Six Seasons of the Farming System Trial in the Southern Mallee

Summary

A farming systems site was established in the year 2000. Four farming systems are compared:

1. 'Fuel Burner' (a conventional farming system, growing primarily cereal crops on fallow);
2. 'Hungry Sheep' (intensive farming system where every millimetre of rainfall is either used for livestock or crop production);
3. 'Reduced Till' (an opportunistic cropping program focused on continuous cropping utilising reduced tillage practices); and
4. 'No Till' (a full stubble retention minimum disturbance sowing operation with narrow points utilising mainly cereals in the rotation).

After six seasons the main results are as follows:

- The six seasons have been one of the driest periods on record, only one year had average growing season rainfall (2000), the other five years had below average rainfall – two of these were drought years (2002 and 2004)
- The soil type at the site, a Mallee clay loam (calcarasol), has severe subsoil limitations to root growth,which resulted in canola and pulse crops failing to produce during the dry seasons.
- Over the duration of the project there has been no change in weed populations as measured either by assessment of the soil seed bank or in-crop monitoring after spraying. The only exception is that brome grass is now recorded at the site at very low levels whereas in the year 2000 it was not present.
- Disease levels as assessed in-crop at flowering have been low. Soil DNA tests for disease have shown varying levels of disease presence. CCN has not been present at the site; Take-all is present in particular plots which are all adjacent and has not changed over time regardless of the farming system or the rotation in place; Pratylenchus neglectus levels are generally moderate to high but are also specific to particular plots which tend to be clustered – the only exception is that whenever field peas have been grown the levels of Pratylenchus decreased in the following year; Rhizoctonia has been present in some plots at high levels but has never been observed to a damaging extent in the field.
- Wind erosion susceptibility risk is very low in the No Till plots, and is moderate in some of the Reduced Till, Fuel Burner and Hungry Sheep plots.
- Soil water levels varied between years but the measuring techniques were not accurate enough, due to the crab hole nature of the paddock, to pick up differences between farming systems. In 2002 and 2004, all plots in crop the previous season, had soil water levels at the Crop Lower Limit (wilting point). Fallow plots in these years contained 20 to 25mm of available water, resulting in some crop growth, albeit with low yields, during these two drought years. In seasons with summer rainfall there was little or no difference in soil water between plots in crop or fallow the previous year, however the fallow plots still yielded more (0.2 to 0.4t/ha) after these wet summers.

- Soil available nitrogen (nitrate) levels were extremely variable and were not related to farming system or rotation. In general the levels were high due to the long term medic history of the paddock. After wet summers the levels were generally higher than after the droughts.
- Livestock performance has been variable due to the late start of some seasons and in drought years the Hungry Sheep system had to outlay significant costs in feeding sheep. However, in the better years this system has had a healthy return from livestock (on average $34/ha over the six years).
- Crop yields have been variable between the different seasons primarily because of the very different growing season rainfalls experienced over the six years. At the start of the trial the No Till system grew a high percentage of canola and pulse crops, which all failed to perform. Since 2004, the No Till system has only been growing cereals in rotation with some chemical fallow and is now performing much better. The most stable system for crop yield has been the Fuel Burner system.
- Financial performance has been poor for the No Till system over the first few years of the project due to crop choice with canola and pulse crops. Since 2004 the No Till system has performed better by growing only cereals in rotation with chemical fallow. The Hungry Sheep, Fuel Burner and Reduced Till systems all had a six year average gross margin of $82 to 85/ha, with $37/ha for the No Till long term gross margin.

Background

The most commonly asked question by farmer members of the BCG is: ‘what farming system is the most viable and sustainable in our area?’

Unfortunately, there is no easy answer because the choice of farming system is based on many factors which directly relate to the farmer as a manager and also to the physical environment where the farm is located.

The farmer will choose a farming system based on aspects of his/her life such as the complexity of a system; how their friends and peers are farming; their attitude to farming and life in general; and it can come down to something as basic as whether they like working with sheep or not. People’s reactions to major events such as droughts are highly variable and are often related to the financial buffers in place for the farming enterprise. All these aspects influence people’s decisions and one particular farming system may suit one farmer but not another.

Over time a particular farming system can be assessed for financial viability – but the problem is that how can this be done on a single farm? Comparing the financial returns of a current farming system to a previous system on the one farm is difficult. Farming takes place in an inherently variable environment where rainfall (the main driver of production) and prices for produce change rapidly and markedly over short periods. To attribute cause and effect in relation to financial viability is not easy.

The sustainability issues; such as erosion risk, deep drainage, and soil health of a farming system, can be ascertained and measured over time but it is often difficult to attribute a dollar value to them. There is no question that they are important and farmers make decisions which have an influence on these issues, but how they affect their farm in relation to a dollar value is not clear.

The BCG started work in 1999 to resolve the physical and financial aspects of different farming systems suited to the southern Mallee. The people factor could not be directly included although we have tried to address the issue of complexity and risk in relation to different farming systems.

The BCG Farming System Trial incorporates four distinct systems which utilise different ways of managing farm operations such as sowing (ie No Till vs Conventional, stubble vs no stubble); weed control (cultivation vs chemical); management (sheep vs no sheep); flexibility (set rotations vs. flexible rotations) etc. The aim of the work was: ‘to determine the medium long term impact of each farming system on financial viability and physical/environmental sustainability’.

After consultations with members it was decided to compare four distinct farming systems. Each farming system is championed by a local farmer who determines the day to day operations for a system. The only constraint on management by the champions is that the philosophy of their system has to remain intact over the duration of the trial.

Hungry Sheep

Championed by Ian and Warrick McClelland. The Hungry Sheep system relies on high intensity cropping and maintaining high stocking rates. The heavy grazing philosophy is not only used to increase profit but also for weed control and stubble reduction. In March, non-cropped paddocks are sown to oats for winter/spring grazing – this results in competition between sheep and cropping when the crops need to be sown in May and June. In seasons with a late break, there is insufficient feed available on the sown pasture paddocks and the stock remain on paddocks ear marked for cropping until there is sufficient feed, which can result in late sowing for at least part of the sowing operation. Stocking rates are determined in May.

Reduced Till

Championed by Brad Martin and the Brim Technology Group. The reduced till system is based around flexibility allowing management practices to change according to environmental conditions, in order to achieve greatest Water Use Efficiency. In most years stubble is retained, crops are sown with narrow points on 23cm row spacing, ideally with most sowing completed by the end of May. Hence many crops were sown dry. Burning, grazing and green manuring are made use of when considered necessary or opportunistic. Livestock are used in this system but only to clean up paddocks after harvest – stock do not interfere with the cropping program. Income from livestock is based on agistment rates.

No Till

Championed by Alan Postlethwaite. The No Till system has the philosophy of profitable grain production with NO negative environmental effects. The No Till system aims to improve soil structure and reduce compaction through the retention of stubbles, continuous cropping and by using a wide row spacing with narrow points for sowing. There are no livestock in this system, weed control is with chemicals only, and generally this system uses canola and pulse crops to break disease cycles in cereals. Over the last couple of years disease breaks and moisture conservation have been achieved with chemical fallow.

Fuel Burners

Championed by Paul Barclay. The Fuel Burner system makes use of conventional fallow to conserve moisture, control weeds and reduce the risk of herbicide resistance developing. It is the philosophy of this system that a cultivated seed-bed improves emergence. Livestock are used only to clean up paddocks after harvest and fallows for the next season are grazed in early winter if feed is available. Over the last year the sheep have been run on a more intensive basis but the financial returns have still been based on the return from agistment.

The BCG appreciate that the farming systems on trial are only a snap shot of the wide array of farming system options available to farmers. In addition, the site is located on a particular soil type which has subsoil limitations. To overcome these restrictions in interpretation the BCG have been working with CSIRO in modeling the outcomes of the farming systems trial over time so that the results of the trial can have wider applicability both in terms of location and also over time (with different climatic conditions).

The project has received funding from GGA (Grain Growers Association) for the day to day operation of the trial over the last six seasons; and from the GRDC (Grains Research Development Corporation) for the modeling work. Without the support from these organisations this work would not have been possible.

Study area and local conditions

The Farming Systems Trial is located 28km North of Birchip on the Birchip-Berriwillock road on the property of Ian and Warrick McClelland.

The soil type is characterised as a Mallee clay loam (calcarosol). The topsoil is a clay loam which changes to a light medium clay at 10 to 20cm depth; further down the profile the clay content increases to a medium clay. The soil is highly alkaline ranging from pH 8.0 in the topsoil to 9.5 down the profile. Subsoil limitations are a feature of this soil type and have a large impact on crop production.

Subsoil limitations

The Systems site is regarded as a site with severe subsoil limitations. In 1999, the set up year, nine soil cores were taken to determine the spatial variation in soil condition across the site. Soil cores were taken to a depth of 90cm, five separate increments were sub-sampled and analysed (0-10, 10-30, 30-50, 50-70 and 70-90cm). The analysis included Electrical Conductivity (EC); Sodicity (ESP), Chloride (Cl) and Boron (B). The Sodicity level or ESP (Exchangeable Sodium Percentage) was determined as the percentage of Sodium as part of the Cation Exchange Complex. The full soil analysis can be found in Appendix 1. Table 1 is an abbreviated version of the data and presents the level of EC, Sodicity, Chloride and Boron for two cores as a demonstration of the range in values across the site.

Table 1: Levels of EC (ds/m), Sodicity (ESP Farming Systems Site), Chloride (mg/kg) and Boron (mg/kg) for five soil increments to a depth of 90cm for two cores at the Systems site in 1999.

Depth cm	EC ds/m		ESP %		Chloride mg/kg		Boron mg/kg	
	plot 21	plot 32	plot 21	plot 32	plot 21	plot 32	plot 21	plot 32
0 – 10	0.23	0.31	4	10	37	110	5	7
10 – 30	0.47	0.78	16	30	175	500	10	28
30 – 50	0.79	0.49	38	43	550	930	41	41
50 – 70	0.88	0.85	45	48	850	1140	48	48
70 – 90	0.61	0.71	45	49	940	1420	46	45

Each of the nine cores taken across the site had high levels of subsoil limitations, at levels which would be toxic to plant growth – There were variations across the site but these variations were minor in the context of the level of toxicity. It is generally regarded that EC values above 0.8 ds/m; ESP above 19%; Chloride above 600 mg/kg; and Boron above 15 mg/kg inhibit root development and affect plant growth. These values generally apply to cereals such as wheat and barley. Canola and pulses such as lentils are much more sensitive to subsoil constraints. The actual level at which these constraints become toxic to other crops, such as lentils, are not well understood, and is part of the modelling study supported by the GRDC.

Plot Lay-out and Crop Rotation

Each of the four farming systems was allocated 5 plots – plots ranged in size from 1.0 to 1.4ha.

A series of plots, called the Standards, were included in the plot design to determine whether there was any spatial variation in yield across the site. The Standard plots had a set rotation of Fallow, Wheat, Field Peas, Canola. Each phase of the Standard rotation was represented – each year and plots were replicated three times. Over the six seasons of running the Farming Systems Trial there were no consistent differences found between the Standard plots which have the same crop in the rotation. Based on this result it was concluded that spatial variation across the site was a minor factor in contributing to yield or other attributes contributing to performance between plots and that any differences observed are due to the crop choice, rotation sequence or system in place.

There were 20 Systems plots (4 farming systems by 5 plots each) plus 12 Standard plots (4 crop phases by 3 replicates) - for a total of 32 plots at the site.

The four farming systems were each managed by the local Champion, the Champion determined the crop rotation and decided the overall management of the crops, the BCG were responsible for carrying out the instructions of the Champions, as well as maintaining and managing the Standard plots.

All plots, except for the No Till plots, had watering points and shelter for sheep.

To ensure that all systems started on an even footing the set up year was 1999. Crops of choice by the Champions were sown with conventional machinery and following harvest in 1999 the crop management practices specific to each system were set in place. The first year for the trial was in 2000.

Table 2. presents the layout of the trial site and includes the rotation of each of the plots since 1999.

Table 2: Plot layout and rotation since 1999.

year	***1 Standard***	***2 Hungry Sheep***	***3 Reduced Till***	***4 Standard***	***5 Hungry Sheep***	***6 No Till***	***7 Standard***	***8 Fuel Burners***
1999	Wheat	Wheat	Lentils	Medic pasture	Lentils	Faba beans	Field peas	Medic fallow
2000	Field peas	Wheat	Barley	Medic fallow	Wheat	Barley	Canola	Wheat
2001	Canola	Oats / medic	Chem fallow	Wheat	Barley	Lentils	Medic fallow	Medic fallow
2002	Medic fallow	Wheat	Wheat	Field peas	Oats / medic	Wheat	Wheat	Wheat
2003	Wheat	Wheat	Wheat	Canola	Barley	Field peas	Field peas	Wheat
2004	Field peas	Barley	Wheat	Medic fallow	Oats / Medic	Wheat	Canola	Medic fallow
2005	Canola	Medic	Canola	Wheat	Wheat	Barley	Medic fallow	Wheat
	9 Standard	***10 Fuel Burners***	***11 No Till***	***12 Standard***	***13 Hungry Sheep***	***14 Reduced Till***	***15 Standard***	***16 No Till***
1999	Medic fallow	Wheat	Faba beans	Medic fallow	Barley	Faba beans	Wheat	Faba beans
2000	Wheat	Field peas	Wheat	Wheat	Medic fallow	Wheat	Field peas	Canola
2001	Field peas	Barley	Barley	Field peas	Wheat	Barley	Canola	Wheat
2002	Canola	Vetch fallow	Lentils	Canola	Lentils	Wheat	Medic fallow	Barley
2003	Medic fallow	Wheat	Wheat	Medic fallow	Lentils	Wheat	Wheat	Vetch
2004	Wheat	Barley	Barley	Wheat	Wheat	Barley	Field peas	Wheat
2005	Field peas	Medic Fallow	Chem fallow	Field peas	Barley	Field peas	Canola	Barley

→ ***N***

	17 Standard	***18 Fuel Burners***	***19 Reduced Till***	***20 Standard***	***21 Fuel Burners***	***22 No Till***	***23 Standard***	***24 Reduced Till***
1999	Faba beans	Wheat	Wheat	Wheat	Medic fallow	Wheat	Medic fallow	Faba beans
2000	Canola	Medic fallow	Chem fallow	Field peas	Wheat	Lentils	Wheat	Wheat
2001	Medic fallow	Wheat	Wheat	Canola	Medic fallow	Wheat	Field peas	Barley
2002	Wheat	Vetch fallow	Barley	Medic fallow	Wheat	Chem fallow	Canola	Medic fallow
2003	Field peas	Barley	Wheat	Wheat	Wheat	Wheat	Medic fallow	Barley
2004	Canola	Medic fallow	Barley	Field peas	Barley	Barley	Wheat	Chem fallow
2005	Medic fallow	Wheat	Wheat	Canola	Medic fallow	Wheat	Field peas	Wheat
	25 Standard	***26Hungry Sheep***	***27 No Till***	***28 Standard***	***29 Fuel Burners***	***30 Reduced Till***	***31 Standard***	***32 Hungry Sheep***
1999	Medic	Wheat	Wheat	Field peas	Wheat	Barley	Medic	Medic
2000	Medic fallow	Lentils	Faba beans	Canola	Medic fallow	Lentils	Medic fallow	Wheat
2001	Wheat	Wheat	Canola	Medic fallow	Wheat	Wheat	Wheat	Lentils
2002	Field peas	Barley	Wheat	Wheat	Medic fallow	Wheat	Field peas	Wheat
2003	Canola	Medic	Barley	Field peas	Medic fallow	Barley	Canola	Wheat
2004	Medic fallow	Wheat	Chem fallow	Canola	Wheat	Wheat	Medic fallow	Oats / Medic
2005	Wheat	Wheat	Wheat	Medic fallow	Barley	Barley	Wheat	Wheat

Legend: Medic fallow – self sown medic, cultivated in September/October; Medic – self sown medic for pasture; Chem fallow- stubble retained, knockdown herbicides used for weed control; Vetch fallow – vetch sown and fallowed in October.

Weather

For most of the seasons that the Farming Systems Trial was in operation the rainfall has been below average (Table 3). Two of the seasons, 2002 and 2004, were drought years for growing season rainfall. In-crop rainfall, also termed Growing Season Rainfall from April 1 to October 31, is the main driver of production in the southern Mallee. For the six seasons that the Farming Systems Trial has been operating (2000 to 2005), five years were drier than average. Summer rain from November to sowing the following season can also make significant contributions to crop production in the following season if the moisture is stored and available to the next crop, 2002/03 and 2004/05 had good summer rains.

Table 3: Monthly rainfall from 2000 to 2005 at the systems site; also included is the 100 year average monthly rainfall for the Birchip weather station.

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**GSR**	**Ann.**
Ave.	*20*	*23*	*22*	*24*	*36*	*36*	*34*	*35*	*37*	*37*	*25*	*22*	*237*	*347*
2000	2	39	7	50	27	24	40	22	39	52	95	28	254	425
2001	18	5	29	0	8	25	57	48	41	19	10	2	197	260
2002	21	0	0	13	29	18	6	18	16	7	2	43	107	173
2003	0	56	0	2	17	40	33	67	16	26	13	19	200	288
2004	1	2	6	2	14	40	24	44	27	6	58	51	155	272
2005	17	43	0	5	2	66	22	30	26	46	27	20	198	333

No serious frosts during the flowering phase of crops were recorded at the site over the duration of the trial. In 2004, in early October, during the flowering stage of the wheat crops, a day with 43^{o}C had a significant detrimental impact on yield.

Methods, Results and Discussion

Detailed monitoring

All systems plots were monitored in detail for a wide variety of biological, chemical, physical and financial parameters:

1. Soil biological activity in the 0-5, 5-10cm depth layers (prior to sowing in 2000 and 2005)
2. Weed seed bank (0-10cm) (prior to sowing in 2000 and 2005)
3. Soil borne diseases using the soil DNA (0-10cm) Predicta B test - annually
4. Soil water and available N (as nitrate) – down to 90cm depth in 4 increments - annually
5. Soil erosion risk during the droughts of 2002 and 2004

In-crop monitoring included:

6. Weeds present before and after herbicide application
7. Foliar and root disease present at the flowering stage of the crops

Crop yield and financial performance

8. All crops were harvested; inputs and machinery use recorded; and sheep numbers and grazing days recorded – for gross margin analysis

Each of the main areas of investigation is addressed separately.

1. Soil Biological Activity

Soil samples were collected prior to sowing in 2000 and again in 2005. This enabled the assessment of five years of different Farming Systems on soil biological activity. Soil samples were sent to DPI for analysis, unfortunately at the time of writing this report the results of the 2005 sampling are not yet available. A full report on how the soil biology has changed over the five years should be available by the BCG Update in February.

2. Weeds

Changes in the weed populations for each of the farming systems was assessed in two ways:

(i) soil seed bank

(ii) in-crop weed populations

(i) soil seed bank

At the start of the project in 2000 and again at the end of the project in 2005, soil samples (0-10cm) were collected from all plots and sent to the CRC for Australian Weed Management where the soil seed bank was assessed. In 2000, the weed seeds found in the soil were ryegrass, wild oats, silver grass, medic and fat hen. The weeds were evenly distributed across the site and no single plot had a higher weed seed bank compared to another plot. This procedure was repeated before sowing in 2005 and the weeds present were ryegrass, medic and mustard. No other weeds were recorded and there were no differences in farming systems in the type and number of weeds in the soil seed bank.

(ii) in-crop weed populations

In 2000, the first year of the Farming Systems Trial, medic, wild oats, ryegrass and mustard were the main weeds recorded in the crop. Five years later, the main weeds were the same, except for brome grass which was not recorded in 2000 but was recorded in two plots in 2005 (Hungry Sheep and No Till). Marshmallow was recorded in 2000 in a Hungry Sheep, No Till and Reduced Till plot – in 2005 it was recorded only in a No Till plot. After five years of the Systems trial there were no significant changes in weed populations – the only new weeds recorded was brome grass

3. Diseases

Crop diseases were assessed in two different ways:

(i) Soil DNA using the Predicta B test; and

(ii) In-crop assessment for foliar and root diseases

(iii) Soil DNA using the Predicta B test

Soils were collected prior to sowing according to the methods as prescribed by the Predicta B test and sent to SARDI for analysis.

For the five years of the study the DNA tests included CCN (eelworm), Take-all (hay-die), Pratylenchus neglectus (root lesion nematode) and Rhizoctonia (bare patch). The Fusarium (crown rot) is a new test and has been included since 2003.

In Appendix 2, the full results of the soil DNA tests are presented for each farming system including the rotation. The main conclusions drawn from the soil DNA testing were:

CCN: little or no CCN was recorded at the site over the duration of the trial. All of the wheat varieties sown at the site have been resistant to CCN and for the last 2 years resistant barley varieties (Vic Sloop) have been sown.

Take-all: Take-all has been at low to high levels in some plots, whilst the majority of plots had no Take-all at any time over the duration of the trial. For the plots with Take-all the levels have been consistently in the low to high levels in the same plots over the duration of the trial – there appeared to be no impact of crop selection or farming system on the level of Take-all. The plots with low to high levels of Take-all were all adjacent to each other (plot 2, 10, 18 and 19 see Table 2 for a plot lay-out). It appears the area covered by these plots started off with low to moderate levels of Take-all at the start of the trial and these levels have been maintained over the five years of the trial. It is not clear why crop selection has not made any difference over time on the level of Take-all. In Table 4, the results of DNA Take-all tests are shown for two different plots. One plot (plot 18) has a continuous presence of Take-all regardless of the rotation; whilst plot 14 which has a continuous cereal rotation does not appear to have any Take-all as assessed by the soil DNA test.

Table 4: Soil DNA Take-all levels in two plots (18 and 14) with different rotations.

Fuel Burners plot 18		**Reduced Tillage plot 14**	
Previous crop	**Take-all**	**Previous crop**	**Take-all**
Medic fallow	2001 Low	Wheat	2001 Not Detected
Wheat	2002 Low	Barley	2002 Not Detected
Vetch fallow	2003 High	Wheat	2003 Not Detected
Medic fallow	2004 Low	Wheat	2004 Not Detected
Wheat	2005 Moderate	Barley	2005 Not Detected

Pratylenchus neglectus (Root Lesion Nematode): Pratylenchus neglectus was found in most plots in most years in levels ranging from low to high. Pratylenchus thornii was present at very low levels in some plots but was not recorded in the majority of plots. The following discussion deals only with P. neglectus.

Similarly to Take-all, some plots had consistently higher levels of Pratylenchus compared to other plots (e.g. Plot 26 had consistently moderate to high levels). The level of Pratylenchus did appear to drop significantly in those rotations which included field peas. The Standard rotation grows a field pea crop every fourth year and the Standard plots have the lowest level of

Pratylenchus compared to any other rotation at the Farming Systems Site. Field peas are known to be resistant to Pratylenchus neglectus and reduce levels. Faba beans are also rated as resistant but they did not have the same effect as field peas at the Farming Systems Site in reducing Pratylenchus numbers. The high level of Pratylenchus in some plots is of concern, however Yitpi wheat is known to be moderately tolerant to Pratylenchus neglectus and maybe this is why the effect has not been as dramatic as it could have been if intolerant varieties had been grown.

Rhizoctonia: there were no trends in Rhizoctonia levels within individual plots, rotations or farming systems. The levels varied between seasons and between plots. The No Till and Reduced Till plots had similar levels of Rhizoctonia compared to the cultivated treatments in the Hungry Sheep, Fuel Burner and Standard plots.

Fusarium: Fusarium levels were assessed from 2003. The Fusarium levels were generally low across all systems and rotations. Occasionally a plot would have a high reading – these were generally associated with continuous cereal rotations however, not all continuous cereal rotations had a high reading. The levels of Fusarium were variable across plots and farming systems.

(ii) In-crop assessment for foliar and root diseases

Cereal crop roots were collected at the flowering stage, washed and assessed for the root diseases: CCN, Take-all and Rhizoctonia. Pratylenchus was not assessed because roots have to be stained and inspected under a microscope to detect Pratylenchus.

The level of these diseases was in all cases low or not detectable. Typical bare patches associated with Rhizoctonia was not a feature in any plot over the duration of the trial, and take-all, although occasionally observed on the roots as a slight infection, did not translate into dead heads across the plots. CCN or eelworm was never detected on the roots of wheat or barley. Crown Rot associated with Fusarium was occasionally detected in wheat plots, however it was not linked to continuous cereal rotations but was primarily due to the tough finishes in September and October which has been a feature of this trial since it commenced in 2000.

Foliar diseases were also assessed at flowering and at no stage during the duration of the trial were foliar diseases on any crop an issue in relation to yield. Traces of stripe rust were recorded on the wheat in 2005 but not at levels at which it could have impacted on yield or quality.

4. Wind erosion risk

The susceptibility of a paddock to wind erosion is a function of the amount of cover protecting the soil and how well the soil is bound into aggregates which are too large or heavy to move due to the force of wind. Both of these factors are influenced by the farming system in place: cultivation and grazing by sheep can reduce soil aggregation and cover and make the soil more susceptible to erosion.

During the drought of 2002/03 the amount of soil cover was assessed at three dates over summer (period when soil erosion risk is the highest). The No Till system retained the same amount of cover throughout the summer and retained enough cover to protect the soil from wind erosion. The Hungry Sheep system started off with a low amount of cover and by February had, on average, 7% cover – arguably not enough to protect the soil from blowing away (Table 5).

Table 5: Soil cover as an average of five plots for each of the farming system plots during the drought of 2002/03

	Soil Cover %		
	1st assessment	**2nd assessment**	**3rd assessment**
No Till	32	29	29
Reduced Till	19	16	14
Hungry Sheep	15	11	7
Fuel Burner	39	25	16

A more comprehensive assessment of erosion risk was undertaken during the drought of 2004/05 following the procedures outlined by Leys (NSW Dept. of Land and Water Conservation; report to Mallee Sustainable Farming project). The in-paddock assessment included both ground cover and soil particle aggregation. From both of these measures the susceptibility to erosion risk was assessed following the procedures of Leys *et al*. (2002).

In March 2005 (towards the end of the 2004/05 drought), each of the Systems plots soil cover was assessed and soil was collected for sieving (>0.85mm sieve) for aggregate determination (Figure 1).

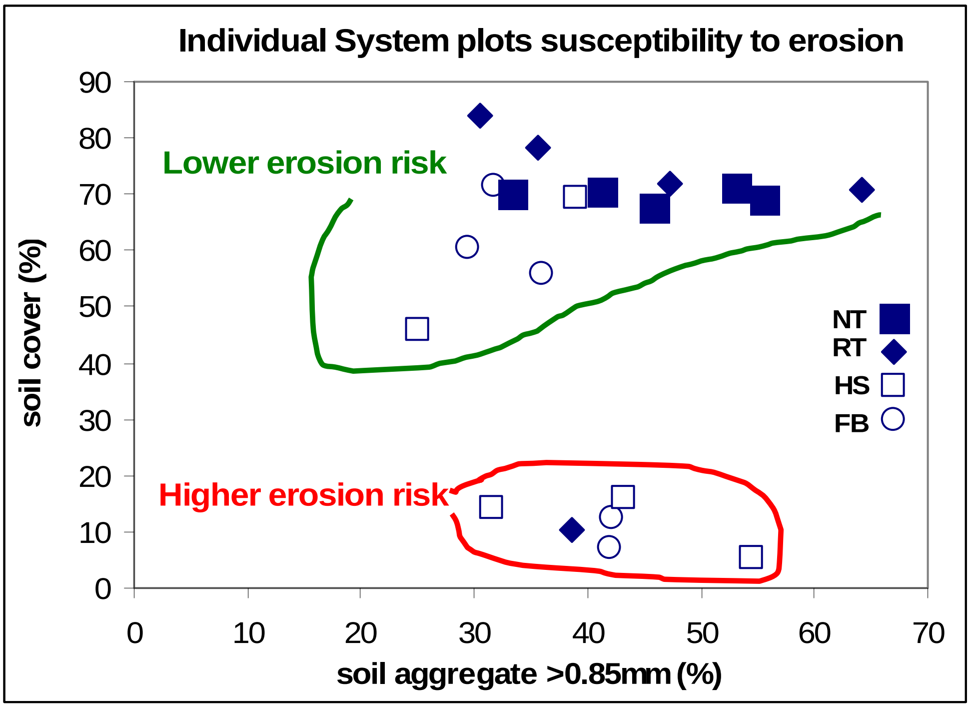

Figure 1: Soil cover (%) and % Soil Aggregates greater than 0.85mm for each of the 20 farming systems plots .

Plots most at risk to wind erosion were the plots with low cover. Aggregate size was consistently high for the No Till system plots, but varied more in the other three systems; however, the difference between systems was not significant ($P>0.05$). Based on these assessments the soil transport rate (reported as Q g/m/s) were calculated (Table 6). A wind erosion risk rating, based on the wind erodibility scale as determined by Leys *et al*. (2002), was used to determine the relative wind erosion risk for each farming system. A 'Q' value of less than 5 is regarded as low risk; whereas a value of between 5 and 25 for Q is regarded as moderate risk. The No Till system had the lowest wind erodibility risk; the Reduced Till system had one plot which was moderately susceptible to wind erosion; the Hungry Sheep and Fuel Burner systems both had two plots which were moderately susceptible to wind erosion, the other plots were low risk.

Table 6: Soil transport rate Q (g/m/s) for each of five plots in the four farming systems, as assessed in March 2004 (drought 04/05).

	Soil transport rate (erodibility function) Q (g/m/s)				
No Till	0	0	1	1	1
Reduced Till	0	0	1	1	7
Hungry Sheep	1	4	4	5	9
Fuel Burner	1	1	2	6	7

This is a similar finding to that found by Leys *et al*. where they reported soil erosion risk for the Mallee Sustainable Farming project. They reported that as a general rule farming systems with reduced cultivation and higher levels of stubble had reduced erosion risk; however there were also examples where No Till farmed paddocks were highly erodible due to poor cover; or conventional tilled paddocks which were not at risk of erosion because of high aggregate levels. At the Systems site the No Till plots had the lowest susceptibility to wind erosion.

5. Soil water and available nitrogen

Soil water and available nitrogen (as nitrate) was monitored prior to sowing each season to a depth of 90cm (4 increments: 0-10, 10-40, 40-70 and 70-90cm). The data collected is being used to calibrate the crop model APSIM for crop performance on this soil type.

The Crop Lower Limit of this soil type has been measured for this soil type to be 174mm or 25% (v/v) (0-70cm depth) (as determined in the associated GRDC funded project BWD17).

At the start of the season in 2002 and 2004, the soil was at the Crop Lower Limit (also known as the Wilting Point of the soil) for all plots which were in crop, regardless of crop type or management. Summer rainfall (November to March) in these two years was 33 and 41mm respectively (average summer rainfall is 112mm). Fallow (mechanical or chemical fallow) during the previous season contributed 20 to 25mm of available water to the crop in 2002 and 2004. This fallow benefit did not translate into yield because the seasons were so dry (Growing Season Rainfall of only 107 and 155mm respectively), essentially the crop died during these two years (for a description of yield see the following sections).

In the seasons with significant summer rainfall 2001, 2003 and 2005 (175, 101 and 169mm respectively) there was little or no benefit from fallowing in relation to measured available soil moisture – presumably because the summer rain contributed more to water conservation than the fallow did in the previous season. However, the yield of crops grown on fallow did benefit to some extent from being grown on fallow (between 0.2 and 0.4t/ha) in these seasons.

The site has a history of medic and soil available Nitrogen at the site was generally very high. Soil available N, measured as nitrate, ranged between 25 and 230kg of N/ha and was highly variable within years and between years. It is likely that the intensity of sampling (4 cores per sample time) was not enough to describe the high variability across the site. There was a trend for higher levels of available N in wet summers (2001 and 2005, with 149 and 126kg of N/ha respectively) compared to drier summers (for example 74kg of N/ha in 2004).

6. Crop production, livestock and financial performance

Yield

System trials are difficult to interpret for crop yield because crop selection and rotation choice are not the same between the different systems, it is only over a rotation that the financial returns from different systems become clearer. The six seasons in this analysis (2000 to 2005) are barely enough especially since two seasons were drought years.

Crop selection can have a large influence on the financial performance of a system, which may not be directly related to the system itself but has more to do with the crop type grown for that particular season. At the start of the trial the No Till system had a high percentage of pulse and canola crops (60%) in the rotation, more similar to a Wimmera rotation rather than a southern Mallee rotation. At the same time the Fuel Burners only had 20% pulse in the rotation. It took 2 to 3 dry years before the extreme nature of the subsoil limitations was appreciated and that pulses and canola are not ‘safe’ break crops on this soil type. Pulses can be grown as shown by the Reduced Till system in 2005 when a 1.6 t/ha field pea crop was harvested, however this was the first pulse crop since 1999 that yielded over 1t/ha. The No Till system changed from a cereal rotation with pulse and canola break crops to a system which now includes chemical fallow and continuous cereal. In 2005, the No Till system grew the highest yielding wheat crop at the site on chemical fallow with a yield of 2.6t/ha.

The yields achieved each season for each of the four systems and the Standard rotation is detailed in Appendix 3.

Each of the four systems selected a very different rotation and the outcomes have been quite varied:

Fuel Burner: the Fuel Burner system relied on mechanical fallow for soil water conservation and N mineralisation. Cereal yields always responded in the following season and in most seasons the yield of crops on fallow was 0.5t/ha higher compared to cereal on crop. In the current run of dry seasons this has been a good strategy.

Hungry Sheep: the Hungry Sheep system does not conserve soil water from one season to the next. Water is either used by medic/oats for sheep feed or it is used by a crop. This system is very intensive and runs the risk of crop failure because of a lack of soil water stored from one season to the next; or the pasture phase does not perform very well during drought conditions and sheep feed has to be purchased. In terms of crop production it has not performed as well as the other systems but the livestock component has been more profitable (see next section).

Reduced Till: the Reduced Till system has been opportunistic in that it does not have a set rotation, a 100% crop intensity was used in 2003 after the 2002 drought, and also in 2005 after the 2004 drought. In other seasons this system will fallow, mainly by chemical means retaining the stubble.

No Till: the No Till system grew poor pulse and canola crops during the early years of the trials, primarily because of the poor seasonal conditions and the severity of the effect that subsoil limitations have on pulse and canola crops was not appreciated as the start of the project. However, since 2004 only cereals have been grown. Some of these cereals are grown on chemical fallow, in 2005 this system grew the highest yielding wheat crop on the site (2.6t/ha on chemical fallow).

The lowest wheat crop for all systems in 2005 was 1.6t/ha in the No Till system on a paddock that was wheat in 2003, barley in 2004 and back to wheat in 2005. This paddock was high in Take all and Rhizoctonia in the DNA soil tests undertaken prior to sowing in 2005. There may be a link between these high levels of disease in the soil and the poor yield. However, there was no Take all or Rhizoctonia recorded on the roots of this crop at the flowering stage of the crop in 2005. Other cereal crops with a similar rotation of continuous cereal do not have this link between poor yield and root disease.

Livestock

Livestock numbers and performance (as weights and body scores) were regularly monitored for all systems. Using these figures, accurate grazing days per plot for each system could be calculated.

The Fuel Burner and Reduced Till system run sheep on an opportunity basis where sheep are used to graze down stubbles after harvest. For these two systems sheep are agisted on, while there is summer feed.

The Hungry Sheep system is the only system that runs sheep all year round. At the system site the livestock component of the Hungry Sheep system has operated as a trading account where sheep are purchased in May when the stocking rate for the season is set. For the last three seasons the system has operated on 6 DSE/ha. The Hungry Sheep system has to purchase sheep feed for those occasions when pasture feed availability is below the requirements of the sheep.

Financial performance

All inputs (fertilisers, herbicides, insecticides and fungicides) and operations are recorded and charged as costs to each system. Operations are charged at 75% of the cost of local contract rates, the 75% level was used because that was regarded as reasonably close to the actual cost paid by a farmer for operations using his own machinery. The return from crops is determined as the cash price for crops over harvest, except for wheat which is pooled (during the first two weeks of December) (Table 7). For livestock, the Fuel Burner and Reduced Till systems are paid on an agistment basis, whereas the income and costs associated with livestock in the intensive Hungry Sheep system is based on a trading account (Table 7). Other costs associated with farming such as borrowings, overheads etc are not taken into account.

Table 7: Yearly crop and sheep gross margins for each system ($/ha) (2000-05)

	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Fuel Burner						
Crop Income	272	334	36	309	72	199
Crop Variable Cost	147	111	133	175	93	100
Crop GM	125	223	-97	134	-21	99
Sheep Agistment	9	9	12	1	5	9
TOTAL GM	134	232	-85	135	-16	109
Hungry Sheep						
Crop Income	312	325	0	194	37	262
Crop Variable Cost	140	150	131	109	103	116
Crop GM	172	175	-131	85	-66	147
Sheep Income		107	121	166	288	206
Sheep Costs		84	151	121	207	159
Sheep GM	40	22	-30	45	81	47
TOTAL GM	212	197	-161	130	15	194
Reduced Till						
Crop Income	274	323	0	392	66	262
Crop Variable Cost	125	149	146	149	126	158
Crop GM	149	174	-146	243	-60	104
Sheep Agistment	5	7	11	1	3	2
TOTAL GM	154	181	-135	244	-57	106
No Till						
Crop Income	225	295	0	256	66	264
Crop Variable Cost	183	190	124	159	121	113
Crop GM	42	105	-124	97	-55	154
TOTAL GM	42	105	-124	97	-55	154

The six year average gross margin (livestock + crop) and the 2005 gross margin are presented in Figure 2. The average gross margin for the Fuel Burner, Hungry Sheep and Reduced Till systems is very similar ($82 to $85/ha), the average gross margin for the No Till system is $37/ha (due to poor performance during the first years of the trial). The current gross margin for the No Till system has improved significantly.

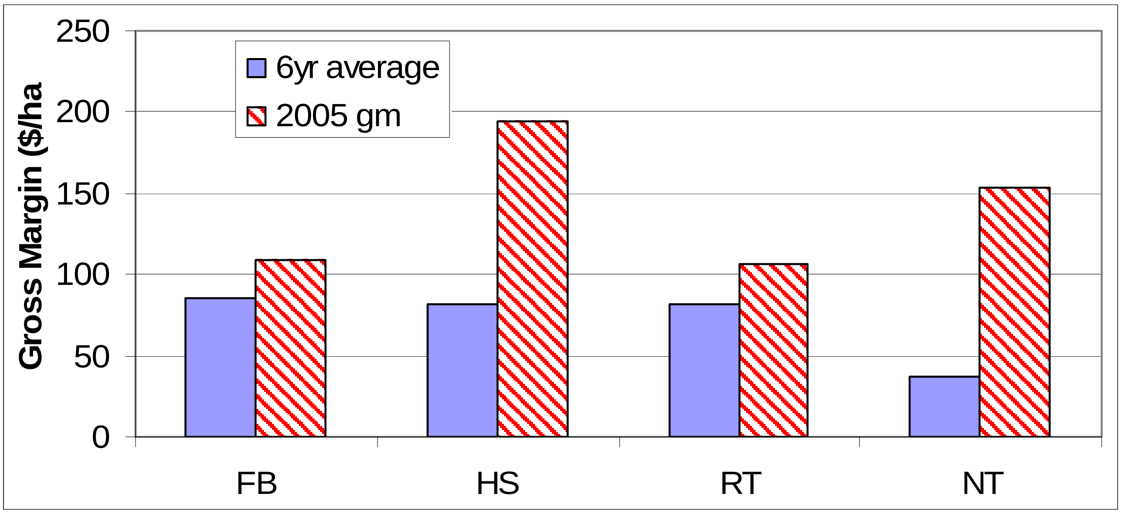

Figure 2: Six year average gross margin and 2005 gross margin for each of the four farming systems (FB=Fuel Burner; HS=Hungry Sheep; RT=Reduced Till; and NT=No Till)

The most important points that come out of the financial performance comparison between the four different farming systems are:

- Six seasons with only one season with average growing season rainfall and the other five years with below average rainfall (including two droughts) resulted in low yields and crop failures (especially in the drought years)
- The high price for meat and the high stocking intensity resulted in good returns for the sheep enterprise in the Hungry Sheep system.
- In the Hungry Sheep system, the cost of feeding during drought years is very high and is a risk to the operation.
- No Till system grew poor performing canola and pulse crops in the first two years of the trial and this system did not perform very well financially. No Till now grows primarily cereals with one or two plots in chemical fallow and is performing better financially.
- Variable costs (including machinery) were high for the No Till systems in the first two years of the trial but these costs have now been brought back to lower levels.
- Reduced Till system has similar crop incomes compared to the other systems but has higher variable costs compared to the other systems resulting in a lower gross margin.
- The Fuel Burner system has performed consistently over the duration of the trial and has the least losses associated with cropping during the drought seasons. This is an important consideration when it has to be remembered that following a drought many farmers have to borrow to put in a new crop.

- In years when there is 40% fallow, as in 2005, the Fuel Burner system does not perform financially as well as systems where the rotation is more intensive. However, if it is a dry season next year then the Fuel Burner system will again perform better because of the higher percentage of fallow in the system.

Conclusion

After six years of running the Systems Site comparing farming systems it has become clear that the critical issues are:

1. conserving soil water into dry seasons, which can be achieved using either mechanical in a conventional system or chemical means in a reduced till or no till system (assuming there is enough stubble to protect the soil surface from evaporation).
2. Since the introduction of Frame and Yitpi (CCN resistant wheats) CCN has not been a problem.
3. Take-all and Pratylenchus neglectus appear to more closely correlate to specific areas in a paddock rather than levels changing because of crop choice or the rotation (field peas did lower Pratylenchus levels). Certainly there did not appear to be any influence of farming system on these two soil borne diseases.
4. Weed levels have not changed markedly over the duration of the trial and there were no differences between systems after six years. Brome grass is now present at the site at very low levels whereas it was not recorded in 1999 and 2000.
5. Wind erosion susceptibility and risk is lowest in the No Till plots because of good stubble cover and aggregation of soil particles. The three other systems all had plots which were moderately susceptible to wind erosion, primarily as a result of low stubble cover.
6. Using current technology and sampling intensity it is not possible to pick up changes in soil available nitrogen levels between different farming systems.
7. Soil changes in soil biological characteristics are currently being assessed and will be reported by the BCG update in February 2006.

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Appendix 1 Soil Analyses for subsoil limitations (samples taken in 1999)

Depth cm	pH water	EC dS/m	Cl^- mg/kg	B mg/kg	ESP %	Depth cm	pH water	EC 1:5	Cl^- mg/kg	B mg/kg	ESP %
Plot 4						**Plot 21**					
0-10	8.6	0.27	56	7	6	0-10	8.5	0.23	37	5	4
10-30	9.4	0.4	320	29	23	10-30	9.1	0.47	175	10	16
30-50	9.9	0.58	610	50	37	30-50	9.6	0.79	550	41	38
50-70	9.6	0.72	790	48	39	50-70	9.8	0.88	850	48	45
70-90	9.9	0.98	1220	54	49	70-90	9.8	0.61	940	46	45
Plot 5						**Plot 23**					
0-10	8.9	0.26	55	8	7	0-10	8.7	0.28	87	5	8
10-30	9.5	0.41	220	18	19	10-30	9.3	0.6	430	22	27
30-50	9.7	0.75	660	39	36	30-50	9.8	0.54	840	46	42
50-70	9.7	1.02	990	62	43	50-70	9.6	0.59	730	47	47
70-90	9.6	1.08	1260	71	47	70-90	9.5	1.38	1460	47	49
Plot 8						**Plot 25**					
0-10	8.7	0.24	36	6	5	0-10	8.9	0.26	84	7	2
10-30	9.3	0.58	270	17	23	10-30	9.6	0.66	490	32	15
30-50	9.6	0.74	700	48	40	30-50	9.8	0.86	970	61	29
50-70	9.7	0.85	860	60	45	50-70	9.9	0.57	1200	65	43
70-90	9.6	0.82	1120	66	48	70-90	9.9	0.51	1400	67	46
Plot 9						**Plot 28**					
0-10	8.8	0.32	85	6	7	0-10	8.6	0.14	24	4	3
10-30	9.6	0.74	450	36	31	10-30	9.3	0.4	220	14	17
30-50	9.8	0.72	710	50	44	30-50	9.5	0.75	520	28	27
50-70	9.5	0.73	950	55	47	50-70	9.7	0.94	1040	59	44
70-90	10	0.47	1040	49	50	70-90	9.8	0.54	1280	62	48
Plot 11						**Plot 32**					
0-10	8.9	0.28	66	6	7	0-10	8.8	0.31	110	7	10
10-30	9.7	0.77	500	39	34	10-30	9.3	0.78	500	28	30
30-50	9.9	0.75	890	67	46	30-50	9.8	0.49	930	41	43
50-70	9.9	0.7	1100	66	50	50-70	9.7	0.85	1140	48	48
70-90	9.9	0.48	1320	61	50	70-90	9.6	0.71	1420	45	49

Appendix 2. Soil DNA test in relation to Farming System and previous crop type.

		Rotation					CCN					Take-all					Rhizoctonia					Pratylenchus neglectus				
plot	ttt	2000	2001	2002	2003	2004	C01	C02	C03	C04	C05	TA01	TA02	TA03	TA04	TA05	Rh01	Rh02	Rh03	Rh04	Rh05	P01	P02	P03	P04	P05
10	FB	**FP**	**B**	**VF**	**W**	**B**	1	2	<1	<1	<1	26	<15	<20	25	22	9	57	<5	<19.5	<19.5	5	4	<1	2	2
18	FB	**MF**	**W**	**VF**	**B**	**MF**	1	2	<1	<1	<1	25	28	107	31	52	1	<15	<5	<19.5	<19.5	8	37	26	13	6
29	FB	**MF**	**W**	**MF**	**MF**	**W**	0	1	<1	<1	<1	0	<15	<20	<20	28	27	<15	<5	<19.5	<19.5	6	22	14	10	14
8	FB	**W**	**MF**	**W**	**W**	**MF**	2	1	<1	<1	<1	0	<15	<20	<20	<20	4	<15	5	<19.5	<19.5	2	8	15	9	1
21	FB	**W**	**MF**	**W**	**W**	**B**	0	1	<1	<1	<1	15	<15	<20	<20	<20	35	<15	9	<19.5	<19.5	2	4	6	4	14
26	HS	**L**	**W**	**B**	**M**	**W**	0	2	<1	<1	<1	10	20	<20	<20	<20	6	<15	<5	40	<19.5	5	39	82	43	26
13	HS	**MF**	**W**	**L**	**L**	**W**	1	3	<1	<1	<1	15	<15	<20	23	<20	29	40	13	<19.5	<19.5	2	40	27	5	21
2	HS	**W**	**O**	**W**	**W**	**B**	1	2	<1	1	<1	60	20	23	45	<20	0	<15	<5	<19.5	<19.5	7	13	6	19	9
5	HS	**W**	**B**	**O**	**B**	**O**	0	3	<1	<1	<1	1	20	<20	23	<20	27	<15	<5	49	<19.5	2	36	30	11	6
32	HS	**W**	**L**	**W**	**W**	**O**	0	2	1	<1	<1	1	20	<20	<20	<20	30	<15	17	87	<19.5	2	27	31	37	18
6	NT	**B**	**L**	**W**	**FP**	**W**	0	2	<1	<1	<1	11	<15	<20	<20	<20	12	<15	<5	<19.5	44	2	13	7	3	5
16	NT	**C**	**W**	**B**	**V**	**W**	1	10	<1	<1	<1	3	<15	<20	<20	<20	0	<15	<5	<19.5	<19.5	2	26	6	8	15
27	NT	**FB**	**C**	**W**	**B**	**CF**	1	4	<1	<1	<1	1	<15	<20	<20	<20	0	<15	46	55	<19.5	6	17	13	13	3
22	NT	**L**	**W**	**CF**	**W**	**B**	1	3	<1		<1	50	<15	<20		107	29	<15	<5		96	4	39	36		17
11	NT	**W**	**B**	**L**	**W**	**B**	1	6	<1	<1	<1	0	<15	<20	<20	<20	0	<15	<5	49	63	3	62	44	34	14
3	RT	**B**	**CF**	**W**	**W**	**W**	0	<1	<1	<1	<1	4	<15	<20	<20	<20	0	<15	<5	<19.5	<19.5	3	8	4	40	20
19	RT	**CF**	**W**	**B**	**W**	**B**	2	4	<1	<1	<1	45	20	23	22	22	0	<15	<5	70	51	6	46	37	26	15
30	RT	**L**	**W**	**W**	**B**	**W**	1	2	<1	<1	<1	40	<15	<20	<20	23	35	29	<5	<19.5	<19.5	3	26	17	26	13
14	RT	**W**	**B**	**W**	**W**	**B**	1	3	<1	<1	<1	0	<15	<20	<20	<20	27	100	<5	<19.5	<19.5	3	24	6	12	13
24	RT	**W**	**B**	**MF**	**B**	**CF**	1	3	1	1	<1	1	<15	<20	<20	<20	26	55	10	25	<19.5	2	27	25	9	7
7	S	**C**	**MF**	**W**	**FP**	**C**	1	1	<1	<1	<1	2	<15	<20	<20	<20	0	105	<5	27	<19.5	2	6	4	2	<1
17	S	**C**	**MF**	**W**	**FP**	**C**	1	3	<1	<1	<1	4	<15	<20	<20	<20	0	<15	85	<19.5	<19.5	3	4	2	1	<1
28	S	**C**	**MF**	**W**	**FP**	**C**	1	1	<1	<1	<1	10	<15	<20	<20	<20	6	<15	8	<19.5	<19.5	3	5	7	<1	<1
1	S	**FP**	**C**	**MF**	**W**	**FP**	1	1	<1	<1	<1	11	<15	<20	<20	<20	1	<15	<5	<19.5	<19.5	6	11	7	26	3
15	S	**FP**	**C**	**MF**	**W**	**FP**	1	2	<1	<1	<1	28	23	<20	<20	<20	25	<15	<5	<19.5	<19.5	5	16	4	5	1
		Rotation					CCN					Take-all					Rhizoctonia					Pratylenchus neglectus				
20	S	**FP**	**C**	**MF**	**W**	**FP**	1	2	<1	<1	<1	50	<15	<20	<20	<20	0	<15	<5	<19.5	<19.5	5	20	5	10	4
4	S	**MF**	**W**	**FP**	**C**	**MF**	1	2	<1		<1	2	<15	<20		<20	0	<15	24		<19.5	2	10	6		5
25	S	**MF**	**W**	**FP**	**C**	**MF**	1	1	<1		<1	4	<15	<20		<20	14	<15	<5		<19.5	2	13	7		2
31	S	**MF**	**W**	**FP**	**C**	**MF**	1	2	<1		<1	0	<15	<20		<20	19	<15	<5		<19.5	2	15	9		3
9	S	**W**	**FP**	**C**	**MF**	**W**	1	1	<1	<1	<1	5	<15	<20	<20	<20	6	<15	<5	92	<19.5	1	2	1	2	3
12	S	**W**	**FP**	**C**	**MF**	**W**	0	1	<1	<1	<1	5	<15	<20	<20	30	0	<15	<5	85	<19.5	2	5	1	1	1
23	S	**W**	**FP**	**C**	**MF**	**W**	1	2	<1	<1	<1	0	<15	<20	<20	<20	27	<15	<5	90	<19.5	2	1	4	1	6

Appendix 3. Crop yield (t/ha) for all four Systems and the Standard rotation

		crop	**crop**	yield	**crop**	yield	**crop**	yield	**crop**	yield	**crop**	yield	**crop**	yield
plot	ttt	**1999**	**2000**	2000	**2001**	2001	**2002**	2002	**2003**	2003	**2004**	2004	**2005**	2005
8	FB	**MF**	**W**	3.68	**MF**		**W**	0.33	**W**	1.94	**MF**		**W**	2.34
21	FB	**MF**	**W**	4.00	**MF**		**W**	0.24	**W**	1.95	**B**	0.83	**MF**	
10	FB	**W**	**FP**	0.67	**B**	2.87	**VF**		**W**	1.65	**B**	0.73	**MF**	
18	FB	**W**	**MF**		**W**	3.12	**VF**		**B**	2.30	**MF**		**W**	2.11
29	FB	**W**	**MF**		**W**	2.84	**MF**		**MF**		**W**	1.12	**B**	1.78
13	HS	**B**	**M**		**W**	2.33	**L**	0.00	**L**	0.02	**W**	0.51	**B**	1.99
5	HS	**L**	**W**	3.17	**B**	3.00	**O**		**B**	2.96	**O**		**W**	2.02
32	HS	**M**	**W**	3.22	**L**	0.43	**W**	0.00	**W**	1.41	**O**		**W**	1.89
2	HS	**W**	**W**	1.93	**O**		**W**	0.00	**W**	1.22	**B**	0.70	**M**	
26	HS	**W**	**L**	0.53	**W**	2.19	**B**	0.00	**M**		**W**	0.27	**W**	2.06
6	NT	**FB**	**B**	1.89	**L**	0.32	**W**	0.00	**FP**	0.03	**W**	0.33	**B**	2.35
11	NT	**FB**	**W**	2.21	**B**	2.08	**L**	0.00	**W**	2.09	**B**	0.78	**CF**	
16	NT	**FB**	**C**	0.40	**W**	2.07	**B**	0.00	**V**	0.02	**W**	0.39	**B**	2.37
22	NT	**W**	**L**	0.35	**W**	2.12	**CF**		**W**	1.55	**B**	0.80	**W**	1.59
27	NT	**W**	**FB**	0.61	**C**	0.36	**W**	0.00	**B**	3.05	**CF**		**W**	2.62
30	RT	**B**	**L**	0.26	**W**	1.79	**W**	0.00	**B**	2.62	**W**	0.65	**B**	1.75
14	RT	**FB**	**W**	2.55	**B**	2.34	**W**	0.00	**W**	1.74	**B**	0.74	**FP**	1.58
24	RT	**FB**	**W**	2.67	**B**	2.43	**MF**		**B**	2.54	**CF**		**W**	2.27
3	RT	**L**	**B**	2.26	**CF**		**W**	0.00	**W**	1.74	**W**	0.52	**C**	0.58
19	RT	**W**	**CF**		**W**	2.15	**B**	0.33	**W**	2.00	**B**	0.70	**W**	2.04
7	S	**FP**	**C**	0.59	**MF**		**W**	0.30	**FP**	0.00	**C**	0.00	**MF**	
17	S	**FP**	**C**	0.81	**MF**		**W**	0.30	**FP**	0.00	**C**	0.00	**MF**	
28	S	**FP**	**C**	0.65	**MF**		**W**	0.46	**FP**	0.00	**C**	0.00	**MF**	
4	S	**M**	**MF**		**W**	3.07	**FP**	0.00	**C**	0.01	**MF**		**W**	2.40
25	S	**M**	**MF**		**W**	3.12	**FP**	0.00	**C**	0.07	**MF**		**W**	2.14
31	S	**M**	**MF**		**W**	3.03	**FP**	0.00	**C**	0.08	**MF**		**W**	2.07
9	S	**MF**	**W**	3.91	**FP**	1.11	**C**	0.00	**MF**		**W**	1.07	**FP**	1.34
12	S	**MF**	**W**	4.49	**FP**	0.87	**C**	0.00	**MF**		**W**	0.99	**FP**	1.39
23	S	**MF**	**W**	3.79	**FP**	0.83	**C**	0.00	**MF**		**W**	1.07	**FP**	1.33
1	S	**W**	**FP**	0.49	**C**	0.64	**MF**		**W**	2.37	**FP**	0.00	**C**	0.46
15	S	**W**	**FP**	0.42	**C**	0.55	**MF**		**W**	1.80	**FP**	0.00	**C**	0.41
20	S	**W**	**FP**	0.55	**C**	0.64	**MF**		**W**	2.22	**FP**	0.00	**C**	0.44