Farming Systems Comparison - Core Site

Catherine Evans, CWFS

Key Points

- Reliance on chemicals as the only weed control option is difficult (almost impossible) in a run of dry years.
- This trial will cease at the end of 2004 (3 years too early to obtain meaningful results) unless other funding is found.
- The trial showed, in the 2003 season, that there was no yield penalty for waiting until rain for sowing, although grain protein was lower in these crops.

Aim

The CWFS farming systems comparison commenced in 1998 and is located on NSW Agriculture's Condobolin Agricultural Research and Advisory Station. Farmers wanted a trial with paddock-sized plots and the researchers involved wanted a fully phased and replicated trial to ensure scientific validity. The trial is fully phased and replicated and covers 160 ha with each plot being approximately 2 ha in size.

The trial is investigating the management, sustainability and profitability of a range of farming systems. The trial consists of four replicates of four farming systems;
(1) grazed perennial pasture
(2) continuous annual cropping using no tillage and no livestock
(3) traditional system of long fallow wheat, short fallow wheat undersown, 3 years of grazed lucerne-based pasture and
(4) a modified system with two long fallow wheat crops and 2 years of grazed lucerne-based pasture.
The first 2 systems are the extremes (100% pasture and perennial system or 100% cropping and annual system) and the other two systems are more middle-of-the-road. The trial aims to demonstrate the differences between the 4 systems to allow farmers to make informed choices about farming systems in central western NSW. The trial has run for 6 years, completing one rotational cycle in 2002 and has commenced the second rotational cycle.

Methods

Each of the four systems is managed as a farm in its own right. A farmer committee oversees each system and management of the trial is discussed with the Chairman of each committee, who is an experienced farmer and an advocate of that system.

The *grazed perennial pasture system* is set up differently to the cropping systems. The perennial pasture system has a 10 ha block, replicated 4 times, each with a central watering point and 12 equal sized cells. Sheep are rotationally grazed around the cells; grazing days are measured. The pasture was sown in 1998, livestock were introduced in 2000 and the system has been continuous except for 3 months in late 2002 and 3 months in 2003 when de-stocking occurred due to drought.

The cropping systems work on a 5 year rotational phase with each phase present in each year (this takes out any 'year' effects and has proven to be a very important factor given 3 dry years). This means that there are 5 plots in each 10 ha block - each plot approximately 2 ha in size.

The ***continuous cropping*** *system* uses no tillage and no livestock and relies on chemicals for weed control. The rotation for the system is; canola - wheat (short fallow wheat after canola; SFWaC) - pulse - wheat (SFWaP) - green manure. The pulse was field peas for the first 4 years and has been lupins since. The green manure crop was also field peas for the first 3 years but was changed to vetch fop 2001 and 2002 and then to high density legumes in 2003.

The ***traditional*** *system* is similar to the system used by many farmers in the district. It relies on tillage and livestock for weed control, although chemicals are also used. The rotation is long fallow wheat (LFW) - short fallow wheat undersown (SFWu/s) - 3 years of grazed lucerne-based pasture.

The ***modified system*** also relies on livestock, chemicals and tillage for weed control. The rotation is a modification of the traditional system allowing for two long fallow wheat crops, to make use of moisture conservation. The rotation is long fallow wheat (LFW) - skip a year (weeds are kept to a minimum by grazing and in August a chemical fallow is used)
- long fallow wheat undersown (LFWu/s)
- 2 years of grazed lucerne-based pasture.

Fallow operations are management decisions made by each individual system. Summer weed control in the 2003 continuous cropping system was carried out by spraying with Shireweed® at 1.1 L/ha in January, Sprayseed® at 2.4 L/ha in March and again in April and then immediately prior to sowing, on 29th April, all plots except that being sown to canola, were sprayed with Triflur® at 1.4 L/ha. Canola was sprayed with Simazine® 1 L/ha and Atrazine® 2 L/ha on 6th May and on 7th May Triflur® was applied at 0.8 L/ha. In the modified system (reduced tillage with livestock), summer weed control in the 2 paddocks to be sown to wheat included scarifying in January, spraying in March with Roundup CT® at 1.2 L/ha and spraying in May with 0.8 L/ha Triflur® followed by cultivation. The traditional system received a working with offset discs in January, scarifying in March and spraying in May with 0.8 L/ha Triflur® followed by cultivation.

Time of sowing is also decided by each system's management. In 2003 the continuous cropping system opted to sow early despite no rainfall. There was the prediction of rain and they took the chance that it would occur - it didn't. Canola (var. ATR Beacon), pulse (lupins, var. Wonga) and high density legumes (as the green manure, using Crimson clover, Berseem clover and Persian clover) in the continuous cropping system were sown from 28th April to 1st May. There is the option for an early (var. Sunbri) and a late (var. H45) sown wheat in each system. Only the continuous cropping system chose to sow the early wheat variety (sown 1st May). The continuous cropping system also chose to sow the late variety wheat on 20th May, on the prediction of rainfall. The traditional and modified systems both waited until rainfall to sow. Sowing occurred from the 4th-7th July and H45 was sown in all wheat plots. Undersown wheat plots were sown with a mixture of Hunterfield Lucerne, Sephi medic, Dalkeith sub clover and Persian clover at 6 kg/ha.

In all wheat and lupin plots, DAP was applied at 75 kg/ha (14 N.15 P:0 K:2 S). The canola had DAP-S applied at 120 kg/ha (19:21:0:14) and urea at 50 kg/ha (23 N). The high density legumes had 50 kg/ha MAP (5:11:0:1). The sowing rate for canola was 2.5 kg/ha, high density legumes 6 kg/ha (2 kg/ha each variety), lupins 100 kg/ha (adjusted for germination test) and wheat 40 kg/ha. All fertilisers were applied at sowing.

In-crop herbicide applications are another management decision controlled by each system. In the continuous cropping system, the HDLs (green manure) were sprayed on 29th August with Sprayseed® at 3.2 L/ha and again on the 19th September with 0.18 L/ha of Kamba® to try to kill Paterson's curse. The sunbri wheat was sprayed with LVE MCPA® at 1.5 L/ha on 30th July to kill broadleaf weeds. H45 wheat was sprayed on 31st July with 1 L/ha Jaguar to kill volunteer lupins. The lupins were sprayed with Verdict® at 0.05 L/ha for grass weed control. Canola had no in-crop herbicides applied. No weed control was carried out on the other systems that were sown later. In the modified system the year 1 pastures (undersown in 2002) were slashed on 17th September to stop seed set of weeds, particularly Paterson's Curse.

The last year of pastures in both the traditional and modified systems had quite substantial lucerne and both system chairpersons decided it best to cut this for hay (to make money and/or produce feed) rather than spraying it out. In October this was cut and a total of 399 bales came from the 15 ha. These paddocks were later sprayed with Roundup® at 1.5 L/ha + Ester at 0.5 L/ha before being worked up in December.

Harvest commenced on the 13 th November with the continuous cropping H45 wheat being stripped first. Between the 17th and 20th November the rest of the wheat was harvested. Canola was harvested on the 25-26th November and lupins on 27-28th November.

Sheep graze 3 of the 4 systems. In the perennial pasture system they continuous rotate around the cells. In the other 2 systems, sheep are moved according to feed status of paddocks. In the mixed farming systems (traditional and modified) sheep graze stubbles and so have access to grain but this is not the case with the perennial pasture sheep that exist on the pasture alone. Sheep were shorn on 19th August 2003. If sheep are moved off the trial for any period of time, they are weighed as they come off the trial and then weighed back onto the trial. Fleece weights are collected at shearing along with fleece quality measurements. Live weights are gathered throughout the year. Sheep were removed from the trial on 17th June 2003 due to the dry conditions and were returned to the trial on 15th September 2003 (effectively a 3 month agistment). Crutching occurred on the 15th March 2004. On 8th April 2004, sheep in the mixed farming systems were again taken off the trial due to lack of pasture after the locusts' visit. As at 7th May 2004, the perennial pasture sheep are still on the trial.

Results

Cropping

The 2002 and 2003 seasons have been notable because of their dry conditions, resulting in low grain yields and high protein and screenings.

The following tables give the rainfall (Table 1) and yield and grain protein (Table 2) for the crops in 2003. A graph (Figure 1) shows the 2003 monthly rainfall and the 122-year average monthly rainfall for comparison.

Table 1: Monthly rainfall (mm) at Condobolin ARAS. Average annual rainfall = 442 mm.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
2002	0.8	172	19.4	11	22.1	4.4	8	6.6	45.1	0	2.8	14.2	306.5
2003	26.2	63	25.7	11.2	7.4	19.7	60.7	70.7	9.8	19.3	16.8	18.3	348.8

Figure 1: Graph showing 2003 monthly rainfall (bars) and the 122-year average monthly rainfall (black line) for Condobolin.

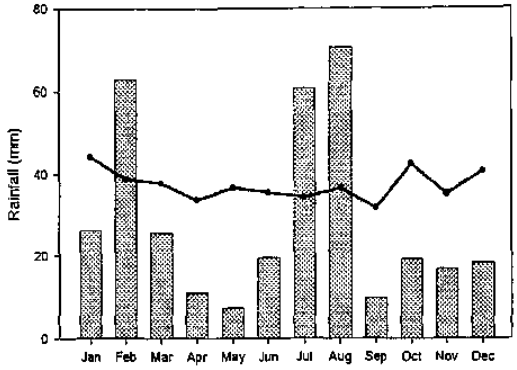

Table 2: Grain yield (t/ha), protein (%) for the 2003 harvest.

System	**Variety**	**Yield**	**Protein**
Traditional (CT)			
LFW	H45	0.70	15.1
SFW undersown	H45	0.86	14.2
Modified (RT)			
LFW	H45	0.84	**14.8**
LFW undersown	H45	1.02	13.4
Continuous cropping (ZT)			
SFW after canola	Sunbri	0.26	16.0
SFW after pulse	H45	0.93	16.4
Canola	ATR Beacon	0.36	-
Lupins	Wonga	0.18	-

There was no significant difference in average wheat yields between the 3 systems (5% lsd 0.3335). There was no significant difference between the yields of the H45 crops between systems (5% lsd 0.36). Sunbri was significantly lower yielding than H45 in the continuous cropping system ($P < 0.01$; 5% lsd 0.3579).

There is a significant difference ($P < 0.001$) in grain protein between the 3 systems (5% lsd 1.002) with the grain protein of the continuous cropping system being higher than either of the other 2 systems.

The Sunbri wheat in the continuous cropping system was sown early, did not get any sowing rains and struggled to stay alive until the rains in late June. The yield is significantly lower than the other wheat yields, suggesting that it was not worth sowing early without rainfall. The H45 in the continuous cropping system also did not yield any better than the other systems where the wheat was sown later, also suggesting that there is no yield benefit to sowing early without rain. There is however higher protein in the wheat from the continuous cropping system.

Sheep

The sheep of the perennial pasture system have cut less fleece/sheep and do not put on as much weight as sheep on the mixed farming systems (Table 3). It is proposed

that the grain in the stubbles has supplemented the diets of the mixed farming sheep, adding to the body weight and fleece. It has been observed that the fleece from the perennial pasture sheep is cleaner and may be of higher quality than that of the mixed farming systems sheep, this is being investigated. Further body weight changes from September 2003 to April 2004 are being calculated presently and will be presented later.

Table 3: Sheep data for the 2003 year, from the systems comparison trial.

System	Average fleece weight (kg/sheep)	Av. body weight change (Dec 2002 to June 2003)
Traditional (CT)	5.67 *b*	7.86 *b*
Modified (RT)	5.36 *b*	11.40 *c*
Perennial pasture (PP)	4.80 *a*	3.45 *a*
5% lsd	*0.3322*	*1.89*

Discussion

Drought years are having an effect on the systems and decisions made in these trying conditions are having an effect on the results. Years of below average rainfall (drought years) are a part of the Condobolin farming system (data from rainfall records for the past 120 years) and so are a valid part of this farming systems comparison. To discount the last few year's results saying that the drought had invalidated them would show a lack of understanding of the Condobolin environment.

Of the 4 systems in the comparison, the continuous cropping system has caused the most management issues. In 2003, the choice of green manure crop, the continuation of an integrated weed management plan (IWMP) and the ensuing weed situation were the greatest problems.

The continuous cropping system chose High Density Legumes (HDLs) as their green manure crop for 2003. After the success of vetch in 2002 this decision was questioned but the system committee believed that weather forecasts predicted a better 2003 and stuck with their decision. The HDLs were a failure. Plants grew sporadically across the paddock and weeds out-competed them. This situation would not be unusual on farms or in research. It is easy to expect something to work and then circumstances cause it to fail (e.g. no rain, locusts, hot winds, frost).

In 2002 an integrated weed management plan (IWMP) was devised for the trial. Of particular concern was the continuous cropping system where Roundup® application had occurred each summer for the past 5 years giving a total of up to 18 Roundup® applications on the plots. After consulting with the NSW Agriculture weeds technical officer, Keith Pengilley, we made the decision not to use Roundup® for the following year and to use a system where Glyphosate (eg Roundup®) is used for 3 years and then an alternative is used. This would give us the greatest chance of avoiding the problem of herbicide resistant weeds, which can develop after about 20 applications of Roundup® (pers. comm. K. Pengilley). Unfortunately herbicides did not work well in the dry conditions of the summer of 2002-3. We stuck with enforcing the no Roundup® rule because we considered developing herbicide resistance to be a breach of our

share farm contract with NSW Agriculture and the far greater of the two issues. So we had a weed problem in 2003.

The weeds on the green manure plot were exacerbated by the poor growth of the HDLs and so this plot was by far the worst affected. As documented in a variety of newspapers and magazines, including *The Land;* 2003 was a good year for Paterson's Curse and the trial was no exception. We sprayed it, without much success, and we mowed it to stop it setting seed. There was nothing else we could do with it. In both of the mixed farming systems, the pastures we had tried to establish under the wheat crops in 2001, 2002 and 2003 were unsuccessful, as was most pasture establishment in the district. So the weeds also became a problem on these paddocks - or sheep feed if you want to look at it more positively!!

So the dry years have posed some challenges to each of the systems. The continuous cropping system has posed the most management issues and that may be a factor as to why it is not widely adopted in the Condobolin district. In a no livestock, no tillage continuous cropping system, you rely entirely on herbicides for weed management. In dry years herbicides have proved to be unreliable or not effective and this has challenged the system. Having an option of grazing or cultivation to manage weeds has seemed to be a far more versatile system and although there are still management issues, there are more management tools available for the farming system.

We have improved the data collected from the livestock part of the systems and this needs to be worked into the economic analyses and statistic analyses in the future. The trial is being used as part of a NSW Agriculture project and Brett Honeysett is collecting pasture and water data from the trial. Over the next year these will also need to be integrated into the analyses so that next year we can publish a more cohesive whole system story, rather than a message about predominantly cropping factors.

Over 2004 we have carried out most of the deep soil sampling of all plots. This will allow us to compare any changes in soil chemical properties between the 1999 samples and 2004 samples. Some of the pastures have been too dry to sample and we will do this as soon as rain permits. A full economic analysis of all years, with variations to sheep and wool prices, still needs to be done, along with further in-depth statistical analysis. With luck, that will all be completed before our funding runs out.

Conclusions

Analysis of the 2003 year has shown a significant difference in grain protein but not yield between the 3 cropping systems. In this low rainfall environment there may be large yield penalty for sowing early when there is no soil moisture (Sunbri in 2003 - the crop struggled out of the ground and continued to struggle all year). In the drought years of 2002 and 2003 we have seen that reliance on herbicides alone have resulted in high weed burdens as conditions have not been favourable for good weed control (e.g. plants moisture stressed, dust abundant, no moisture to activate some herbicides). Systems comparison trials need time for the effects of a system to occur. The next 5 years will be when the true effects will be seen.

The Future of the Trial

The future of the CWFS core farming systems comparison trial is uncertain. GRDC have made it quite clear that they will not be funding this trial in the future. The trial costs about $70 000 a year to run (including a staff member to carry out the operations) and for this trial to continue, those funds will need to be found. In my mind, it seems like an awful waste of money, effort and energy to carry out 7 years of work and scrap the trial before any meaningful results are obtained (after 2 rotational cycles, 10 years, some meaningful system comparisons are likely). I believe that we are starting to see some differences between the systems, particularly during the last few dry years. Dry years are a part of the farming system in Condobolin and to discount any results found during that last few years shows a lack of understanding of the environment in which we work and farm. I will be very disappointed to see the end of this trial. It is extremely well designed, has enough flexibility within the systems to keep them up-to-date and is starting to show some interesting trends. There is national interest in this trial and to lose it will be huge blow to farmers and research in central western NSW. Cath Evans, CWFS Research Coordinator.