Challenges to Developing High Rainfall Cropping Systems

1. The Potential

The "cool climate high rainfall" zone of Southern Victoria has an extremely large potential for sustainable and profitable crop production. In most areas this potential is far from being realised. It is estimated there is conservatively 500,000 hectares of traditional grazing land that could convert to cropping or a mixed farming operation in southern Victoria alone. That is, if we can do something about our major limiting factor, namely winter waterlogging. If this change in land use was to take place, the production of high yielding crops could mean an addition of 400 to 600 million dollars to the economy on an annual basis.

2. Background

Historically, the area has relied heavily upon wool production as its major source of primary production income. It can also be argued that wool production has served the area well with very good returns being possible prior to the dramatic downturn in prices in the last decade. Despite the current low price for wool, most farmers still have wool production as their major enterprise.

There has been a significant amount of work undertaken in recent years to benchmark the performance of industries in the South-West Region of Victoria. Possibly the most important work has been undertaken by the Department of Natural Resources and Environment with the South West Monitor Farm Project. This project clearly demonstrates the high reliance on wool production in the area. According to the1998 study, the typical farm in for 1996/97 was 898 hectares in size, ran 5,596 sheep and 262 beef cattle and cropped 49 hectares. This represented an average enterprise mix consisting of 62 % wool sheep, 15 % prime lambs, 19 % beef cattle and 3 % cropping.

Why is it then that crop production has been a very low priority for most farmers? Quite simply, it has been due to the very poor returns from cropping in most years. It has been proven time and time again, that cropping for many farmers in the high rainfall cool climate zone of South-West Victoria has resulted in either failed crops or extremely poor yields. The poor performance has been due to a combination of factors including waterlogged soils, too many weeds, inadequate nutrition and poor management. In many cases, crops have been grown to supplement the livestock enterprises and have been used as a means to "clean up a paddock" to prepare for the sowing of a new pasture. Crops have often been viewed as an opportunity enterprise when conditions were seemingly right. When crops failed because of climatic conditions beyond the control of the grower, such as too much winter rainfall, then this has generally been accepted as something that could not be avoided. Farmers in the main have become locked into the cropping paradigm.

3. The Challenge

Southern Farming Systems began in 1995 to objectively look at the cropping and livestock enterprises in the high rainfall zone and realised that there needed to be a change made to the traditional farming system, to enable farmers to capture the opportunities that the area presented. One of the major driving forces was that of profitability, as it was identified that unless something was done to dramatically change the economic situation of farmers in the region, that many of them could not survive the projected long term wool downturn. The farming community was also very aware that any new system needed to be sustainable in terms of responsible land use.

A detailed analysis and consultation process undertaken to identify the strengths, weaknesses, opportunities and threats for the region. It was identified quite early in the investigation, that one of the region's strengths was the excellent rainfall, which in most years was well distributed and quite reliable for winter cropping. In fact, the growing conditions for crops were recognised as being superior to those experienced in the Mallee and in many areas of the Wimmera. It was also recognised that whilst the rainfall was a significant strength to the region, it also presented significant weaknesses with regard to winter waterlogging of the region's predominantly heavy basalt soils. This was mainly a result of the significant water-holding capacity of the soils and the low ambient temperatures resulting in low crop evapo-transpiration.

One of the real strengths of the "high rainfall cool climate" zone of Southern Victoria is its potential for crop production, particularly that of oilseeds. The long and cool growing season means that Canola is particularly well suited, with oil quantity and quality generally being very high because of the extended cool finish to the season. Linseed and Linola are also well adapted to the region and offer greater rotation flexibility. The opportunity exists to establish South West Victoria as the premier oilseed producing region of the State.

The area is also very well suited to the production of high quality malting Barley. The cool finish and extended growing season is conducive to large grain size and good malting characteristics. A large plant situated in Geelong has the capacity to service significant tonnages out of the region.

Another clearly identified strength, is the ability to grow the new winter, feed wheat varieties becoming available. The long growing season suits the genotypes well and perhaps gives the opportunity to undertake a grazing if sown early enough. The vernalisation requirement of these cultivars would also mean that the risk of frost damage at flowering, one of the real weaknesses, could be significantly reduced. The opportunity is there to significantly increase the feed grain production out of South West Victoria to service the needs of the expanding feed grain dependent intensive livestock market. Recent studies have shown that the demand for feed grain is approximately 1.1 million tonnes annually. This equates to approximately 275,000 hectares of feed grain production annually, assuming a yield of 4 Tonnes per hectare.

Another major strength for the area is the ability to grow a range of plant species and the opportunities to establish flexible rotation systems. There is the ability to grow crops and pastures for nearly 12 months of the year in many areas. This significantly reduces the likely threats associated with market collapse of individual enterprises.

The major weakness or limiting factor identified is winter waterlogging of the region's soils. The ceiling for plant yield is continually being set at a low level because of the significant waterlogging of the soils over winter. The ability of plants to extract nutrients is reduced because of this waterlogging. The weed problem, particularly that of toad rush, could also be attributed largely to the wet soil problem over winter. This weed problem is also made worse because of the need to cultivate these waterlogged soils to get them into a decent tilth prior to sowing.

Another significant problem identified is the declining soil structure in cropped soils and the ability to only grow profitable crops after a prolonged pasture phase in the dispersive heavier soil types. This declining soil structure is amplifying the negative affects of winter waterlogging and makes cropping extremely difficult. It is also significantly restricting the paddock options available to growers.

As a result of the analysis the major opportunity to come to light was to change the way that we managed our soils so that we could capitalize on the climatic strengths that the region possessed. If we could reduce our winter waterlogging problem, then significant gains could be made in plant yields. Given the opportunities emerging in the oilseed and feed grain areas, attention was turned to trying to significantly increase crop yields.

4. The Vision

Southern Farming Systems has set the target for wheat yields to increase from 2.1 Tonnes per hectare to 5.5 Tonnes per hectare as a regional average by the year 2005. It is also envisaged that 7.5 Tonnes per hectare for wheat should be a reasonable target yield for the top 10% of growers.

To achieve this significant lift in productivity may seem beyond the realms of possibility, particularly given the current very low average yield of approximately 2.1 Tonnes per hectare for wheat. The reason for thinking it is possible, is in the exceedingly dry 1997, when for the most part waterlogging was not an issue, winter wheat was yielding in excess of 7 Tonnes/Ha. Perhaps 1997 sets the base for what is possible, with yields expected to improve on this.

5. The System

Southern Farming Systems is embarking on a new system of growing crops, on raised beds using controlled traffic technology. Actually the system has been around for years, particularly in the irrigation areas in NSW and QLD and also in the vegetable growing industry. What we are really doing is applying irrigation technology in reverse. Instead of using raised beds to apply water down the furrows, we are using them to manage the excess water during the winter. The adoption of controlled traffic technology, a major feature of raised bed farming, is an integral system component in order to improve soil structure in the long term.

Why has it taken so long to wake up to trying this new approach? Well once again we have been blinded to this opportunity for many years, because we have grown to accept that our crops get water-logged over winter and that there is nothing we can do about it. We have had to unlock our minds to the new opportunity. We have in fact, had to look at converting a weakness into a real opportunity.

The system of raised bed farming simply means that furrows are formed approximately 2 metres apart and crops are grown between the furrows or on the "beds". The beds are raised approximately 20 centimetres to get the crop out of the waterlogged soil. All traffic such as planting and spraying is confined to the furrows to avoid compaction. Harvesting is the only operation to take place on the beds, although over time this too will change.

Excess water over the winter and spring months is stored on farm to be possibly re-used on high return crops over the summer.

6. The Results

The results so far have been very encouraging with significant increases in crop yield, across a range of soil types and crop types. These results have been achieved largely in broadacre farmer demonstrations and not in replicated trials. Detailed trial work using fully replicated trials will begin this year.

A detailed demonstration study into different drainage techniques has been conducted at Gnarwarre over the last two years. Table 1 gives the results from the 1996/97 season where Canola was grown on different drainage treatments

Table 1

	20 metre wide raised beds	**Underground Drainage**	**Control – spoon drained**	**1.5 metre narrow raised beds**
Yield T/Ha	3.30	3.33	2.20	3.55
Oil content	42.4%	44.3%	N/A	41.7%
Gross Margin	**$1,068**	**$1,118**	**$580**	**$1,156**

Variable Costs of $300/Ha and grain price of $400 per tonne

It is important to highlight that if spoon drainage was not used in the control area, then no crop could have been grown due to flooding of the site.

The above demonstration area was then sown to Franklin Barley in 1997. Table 2 gives the results of the 1997/98 demonstration trial.

Table 2

	20 metre wide raised beds	Underground drainage	Control – spoon drained	1.5 metre narrow raised beds
Yield (T/Ha)	6.55	6.90	5.70	6.30
Protein	11.4%	10.7%	10.8%	11.3%
Screenings	30.5%	17.2%	16.3%	12.9%
Moisture	12.7%	13.0%	12.8%	12.7%
Skinning	8%	18%	8%	14%
Classification	Feed	Feed	Malt 5	Malt 2
Gross Margin	**$703**	**$755**	**$661**	**$917**

Variable costs of $280/Ha. Feed Price $150/tonne, Malt 5 price $165/tonne and Malt 2 price $190/tonne

When we combine the gross margins over the two years, then we have the following situation as outlined in Table 3

Table 3

	20 metre wide raised beds	Underground drainage	Control – spoon drained	1.5 metre narrow raised beds
Canola Gross Margin 96/97	$1,068	$1,118	$580	$1,156
Barley Gross Margin 97/98	$703	$755	$661	$917
Total	**$1,771**	**$1,873**	**$1,241**	**$2,073**
Difference to Control	**$530**	**$632**	**$0**	**$832**

Another finding is that there also appears to be a significant improvement in soil structure in a very short period of time. Recent tests indicate that in just two years, soil structure in the raised bed treatment compared to the control at the Gnarwarre site has improved dramatically. Table 4 clearly shows this.

Table 4

Test	**20 metre wide raised beds**	**Underground drainage**	**Control – spoon drained**	**1.5 metre narrow raised beds**
PH (Water)	5.7	5.7	5.8	5.4
Aluminium	10	11	<10	<10
Electrical Conductivity (Water)	0.18	0.16	0.17	0.34
Total Soluble Salts	.06	.05	.05	.10
Olsen Phosphorus	10	11	11	12
Potassium	260	290	310	220
Sulphur	40	29	51	160
Dry aggregate slaking	Partial	Partial	Partial	Water Stable
Dry aggregate dispersion (2 hrs)	Nil	Nil	Slight	Nil
Dry aggregate dispersion (20 hrs)	Nil	Nil	Moderate	Nil
Remoulded aggregate (2 hrs)	Strong	Strong	Strong	Nil
Remoulded aggregate (20 hrs)	Strong	Strong	Complete	Nil
Oxidisable Organic Carbon	1.6	1.9	2.1	1.9
Organic matter	3.1	3.6	4.0	3.6

6.1 Discussion

In terms of dispersion and slaking, the narrow raised beds have been given a completely clear bill of health. The soil is in excellent physical condition, whereas the other treatments show some signs of slaking and dispersion. This corresponds very well with the "eyeball analysis and feel tests" conducted. Right throughout the summer period, the narrow raised beds have maintained excellent structure whereas the other treatments have set quite hard.

Further studies by Ballarat University, has indicated significantly greater porosity in the raised bed treatment compared to the control. This greater porosity is due to an increased depth of aggregates, from the self-mulching of the surface soil along with the absence of traffic.

The force required to push a probe into the raised bed soil was considerably lower than the control, with easy penetration down to 45 cm in the raised bed treatment compared to only 6 cm in the control. Given the better soil structure in the raised bed treatment, there was significantly more summer rainfall stored in the soil by comparison to the flat land control. In the latter case, the summer rainfall is thought to have disappeared down the severely cracked soil, or lost through surface run-off. There was virtually no cracking in the raised bed treatment.

These results are extremely encouraging and we are seeing changes in soil structure much faster than we had originally anticipated.

It appears that waterlogging may have a greater damaging effect on soil structure than cultivation. This however requires further analysis over time. The controlled traffic aspect also should be contributing to this improvement in soil structure.

If we can improve the soil "health", then we are well underway to developing a much more sustainable farming system.

7. Economics of the System

It is extremely difficult to accurately determine what the returns and costs are likely to be, because no two farming systems are the same, however Table 5 presents an approximate analysis. The analysis includes the cost of establishment for the system, which is amortised over 3 years.

Table 5 – Gross Margin / ha for Canola

	Contract	Own Equipment*
Returns		
2.5 Tonnes/Ha @ $350 / Tonne	$875	$875
Costs		
Surveying	$15	$15
Cultivation – 3 passes	$150	$75
Grader work	$15	$15
Bed forming	$50	$20
Total Set Up Cost	$230	$125
Amortised Cost over 3 years	$77	$42
Crop Variable Costs	$350	$300
Gross Margin	$448	$533

* Contract windrowing and harvesting is carried out. The yields given are regarded as being conservative.

When comparing between contract versus owning your own equipment, it is essential that the machinery overhead costs are taken into account. Obviously the overhead costs are going to be substantially higher in the situation where your own plant is used.

Table 6 shows a similar analysis this time for wheat.

Table 6 – Gross Margin / ha for Wheat

	Contract	Own Equipment*
Returns		
4.0 Tonnes/Ha @ $150 / Tonne	**$600**	**$600**
Costs		
Surveying	$15	$15
Cultivation – 3 passes	$150	$75
Grader work	$15	$15
Bed forming	$50	$20
Total Set Up Cost	$230	**$125**
Amortised Costs over 3 years	$77	**$42**
Crop Variable Costs	**$300**	**$250**
Gross Margin	**$223**	**$308**

* Contract windrowing and harvesting is carried out. The yields given are regarded as being very conservative.

7.1 Discussion

The results clearly indicate that Canola is the higher returning crop, and in most situations will be the best crop to start the rotation cycle with. The crop should give you the returns to help finance the establishment of the system.

The yields given in the analyses are reasonably conservative, however it is better to adopt this approach rather than giving expected top yields.

The high establishment costs of the system assume that significant cultivation needs to be undertaken to establish a soil condition required for the successful establishment of the beds.

The bed establishment costs has been averaged over 3 years. It is anticipated that the beds should last 3 – 5 years before total re-establishment is required. A small amount of bed maintenance work may be needed at the end of each year to reshape the beds.

The system relies on keeping grazing animals off the area in order to minimise damage to the beds and to keep compaction to a minimum.

7.2 Comparison to the Grazing System

Table 7 gives the average and top 10% of farmer results for the beef, wool sheep and prime lamb enterprises in the South West Monitor Farm Project for 1996 – 97.

Table 7

	Average	Top 10%
Beef Gross Margin per hectare	$41	$113
Prime Lamb Gross Margin per hectare	$282	$421
Wool Sheep Gross Margin per hectare	$142	$240

8. Adoption of the new System

The adoption of this raised bed technology should proceed with caution. There are many factors to consider and we would really like to see the system tested over at least 2 more wet years. The results are however at this stage extremely encouraging.

There are several system parameters that need to be carefully considered, namely

1. Movement of water off the paddock. Care must be taken that water coming off the paddock does not contain pesticides or nutrients. It is envisaged that given soil structure is improving along with significantly greater plant growth, "drainage water" may in fact decrease over time compared to a traditional flat land system. This has in fact been shown to be the case in Western Australia.

2. The timing and rates of nutrient application need to be re-assessed, given that we are looking at a totally new system. Since we are able to traffic the country at any time over winter, then I believe that we can be far more strategic in our timing of nutrient application. We will possibly see more frequent applications of low rates of fertiliser, in order to increase plant uptake of nutrients and to reduce the leaching losses.

3. The water that is coming off the raised bed country should be contained on the farm to be re-used on possibly high return summer crops. Downstream effects of water flow needs to be reduced to a minimum or in fact eliminated. Farmers should be encouraged to collect all their run-off water. In no circumstances is water to be allowed to flow onto road ways or directly into water-ways.

4. A filter trap should be installed before collecting water in dams. This could consist of at least a 50 metre wide pasture buffer across the direction of water flow. This is aimed to trap any soil particles, which may contain pesticide residue and other contaminates.

5. The slope of the country is critical to the success of the system. Any more than 2.5% - 3% slope could cause significant erosion problems in some soil types. Any less than 1% slope may not drain the water effectively.

The water flow and water quality parameters are being assessed at our research site at Gnarwarre with a system of weirs installed in a large scale drainage and farming system trial.

9. Further Potential

The system certainly does uncover the possibility of more crops and pasture species being adapted to the high rainfall cool climate zone. If we can overcome waterlogging, crops such as lupins and other pulse crops along with lucerne may be a possibility on our heavier basalt soils.

There is the possibility that the system may have some application in saline country. Given that we can keep the plants out of the salty water in the beds, then we should be able to establish the seedlings in a relatively salt free environment. By the time the plant roots reach the soil containing higher salt loads, plant tolerance will have increased.

The investigation so far certainly indicates that cropping may be a far more viable option for farmers in the high rainfall cool climate zone of South West Victoria than it has been in the past. It certainly is not suggested that cropping should replace the grazing enterprises, however if carried out in such a way as to reduce the possible risks, then it should offer greater flexibility to the producer in the region.

The new system I believe should provide the producer an ability to be more flexible in the choice of enterprises for the farm and with this, hopefully result in a much more sustainable and profitable farming system for the future.