropping.

Dr Christine Jones and Colin Seis: Keynote speakers

Colin and Christine provided extremely informative sessions on topics including:

- Building soil carbon for all the right reasons
- Pasture Cropping and grazing management
- The importance of groundcover and biodiversity
- Farming practices that influence soil carbon dynamics
- Increasing the long term sustainability of your farm
- Rejuvenating pastures and the economics of re-sowing
- Better utilizing rainfall to increase profits
- Benefits of perennial pastures and native grasses
- Low inputs for better profits
- Efficient use of fertilizers
- The importance of Soil biology.

This was followed by a presentation by each of the trial participants on their personal experience of the success of Pasture Cropping, both on their trial paddocks and also in other paddocks on their properties. Participants had the opportunity to visit two of these trial sites.

Each participant also received a Pasture Cropping kit bag which included information on Pasture cropping and native perennials in this area, sample seed bags of some native perennial grasses and other useful information.

Visiting Russell Ellis' trial paddock.

Native Grasses in the North-East Region

Native perennial grasses have many benefits in Pasture Cropping systems. These grasses have withstood the test of time, having the ability to flourish in years with good rainfall and persisting during low rainfall and drought events.

Native grasses enhance the diversity of grasses and improve groundcover throughout the year. The use of native C4 species increases production over summer, thus utilizing the rainfall events throughout the year. The increased mulch layer resulting from achieving 100% groundcover throughout the year assists in water efficiency. Runoff is limited, allowing the rain to soak and be used by these deep-rooted plants. The mulch layer also assists in the suppression of weeds, and protects the soil against erosion by water and wind. It allows for a healthy biological environment that supports micro-organisms and the establishment of more desirable plants.

Many native perennial grasses are more drought tolerant than introduced species, and are more persistent due to adaptability to varying soil types. With correct management many native grasses can be highly productive.

Some of the common native grasses found in the North-East Region of Victoria include:

Common Wheat Grass: *Elymus scaber*
Kangaroo Grass: *Themeda triandra*
Red Grass: *Bothriochloa macra*
Spear Grass: *Austrostipa scapra*
Tussock Grass: *Poa labillardierei*
Wallaby Grass: *Austrodanthonia spp.*
Weeping Grass*: Microlaena stipoides*
Windmill Grass: *Chloris truncata*

Other species being trialled include:
Hairy Panic: *Panicum effusum*
Warrego Summer Grass: *Paspalidium jubiflorim*
Curly Windmill Grass: *Enteropogon acicularis*
Prairie Grass: *Bromus catharticus*
Arm Grass Millet: *Urochloa pubigera*
Lab Lab: *Lablab purpureus*

A crop sown into native grasses in the Pasture Cropping Trial

Conclusions

The establishment of six trial sites across two management catchments has been an excellent commencement to Pasture Cropping comparisons for this area. These sites represent a range of different soils and conditions and, in particular, different rainfall to trials that have occurred in other areas in Australia. Summer rainfall for example is not as prevalent in Victoria and therefore the question arises, "Is Pasture Cropping suited to our conditions?"

At this early stage, it definitely appears that Pasture Cropping is suitable to the needs of many producers in this area. All six producers who have provided trial paddocks are excited about many of the benefits they are seeing and hearing about Pasture Cropping, and are continuing to develop this technique on their properties. The uptake from other producers who have come to field days, and then trialled Pasture Cropping on their farms is also significant. At the most recent field day, on a show of hands approximately 40% were already Pasture Cropping and approximately 50% plan to Pasture Crop in the future. A further 10% were learning about Pasture Cropping for the first time.

Native plants:

Methods of sowing native grasses have been trialled by the producers in this project. Native seeds were hand broadcast by walking, riding a motorbike over the paddock or from the back of a tractor. Although these methods are effective for small trial paddocks, this would not be practical for broadacre sowing.
Producers also trialled mixing seed into the seed box whilst sowing the crop, and trialled using a converted vegetable seeder.

Bus trip to local trial paddocks
Photos: Sonya Dicker

These methods suited the smaller, coated seeds to some degree, but were not successful for those seeds with awns, as these seeds did not flow through the machinery. The vegetable seeder also tended to create heavy disturbance to the grasses already in the paddock.

The lower than average rainfall that has occurred over the trial period severely hampered the establishment of native perennial grasses particularly in the first year. It was not possible therefore to come to any conclusion about the effectiveness of different sowing methods. Where these grasses have already existed however, the Pasture Cropping methods have shown an increase in numbers over the trial period. These results have been variable, but most significant in case study two where there was up to a 50% increase in the natural recruitment of some perennial native grasses.

Natural recruitment appears to be the best option for establishment of perennial native grasses where they already exist, and when sowing seeds, producers in the trial have become more aware of how to assist this recruitment, using methods such as sowing on the side of the paddock which allows for maximum wind distribution, placing animals in the paddock after sowing to achieve better seed to soil contact and using grazing management practices which allow for maximum yield of desirable seeds.

Even though rainfall occurs predominantly in winter in Victoria, statistics show that up to 40% of rainfall falls between October and March (as shown in figure 3, pg 22). November 2009 saw some useful rainfall across the region. This has highlighted the advantages of Pasture Cropping techniques to producers in this region as it enables them to take advantage of these events. The C4 grasses present at this time ensure that this rain does not fall on bare ground and is therefore not wasted due to runoff or evaporation.

Although this project has concluded, producers are planning to continue to monitor their paddocks, and as a result of the recent rainfall are expecting better results in the establishment of native perennial grasses over the summer months of 2009 - 2010. Further investigation into identification of suitable sowing methods and also which C4 grasses work best in the different areas needs to be completed. Some producers also wish to investigate the benefits of maintaining and establishing more C3 plants, and how this will effect crop yields and pasture availability.

Photo:K Mitchell

Crops:

The sowing of crops into existing pastures in the trial paddocks used both traditional and converted machinery. Although the conventional machinery was adequate, the converted combines were far more desirable as there was minimal disturbance of soil and existing native plants using the narrow points and wider spacings.

Oats was the preferred cereal sown into the pastures. With the lower rainfalls occurring during the trial, it is difficult to come to any conclusion to the benefits of the different varieties.

It was noted by one producer that one criterion in the choice of variety will be its ability to emerge early after dry sowing, so as to assist weed control. Varieties that can be used as forage if the season is dry, but will also yield reasonably well if feed is not required for stock, is also a consideration.

Grazing Management:

Grazing management is seen as an imperative part of the Pasture Cropping program. All trial participants used stock to graze the paddocks for varying lengths of time and for a variety of different reasons.

The feed value for stock of pastures and stubble throughout the year was an obvious advantage noted by producers.

Extra feed was trampled by stock to create extra groundcover, particularly of the summer months by several producers.
Stock were used also use to assist in seed to soil contact when sowing natives.

Good grazing management practices assist the overall benefits of the Pasture Cropping program

Grazing the pasture prior to sowing prevents shading of the emerging crops. It also helps in created mulch to assist in weed control.

Intense grazing, followed by longer periods of recovery after grazing was seen as an important management tool to improve the persistence and production of native perennials, and intense grazing at appropriate times to reduce weeds was also identified.

Several participants plan to monitor their grazing management practices more closely to gain a deeper understanding of its effect on the condition of their pastures and to determine if their management is increasing perenniality in their pastures.

Participation:

As noted elsewhere in this report, there has been strong participation and interest in the Pasture Cropping trials, and the introductory courses and other activities of this project. We expect that interest will continue to grow. To date, the main interest has come from farm businesses that have a livestock grazing aspect. Low grain prices and high sheep prices are causing a shift back towards mixed enterprises and this provides an opportunity to engage with a large number of businesses that have been solely focussed on grain production. Additional robust evidence regarding the possibilities for soil carbon sequestration and the implementation of a cap-and-trade system for managing carbon emissions will provide further momentum for a very large cross-section of the farming community to consider the possibilities of Pasture Cropping.

Glossary

Advanced Sowing: Dry sowing of crops without killing the existing plants

Annual Plant: A grass that germinates, grows and then dies within one year

Awns: A hair or bristle-like appendage attached to the seed

C3 grasses: A grass that utilizes the C3 photosynthetic pathway for carbon fixation. These grasses generally have an active period of growth in the winter months. Examples of C3 grasses are Wallaby grass and Weeping grass

C4 grasses: A grass that utilizes the C4 photosynthetic pathway for carbon fixation. These grasses generally have an active period of growth in the summer months. Examples of C4 grasses are Kangaroo grass and Red grass

Grazing Management: Process of managing the frequency and intensity of grazing livestock to make the best use of the pastures grown and also to ensure groundcover and persistence of desirable species

Ground Cover: Area of ground covered by actively growing plants or dead material

Pasture Cropping: Zero till sowing of crops into existing perennial grasses

Perennial grasses: A grass that is capable of surviving more than two years

Rotational Grazing: Grazing stock on smaller sized paddocks so that the pasture is grazed quickly and stock removed to allow a period of rest

Stipa: Common variety of grass now called Austrostipa. Speargrass is the common name of this genus

Time Control Grazing: Grazing rotations based on the period of plant recovery

Photo: R Ellis

Appendix 1: Useful Resources

Websites:

Advanced Pasture Cropping Company:	*www.pasturecropping.com*
Amazing Carbon!:	*www.amazingcarbon.com*
EverGraze:	*www.evergraze.com.au*
Flora Victoria:	*www.floravictoria.com.au*
Goulburn Broken Indigenous Seedbank:	*www.dookie.unimelb.edu.au/research/seedbank.html*
Goulburn Broken Catchment Management Authority:	*www.gbcma.vic.gov.au*
KoWarra Native Grasses	*www.nativegrasses.com.au*
Native Seeds:	*www.nativeseed.com*
Stipa:	*www.stipa.com.au*

Books:

Cluff, D. (2003) Farming Without Farming. 63 pp. Stipa Native Grasses Association Inc..

Cunningham, G.L., Mulham, W.E., Milthorpe, P.L. and Leigh, J.H. (1981). Plants of Western New South Wales. NSW Soil Conservation Service, Sydney. ISBN 0 409 30687 8

Eddy, D., Mallinson, D., Rehwinkel, R. and Sharp, S. (1998) Grassland Flora: A field guide for the Southern Tablelands (NSW and ACT). Environment ACT, Canberra.

Gibbs, J. and Gibbs, R. (2005). Grass Identification Manual – for Everyone. Native Grass Resources Group Inc. – South Australia.

Lamp, C.A., Forbes, S.J. and Cade, J.W. (1990). Grasses of Temperate Australia. Inkata Press, Melbourne and Sydney.

Lunt, I., Barlow, T. and Ross, J. (1998) Plains Wandering: Exploring the grassy plains of south-eastern Australia. Victorian National Parks Association and the Trust for Nature (Victoria).

Marriott, N and J. (1998). Grassland Plants of Southern-Eastern Australia. Bloomings Books, Melbourne.

Mitchell, M. (1996) Native Grasses: Identification Handbook for Temperate Australia Agmedia, Melbourne

Scarlett, N.H., Wallbrink, S.J. and McDougall, K.(1992) Field Guide to Victoria's Native Grasslands. Victoria Press, Melbourne.

Waters, C, Whalley, W. and Huxtable, C. (2000) Grassed Up: Guidelines for revegetating with Australian Native Grasses. NSW Agriculture, Dubbo.

Appendix 2: Soil Test Results

Client:	GECKO ClaN Pasture Cropping Trials - FIRST ASSESSMENT	**Sample :**	FS 92975 / 6
		Received:	17 Dec 2008
		Despatch:	08 Jan 2009
		Submitted:	Irene Ham Charlie
		Email:	Sexton

ANALYSIS		UNITS	Laboratory Identification:	FS 92975 - 92980				
			R 1 DORE	VINEYARD HILL NEARSIDE ELLIS	BORE FALCONER	SMITH'S No 1 JAMES	KANGAROO MITCHELL	No 1 WOOD
Phosphorus	(Olsen)	mg/kg	13.2	12.6	9.0	19.8	27.3	10.6
Phosphorus	(Colwell)	mg/kg	36.0	32.0	22.0	39.0	64.0	22.0
Potassium	(Colwell)	mg/kg	178.0	205.0	339.0	254.0	294.0	173.0
Sulphur	(KCL40)	mg/kg	14.5	6.8	7.6	7.8	4.9	7.8
pH	(1:5 water)		6.3	5.1	5.3	5.2	5.9	5.2
pH	(CaCl2)		5.6	4.2	4.6	4.3	5.0	4.4
Salinity (EC)	(1:5 water)	dS/m	0.06	0.07	0.10	0.11	0.04	0.08
Soil Texture			Clay loam	Clay loam	Clay loam	Loam	Loam	Clay loam
Organic Carbon		%	2.74	2.12	2.69	2.33	1.69	2.93
Total Carbon		%	3.88	2.96	3.29	2.93	2.35	3.93
Nitrate		mg/kg	14.0	32.0	38.0	44.0	7.0	28.0
Ammonium		mg/kg	5.0	4.0	7.0	3.0	2.0	3.0
Calcium	(Exch)	meq/100 g	8.03	2.97	2.99	3.47	3.30	2.83
Magnesium	(Exch)	meq/100 g	1.93	1.79	0.64	0.64	0.79	0.58
Sodium	(Exch)	meq/100 g	0.29	0.42	0.13	0.07	0.04	0.17
Potassium	(Exch)	meq/100 g	0.39	0.44	0.75	0.57	0.67	0.39
Aluminium	(Exch)	meq/100 g	< 0.01	0.84	0.45	0.35	0.04	0.55
Calculations								
Sum of cations	(CEC)	meq/100 g	10.64	6.46	4.96	5.10	4.84	4.52
Calcium/Magnesium ratio			4.2	1.7	4.7	5.4	4.2	4.9
Sodium % of cations	(ESP)		2.7%	6.5%	2.6%	1.4%	0.8%	3.8%
Aluminium % of cations			< 0.1%	13.0%	9.1%	6.9%	0.8%	12.2%

Client:	GECKO CLaN Pasture Cropping Trials - SECOND ASSESSMENT	**Sample :**	FS 102479 / 3
		Received:	27 Nov 2009
		Despatch:	08 Dec 2009
		Submitted :	Irene Ham
		Email:	Charlie Sexton

ANALYSIS		UNITS	Laboratory Identification:			FS 102479 - 102481		
			R 1 DORE	VINEYARD HILL NEARSIDE ELLIS	BOB & MARJ FALCONER BORE	JAMES SMITHS No 1	KANGAROO MITCHELL	ALAN WOOD No 1
Phosphorus	(Olsen)	mg/kg	14.2	13.1	8.8	20.5	27.9	10.6
Phosphorus	(Colwell)	mg/kg	41.0	30.0	21.0	48.0	66.0	26.0
Potassium	(Colwell)	mg/kg	188.0	203.0	347.0	293.0	348.0	181.0
Sulphur	(KCL40)	mg/kg	11.6	8.9	8.2	8.4	9.1	9.1
pH	(1:5 water)		6.3	5.0	5.6	5.2	6.0	5.2
pH	(CaCl2)		5.4	4.2	4.6	4.5	5.3	4.5
Salinity (EC)	(1:5 water)	dS/m	0.11	0.07	0.06	0.09	0.12	0.10
Soil Texture			Clay loam	Clay loam	Clay loam	Loam	Clay loam	Clay loam
Organic Carbon		%	2.75	2.26	2.53	2.64	2.01	2.87
Total Carbon		%	3.81	2.89	3.22	3.19	2.29	3.88
Nitrate		mg/kg	13.0	12.0	7.0	21.0	13.0	4.0
Ammonium		mg/kg	4.0	15.0	6.0	4.0	2.0	6.0
Calcium	(Exch)	meq/100 g	8.20	2.36	3.34	4.53	4.02	2.62
Magnesium	(Exch)	meq/100 g	2.13	0.94	0.64	0.79	1.14	0.61
Sodium	(Exch)	meq/100 g	0.46	0.27	0.13	0.09	0.36	0.34
Potassium	(Exch)	meq/100 g	0.45	0.44	0.85	0.70	0.84	0.44
Aluminium	(Exch)	meq/100 g	0.02	0.64	0.28	0.34	0.04	0.58
Calculations								
Sum of cations	(CEC)	meq/100 g	11.26	4.65	5.24	6.45	6.40	4.59
Calcium/Magnesium ratio			3.8	2.5	5.2	5.7	3.5	4.3
Sodium % of cations	(ESP)		4.1%	5.8%	2.5%	1.4%	5.6%	7.4%
Aluminium % of cations			0.2%	13.8%	5.3%	5.3%	0.6%	12.6%

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