Waikerie Core Site Farming Systems Trial 11 Years On

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Waikerie MSF Core Trial Site, SA

Key messages:

- Long term trial shows advantages to be gained from no-till intensive cropping systems in soil health, grain production and gross margins.
- Soil rhizoctonia levels have increased in recent years, but impact on crop varies with farming systems.
- High levels of fertiliser application in recent seasons has lead to substantial increases in soil P and high P reserves.

Aims:

- To assess the long term affects to soil health and potential profitability of the Waikerie Core site trial.
- To commence a phase of cropping the same varieties and inputs across all plots to more clearly identify crop differences that can be attributed to the changes in the soil due to the previous farming systems over time.

Background:

The Waikerie Core Site Farming Systems Trial was established in 1998 and has continued with generally the same farming systems treatments on the same plots for 11 years. It has an average annual rainfall of 250mm and growing season of 166mm. Treatments ranged from district practice crop / pasture systems, to intensive cereals as well as pulses and canola, cultivation and direct drill, as well as district practice to higher fertiliser inputs. This has lead to significant differences in soil microbial activity, fertility, production and disease levels (see Table 1). This year separate samples were taken form both the loamier flat half of the trial, as well as the sandier top half, to try and identify how the various farming systems treatments have impacted on the different soil types.

About the trial:

Due to changes in funding and research priorities the site has been maintained through the input of MSF and Rural Solutions SA, but not studied to the same extent in recent years. This year it was decided the site should all be sown to the same variety (Mace wheat), at the low fertiliser rate of 30kg/ha DAP, to see what impact the previous systems would have in terms of fertility and disease control.

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Due to initial uncertainty about the trial going ahead, it was sown late, after a period of volunteer weed growth. While knockdown weed control was used prior to seeding, subsequent later germinations led to poor grass control across the site. This unintentionally gave root disease every chance to establish and produced some interesting monitoring results.

The site was deep soil, surface and root disease tested on both the loamy and sandy ends of each treatment. Disease counts were measured on both surface and seminal roots, along with visual assessment. The aim was to see how soil inoculum levels translate into crop damage and the impact of treatment history.

Assessments:

Table 1. 2009 Soil and Crop Results, Waikerie Core Site Trial.

Treatment	P ppm	OC %	Avail. N kg/ha 0-70cm	Rhizo Level RDTS	Rhizo Risk RDTS	July Disease Score Low 0 - 5 High	2009 Yield kg/ha
1 Flat	19	0.7	72	2.4	High	3.3	229
1 Sand	19	0.6	40	2.3	High		235
2 Flat	16	0.6	45	2.1	Medium	2.7	276
2 Sand	21	0.5	39	2.5	High		271
3 Flat	34	0.6	98	2.6	High	3.0	333
3 Sand	23	0.5	44	1.8	Medium		313
4 Flat	22	0.7	38	2.8	High	3.7	335
4 Sand	20	0.5	32	3.0	High		301
5 Flat	38	0.6	21	2.4	High	3.0	264
5 Sand	31	0.5	38	2.6	High		338
6 Flat	32	0.6	87	2.8	High	4.0	269
6 Sand	27	0.3	25	3.1	High		205
7 Flat	22	0.6	37	2.4	High	3.0	311
7 Sand	31	0.5	17	2.7	High		211
8 Flat	33	0.7	91	2.7	High	2.7	455
8 Sand	34	0.5	40	2.5	High		235
9 Flat	38	0.8	57	2.5	High	1.7	415
9 Sand	38	0.7	46	1.4	Low		385
10 Flat	43	0.8	68	2.2	High	3.3	311
10 Sand	36	0.6	26	3.0	High		264
11 Flat	33	0.6	52	2.3	High	3.0	365
11 Sand	31	0.5	25	3.0	High		410

Rhizoctonia Level and Risk is expressed as a log (DNA) measurement, with <1.0 considered as a risk rating of Below Detection, >1.0-1.7 as Low, >1.7-2.1 as Medium, and >2.1 as High Risk. July Disease Score was done by sampling and scoring rhizoctonia root damage, while later patch scoring was conducted in September.

Table 2. Yield, Gross Margin results 1998-2008, Waikerie Core Site.

		Year >	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Ave wheat	Total	Cum GM
Growing Season Rainfall >			160.5mm	152.4mm	196.5mm	195.5mm	92.7mm	179.9mm	116mm	161.1mm	114.4mm	111.7mm	112.2mm	Yields t/ha	Grain t/ha	($/ha)
Treatment	Tillage	Inputs														
1 W/Pas	CC	DP	Wh 2.19	Pa	Wh 1.48	Pa	Wh 0.13	Pa	Wh 0.40	Pa	Wh 0.91	Pa	Wh 0.87	1.00	6.0	$709
2 Pas/W	CC	DP	Pa	Wh 1.57	Pa	Wh 2.25	Pa	Wh 2.38	Pa	Wh 2.01	Pa	Wh 0.93	Pa	1.83	9.1	$1,458
3 W/Pas	CC	High	Wh 2.52	Pa	Wh 2.23	Pa	Wh 0.06	Pa	Wh 0.45	Pa	Wh 0.98	Pa	Wh 0.80	1.17	7.0	$613
4 Pas/W	DD	DP	Pa	Wh 1.89	Pa	Wh 2.47	Pa	Wh 2.44	Pa	Wh 1.98	Pa	Wh 1.22	Pa	2.00	10.0	$1,592
Ave of 1-4 Crop/Past	Average of crop yields across crop / pasture system as run of better seasons in odd years can skew results.													1.50	8.0	$1,093
5 W/Pulse	CC/DD	High	Wh 2.47	Vet not harv	Wh 2.25	Pe 1.27	Wh 0.08	Pe 0.35	Wh 0.46	Pe 0.64	Wh 1.12	Pe 0.05	Wh 1.03	0.98	9.7	$411
6 Intensive	CC	High/DP	Vet 0.93	Wh 1.89	Pe 0.77	Wh 3.01	Trt 0.04	Pe 0.35	Wh 0.52	Wh 2.17	Wh 1.02	Wh 1.1	Bar 0.82	1.62	12.6	$841
7 Intensive	DD	High/DP	Vet 0.72	Wh 1.63	Pe 0.7	Wh 2.44	Can 0	Can 0.75	Wh 0.47	Wh 2.06	Wh 1	Wh 1.18	Bar 0.92	1.46	11.9	$797
8 W/Pulse	DD	High	Wh 2.5	Vet not Harv	Wh 2.14	Pe 1.24	Wh 0.14	Pe 0.32	Wh 0.48	Wh 2.14	Wh 1.13	Pe 0.07	Wh 1.26	1.44	11.4	$642
9 W/Can	DD	High	Wh 2.37	Can 0.45	Wh 1.85	Can 1.04	Wh 0.05	Can 0.62	Wh 0.4	Can 0.6	Wh 1.15	Can 0.16	Wh 1.01	1.14	9.7	$651
10 Wheat	DD	High	Vet 0.9	Wh 1.86	Wh 2.13	Wh 2.99	Wh 0.05	Wh 2.65	Wh 0.36	Wh 2.42	Wh 1	Wh 1.22	Wh 0.68	1.54	16.3	$1,428
11 Opportune	DD	High	Wh 2.46	Wh 1.56	Can 1.23	Wh 3	Wh 0.03	Wh 2.81	Wh 0.28	Wh 2.29	Can 0.13	Wh 1.73	Bar 0.98	1.77	16.5	$1,658

W = wheat, Pa = pasture, Vet= vetch, Pe = peas, Can = canola, Bar = barley CC = Conventional Cultivation, DD = Direct Drill,
High inputs = Wheat 75 kg/ha MAP, 2 kg/ha Zn, 43 kg/ha Urea, Canola 150kg/ha Super P, 43 kg/ha Urea, Sowing rates Wheat 70 kg/ha, Canola 5 kg/ha
DP (district practice) = Wheat and Peas 50 kg/ha MAP, Sowing rates Wheat 45 kg/ha, Peas 90kg/ha

Results:

Soil Phosphorous

Soil Phosphorus measurements revealed a large difference between farming systems (Table 1). The Crop / Pasture rotations being fertilised every second year with 50kg/ha MAP averaged (plot 1and 2) 17.5ppm on the flat and 20ppm on the sand.

Tmt 3 is same rotation as Tmt 1, except it has higher inputs. This has lead to an increase of 15ppm soil P and the flat and 4ppm more on the sand (an average of nearly 10ppm higher). It is calculated that these plots have had an extra 30kg/ha P added, with an extra 3kg/ha P removed in grain. There is a rule of thumb that states that for every 3kg of unused P, soil levels will rise by about 1ppm. This certainly is verified in this instance, although retention in different soils will vary. On average, over the 11 year period, taking in to account P application, removal and tie up, the crop / pasture systems have been estimated to have had about 28kg/ha of applied P un-used.

The higher input continuous crop systems have an average of 37ppm on the flat and 34ppm (Treatments 5, 8-11). This higher level than the crop / pasture systems is due to the yearly application and the run of poor yielding seasons where 15kg/ha has been excessive.

When taking into account P application, removal and tie up, it is estimated that these intensive plots have had approximately 90kg/ha applied P un-used which certainly explains the jump in soil P levels. It could be argued that these levels should therefore be even higher, but it must be cautioned that the dynamics of P availability is affected by many factors and these soils may yet have a higher bank of P yet to be released. There has also been more P measured within the microbial biomass associated with these systems.

Tmt 7 had high inputs until 2006 when it changed to district practice, with Tmt 6 having reduced inputs from 2007.

It must be remembered that this is a trial situation and was originally set up to see what could be achieved when adequate nutrition was available to help drive the whole soil system. In the 2001 these systems yielded 3t/ha, and over 0.6t/ha higher than the district practice plots. For trial purposes, these inputs were generally maintained, and despite these extra costs, these tmts (10 & 11) have still been ahead in gross margins. The reality is that with the run of poor seasons we would encourage farmers to look at their P budgets and soil levels and adjust their rates accordingly. In reality this is what has happened, allowing for greater risk management with these intensive systems though this period of poor seasons.

Soil Nitrogen

Deep soil plant available N can vary greatly depending on soil type, rotation, summer rainfall and, in the case of intensive cereal systems, the activity of non-symbiotic nitrogen fixing bacteria in breaking down various levels of residual stubble.

It has also been previously measured that the more traditional systems with early cultivation, tend to mineralise more available N at the start of the season, but the No-till intensive systems result in more available N being supplied throughout the growing season, due to improved biological processes.

Coming from 2008 where pasture crop growth was poor, stubble levels were low and there was very little summer rainfall for mineralisation until the late April season opening in 2009, all factors that could potentially limit N availability.

There is a clear consistent difference in soil type with the flats averaging an organic carbon of 0.66 and available N of 60kg/ha, while the sand with 0.52 OC ave. had only 34kg/ha available N on average. In recent dry years it has been the sandier soils that have been able to yield higher with higher plant available water. This result emphasises why these soils still require higher N inputs than the flats to achieve this, due to their lower natural fertility.

It is interesting that the poor pasture plots from 2008 (2 and 4) resulted in much less N contribution than after the crop phase in this rotation (1 and 3). Plots 6, 7 and 9 had the lowest N levels on the sand, and these were the only ones following barley crops (Table 2.).

Given the low and variable yields with high weed competition, it is difficult to draw any clear relationship with N levels and yields in the 2009 season.

Root Disease Levels

It is interesting to note that there was medium to high levels of rhizoctonia inoculum measured across all plots, except for Tmt 9 on the sand, which has had a consistent history of canola in rotation.

It is clear from this trial and measurements across mallee farmer paddocks that rhizoctonia is generally high in the soil, despite different farming systems and soil types. The issue is however, how this affects crop performance. In this trial, soil samples were also measured for their potential root disease suppression due to the activity of competing soil microbes. This revealed a higher degree of suppressive action in intensive systems which had a direct correlation to lower rhizoctonia levels observed in the crop in September, as well as to increased crop yield. This is explained in more detail in a separate trial report entitled “Effect of Intensive no-till cropping systems on Rhizoctonia disease incidence at the Waikerie Core site”.

Long Term Production and Economic Outcomes, 1998-2009

When assessing the cumulative gross margins, there are some important considerations.

- While some of the crop / pasture gross margins have got closer to or surpassed some of the more intensive systems through the recent run of generally poorer seasons, mainly due to lower input costs, treatments 2 and 4 just happened to have their crop years in the run of better years, being 2001, 2003 and 2005 (also reflected in lower P levels due to greater export). It is far more realistic to take an average between the odd and even pasture crop years, resulting in a cumulative GM of $1093/ha and a total grain removal of 8t/ha.

- Because the crop / pasture systems 1-4 have had no actual grazing and pasture removal, their soil health is actually in a higher state due to greater carbon and nitrogen turnover, than in an actual paddock situation. It is hard to gauge what actual difference this would have made. A standard sheep grazing gross margin was applied to each pasture phase of $22/ha, which is very simplistic, and would in reality vary substantially for different years, prices and farmers.
- The total tonnage of grain taken is worth considering in relation to wheat pricing. These gross margins were worked out using each years local harvest price. If prices are generally higher, as they have been in recent years, then systems 10 and 11 will prove to be relatively more profitable, however, if prices remain at current lower levels and the cost remain high, and seasons poor, then lower input systems will have comparative advantages.
- Tmt 5-9 have not performed well, due to having a much higher risk due to more regular pulse or canola crops, which is well recognised as not a suitable strategy for this highly variable 250mm ave. annual rainfall area. These plots were originally set up to test various affects on soil dynamics, rather than actual intended possible local farmer rotations.
- Tmt 10 and 11 have proved to have shown the highest gross margins, despite using high fertiliser inputs (75kg/ha MAP with Zn, plus 43kg/ha urea). While very important in the early years, and supporting crops of up to 3t/ha in better seasons, this has been excessive in 6 of the last 8 season, as shown by the high build up of soil P in both the sands and flats soils. These plots continued to be given high input levels for the sake of trial comparisons, however, in reality (as previously discussed), Mallee farmers have been using these intensive cereal rotations with far lower fertiliser inputs. This has greatly reducing risk, but still achieving good yield for each season's rainfall.

Summary:

When this long term trial started there were real questions amongst Mallee farmers as to whether continuous cropping was sustainable in the Mallee as it was widely thought that the ground needed "a rest". Continuous cereal was also not used, as rotations were thought to require a legume phase, and apart from medic pastures there were generally no pulse options suitable for these low rainfall mallee conditions. Paddocks were regularly worked 4 times prior to sowing, and according to many farmers, No-till seeding would never work!

However, over a 10 year period, this trial has shown that soil health can actually be improved with intensive No-till cropping, with higher organic matter turnover increasing microbial activity and nutrient availability throughout the growing season.

Systems 10 and 11, which more generally represent what has been adopted by northern Mallee farmers, have shown to have doubled total grain production and in the trial environment had a 50% increase in gross margins. All with the added bonus of maintaining complete soil cover and halting erosion risk.

This had greatly increased the farming options available in the region and it has been amazing what has been produced in the last 5 seasons despite generally very poor rainfall. Farmers have tended to take this information and make it work for them and their particular situations, often starting out with modified machinery and building up confidence in the systems.

Many have successfully integrated their livestock enterprises which have been very important in maintaining diversity of income, while others have removed livestock completely. Many graziers are now using sown cereals for pastures which have still been No-tilled into stubbles, providing excellent earlier feed and helping maintain adequate soil cover.

While Mallee farming has been particularly challenging in recent years, it has been pleasing to observe that Mallee farmers have adopted systems based on many of the long term trials findings. They have achieved excellent water use efficiency and have generally kept our fragile mallee landscape free of dust storms.

Who's Involved:
This trial was originally conducted by CSIRO Land and Water, and was funded by the GRDC. In recent years it has been funded by MSF Inc and conducted by Rural Solutions SA.

Activities, Events and Industry Participation:
This site featured in the SA MSF Field Day in Sept 2, 2009 "A Decade of Difference", attended by 180 farmers and industry representatives, including the ABC Country Hour's live broadcast.

Future Directions:
It is hoped that this site will continue to be sown this year, with the same inputs across all plots, to again assess the inherent impacts of the previous farming systems. It will be planned for optimal management for the crop this season, including timely sowing and best practice grass weed and disease control. It is likely that fertiliser rates will be kept low, given the adequate soil levels and to reflect the pressures on local farmer budgets.

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