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Profitability of Intensifying Cropping in the Mallee Region of Victoria

Victorian Institute for Dryland Agriculture, Horsham

Abstract

A whole farm linear programming model, PRISM, was used to investigate the profitability of adopting a more intensive crop rotation in the central Mallee region of Victoria (annual rainfall 300-350mm). The model was optimised for farm profit with different amounts of working capital so that optimal proportions of a wheat-field pea-wheat-lupin rotation and a pasture-pasture-wheat rotation were included in the enterprise mix. Based on average yields from a 10 year rotation at the Mallee Research Station, Walpeup, increasing crop intensity from 33% of the farm to 77% of the farm increased annual profit by 38%. When the model was run again using typical input costs and average yields achieved in the region, intensification of cropping decreased annual profit by 86%. Average crop yields and wheat growing costs in the region were 20% lower than the Mallee Research Station, Walpeup. The analysis indicated that the profitability of more intensive cropping in this region is highly dependant on crop yields.

Introduction

This paper investigates the economics of increasing crop intensity in the Central Mallee (300-350mm) region of Victoria. This region is predominantly a cereal growing area producing high protein wheat, malt barley and feed barley. Cereal cropping is complemented by lamb production in the region (Merino ewes crossed with Dorset rams). Recently, farmers in this region have questioned the role of medic pastures in crop rotations due to variability of pasture production and low wool prices.

Previous economic analysis of research station plot trials (Wimalasuriya 1998), indicated that intensive crop rotations such as wheat-field-pea-wheat-lupin, canola-barley-lupin-barley and pasture-lupin-wheat were more profitable than traditional rotations such as pasture-fallow-wheat. The analysis used yields and costs obtained from research plots on the Mallee Research Station between1980-1989.

Economic analysis of research plot yields and costs may not reflect farmer returns from intensive cropping. This is due to: the variability inherent in experimental materials and cultural practices, management skills of farmers and soil variability (Odulaja and Nokoe 1997). Also, edge effects in research plots can result in overestimation of grain yield (Hadjichristodoulou, 1983).

Therefore, to examine the economics of intensive cropping at a farm level, paddock records of rotations on the Mallee Research Station were used. Inputs and yields from paddocks between 3.5 and 40 hectares are more realistic than experimental plot data, giving a better indication of commercial returns. The records included yields, costs and wheat protein concentration from two rotations used on paddocks between 1987 and 1997. The rotations included a high intensity crop system, wheat-field pea-wheat-lupin (W-Fp-W-L) and a low intensity system, pasture-pasture-wheat (P-P-W).

Even though crop yields and inputs would be closer to district average, it was expected that continuous cropping would give higher returns than less intensive cropping. This was because of the low stocking rates and present low returns of livestock enterprises in the Mallee.

Methods

A linear programming model, PRISM (Profitable Resource Integration Southern MIDAS) was used to evaluate the profitability of moving from a low intensity crop rotation (pasture-pasture-wheat) to a high intensity crop rotation (wheat-field pea-wheat-lupin) on sandy loam soils. Data for labour, machinery and capital requirements for the analysis was provided by local farmers. Crop costs, yields and wheat proteins were obtained from 11 years of paddock records of the two rotations at the Mallee Research Station, Walpeup. Regression analysis was used to generate average crop yields and protein concentrations for the PRISM analysis.

The PRISM model was set up to represent a traditional farm and enterprise mix for the central Mallee region. The farm size was 1200 hectares, of which one third was cropped annually and the remainder was a medic based pasture. The farm had two soil types: sandhill soil (33% of the farm) and sandy loam soil (67% of the farm). The sandhill soil was not suitable for field pea crops. Lupins can be grown on sandhills with a low pH, but were not included in the analysis because of lack of data. In the analysis the rotation on this soil, pasture-pasture-barley (P-P-B), remained constant. Barley yield on the sandhill soil remained constant at 1.9 tonnes per hectare. The sandy loam soil, which was suitable for pulse crops, was modelled as combinations of the low crop intensity P-P-W rotation and the high crop intensity W-Fp-W-L rotation.

In PRISM, livestock have access to different feed sources throughout the year. From December to April, livestock could graze crop residues or be fed grain. In May, pasture and grain were available and from June to November, livestock had access to pasture. For this analysis, the livestock enterprise remained constant as a lamb producing enterprise (Dorset Ram crossed with Merino Ewes). In the model, lambing for this enterprise commenced in May and lambs were sold at 24 weeks when they reached a carcase weight of 19 kilograms. In the Mallee, farmers usually sell 60% of their lambs at 18 weeks and 40% of their lambs at 34 weeks. The weaning percentage was 90. The annual average dry stock equivalent rating of the livestock enterprise was 1.8 DSE per ewe. The gross margin for this flock ($37 per head) did not include grain feeding costs (these were calculated by the model) or pasture establishment and maintenance costs ($13 per hectare of pasture per year).

The model was optimised for farm profit at different levels of working capital to ascertain the relationship between level of working capital (variable cost of production, cash overheads and operators allowance), farm profit and enterprise mix. At different levels of working capital, optimal proportions of P-P-W and W-Fp-W-L rotations were included on the sandy loam soils in the enterprise mix. The starting amount of working capital was the amount required for a low intensity 1200 hectare farm. Working capital was then increased by $20,000 increments. Due to soil type and rotation constraints in the model, the maximum area of cropping was 77% of the whole farm.

The interest charged on working capital required for intensifying cropping was 12%. The value of ewes replaced by cropping was $25/hd. Farm profit was total farm gross margin, less overhead costs ($37,700), less operators allowance ($30,000). Overhead costs included: administration, rates, depreciation, insurance, casual labour and finance costs (ABARE 1995).

A group of five farmers were asked to provide information relating the machinery and capital required for increasing crop intensity from 33% to 77% of the whole farm. The farmers agreed that the low intensity crop farm was run by a single operator. Available machinery included a 150 horsepower tractor, a 30 foot seeder and a PTO harvester. Increasing the crop area meant that a spray contractor would be needed at sowing and pulse crops would be contract harvested. This increased the costs of growing pulse crops by $22/ha (harvesting costs) and the cost of the W-Fp-W-L rotation by $5/ha (contract spraying costs).

Regression analysis was used to generate rotation effects, average crop yields and current costs for crops in the P-P-W and W-Fp-W-L rotations. These data were then used in the PRISM model for the economic analysis. Data that were used in regression analyses included: (1) wheat yield from 1987 to 1997 versus growing season rainfall (GSR) and rotation, n=11 (2) wheat protein versus GSR and rotation, n=6 (3) pulse yield vs crop type and GSR, n=11 (4) cost of growing wheat vs time and rotation, n=8 (5) cost of growing pulses vs type and time, n=8.

Medium term forecast prices (Gorden., et al, 1997) used in the analysis were wheat (12.7% protein) $187/t, Malt Barley $167/t, Field Pea $223/t, Lupin $223/t, dressed lamb meat $1.72/kg and clean wool (eastern market indicator) $6.91/kg.

The analysis was repeated using average crop yields from 1988 to 1993 for the central Mallee: wheat 1.58t/ha, barley 1.54t/ha, field pea 0.95t/ha and lupins 0.8t/ha (McSwain, 1996). Lower wheat growing costs (decreased by $20 per hectare) and a lower operators allowance ($25,000) were also used to be more representative of farmer inputs. These yields and prices were run for the enterprise mixes that were optimum using MRS yields.

To ascertain the risk associated with growing pulse crops compared to cereal crops, gross margins for wheat and field pea were calculated for 10 different season types called deciles. Growing season rainfall deciles were calculated by the Potential Yield Calculator model. In the model, 10% of rainfall records are lower than a decile 1 season and 90% of records are higher. Similarly for a decile 2 season, 80% of rainfall records are higher rainfall and 20% are lower.

Yields for wheat and field pea were calculated by using growing season rainfall deciles in the regression equations produced from Mallee Research Station data. The analysis was repeated using 20% lower crop yields and 20% lower wheat growing costs to represent district average.

Results

Regression Analysis

Time and paddock history explained 40% of the variation in the cost of growing wheat. The estimated cost of growing wheat was $92± $5/ha in the W-Fp-W-L rotation and $102±$5 for the P-P-W rotation in 1997. The extra cost of wheat in the P-P-W rotation was due to extra cultivation. Time, type of grain legume (field pea or lupin) and the time by type interaction explained 79% of the variation in grain legume costs. Although lupin was originally cheaper to grow than field pea, in 1997 the costs were very similar (field pea $125/ha and lupin $138/ha). For the analysis, the cost of growing field pea ($147) and lupin ($160/ha) included a contract harvesting cost.

There was no significant ($P<0.05$) difference between wheat yields or protein percentage in the two rotations; growing season rainfall explained 69% of the variation in wheat yield and 44% of the variation in wheat protein (Table 1). The adjusted mean wheat yield and protein percentage was 1.96t/ha and 12.7% respectively. Growing season rainfall explained 53% of the variation in pea and lupin yields; type of grain legume did not significantly ($P<0.05$) improve the regression. The adjusted mean for field pea and lupin yields was 1.08t/ha.

Table 1 Linear regression coefficients for growing season rainfall (mm) and wheat yield, wheat protein and grain legume yield at the Mallee Research Station. The adjusted means are for the average growing season rainfall of 220 mm.

Variable	% variance accounted for	Parameter	Constants and Coefficients	Standard Errors	Adjusted mean ± Standard Error
Wheat yield (t/ha)	69.0	a	-1.132	0.350	1.96±0.09
		b_1	0.014	0.002	
Pulse yield (t/ha)	53.1	a	-0.468	0.333	1.08±0.09
		b_1	0.007	0.001	
Wheat protein (%)	44.1	a	16.078	0.851	12.7±0.29
		b_1	-0.015	0.004	

PRISM Analysis

The PRISM model optimised enterprise mix for four different levels of working capital, starting at $119,300 and increasing by $20,000 increments. As available working capital increased, more intensive cropping was selected in the optimal mix (Table 2). This was due to the selection of the W-Fp-W-L rotation at the expense of the livestock based P-P-W rotation. Increasing crop intensity from 33% to 77% of the farm, caused livestock numbers to decrease from 960 to 70.

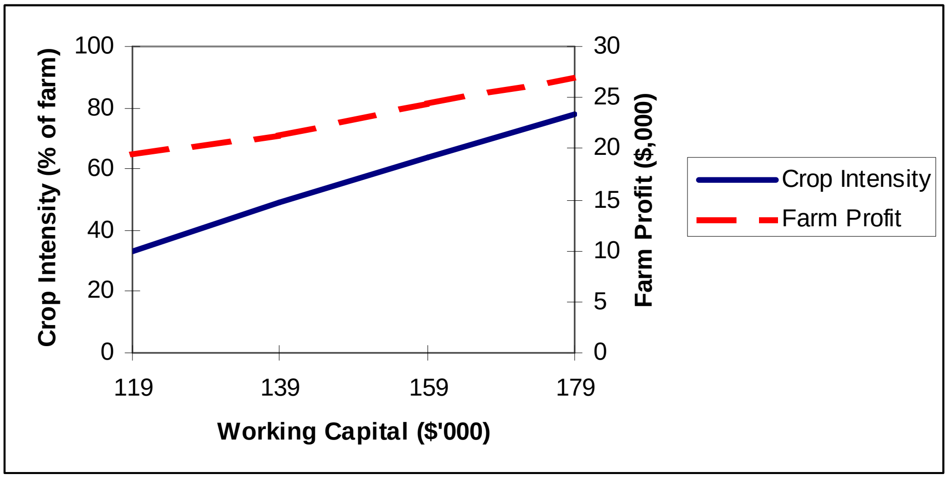
There was also a decline in the stocking rate from 2.2 DSE/ha to 0.5 DSE/ha per hectare as a result of sheep being allocated to the lower productivity soil type (sandhill) while cropping was allocated to the more productive soil type (sandy loam).

Table 2 Effect of working capital on crop intensity and sheep numbers

Working Capital $	Crop Intensity % of farm	Sheep Number Ewes	Stocking Rate DSE/ha
119,300	33	960	2.2
139,300	49	650	1.9
159,300	64	340	1.4
179,300	78	70	0.5

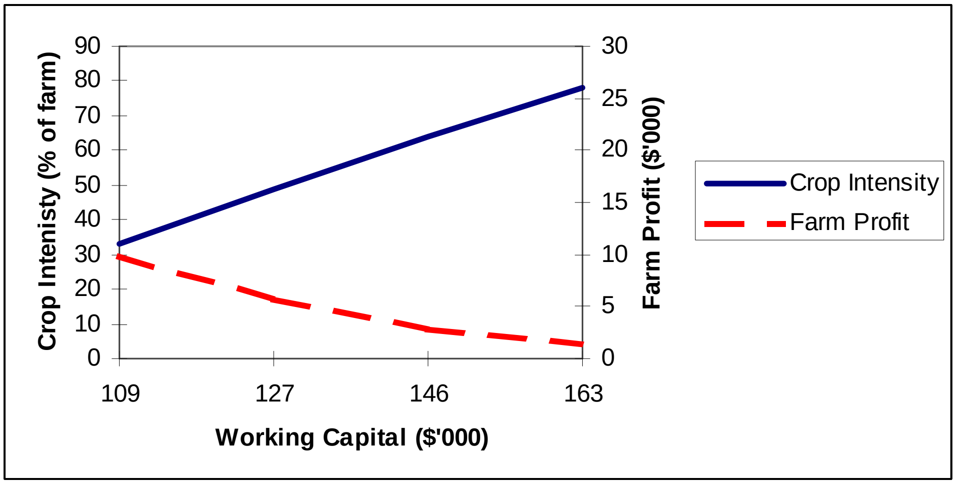
Increasing working capital from $119,300 to $179,300 (an increase of 50%) increased farm profit from 19,600 to $27,100 (38%) as a result of intensive cropping replacing the low intensive rotation (Figure 1). The outlay of $60,000 to increase crop intensity earned a profit of $7,500, or a 12.5% return on investment.

Figure 1. The relationship between working capital, crop intensity and farm profit: yield and costs from paddock records at the Mallee Research Station.



For the second analysis, using lower yields and costs to represent a more typical farm scenario, increasing crop intensity from 33% of the farm to 77% of the farm decreased farm profit by $8,600 or 86% (Figure 2). Working capital expended to increase crop intensity was $54,500 (an increase of 50%). This indicated that increasing crop intensity was not economically viable for farmers whose crop yields were equal to the district average.

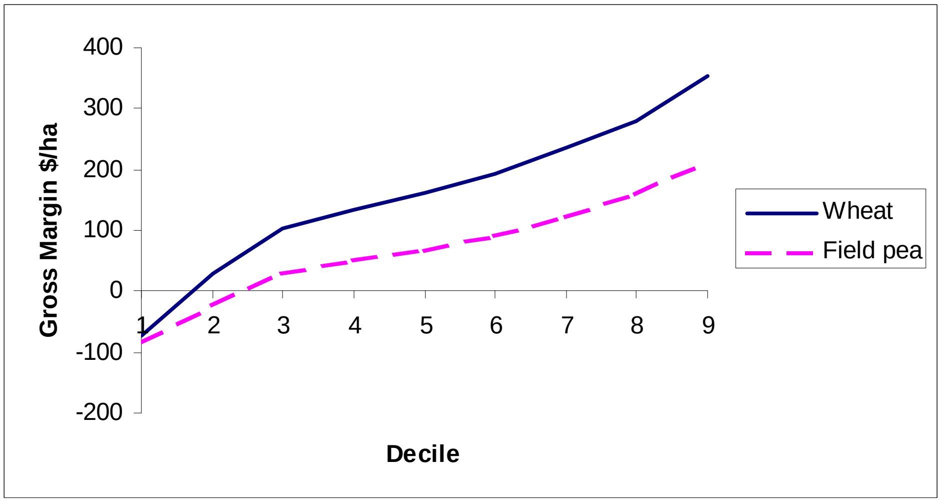
Figure 2. The relationship between working capital, crop intensity and farm profit using lower costs and average yields for the central Mallee region.



Risk analysis

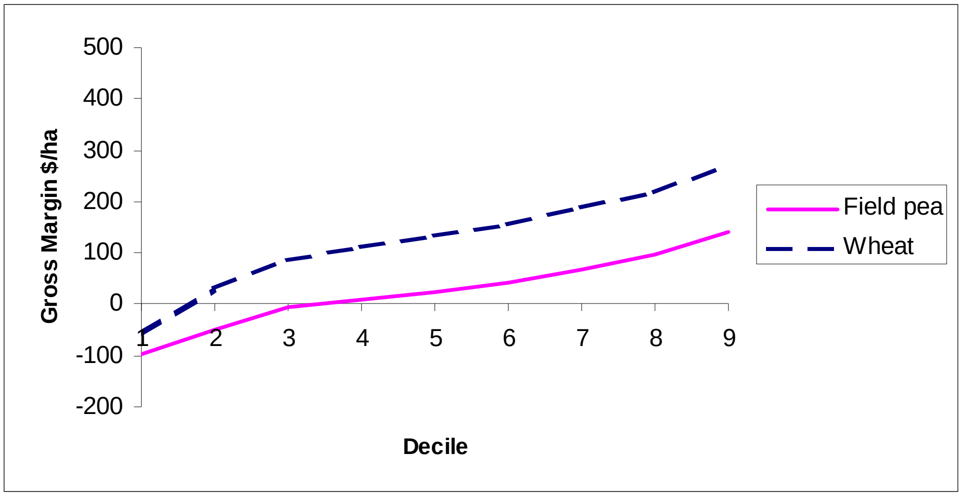
Analysis based on Mallee Research Station data showed that wheat gross margins were higher than field pea gross margins for all decile seasons and that this difference was larger in higher rainfall years (Figure 3). The second analysis, using data with reduced costs and yields to represent the district average, demonstrated the same trends as the Mallee Research Station data (Figure 4).

Figure 3. Gross Margin for wheat and field pea for 10 different season types based on Mallee Research Station data.



Overhead costs in the first analysis were $67,000 or $56/ha. Therefore if gross margins were greater than $56/ha, a profit was generated by the farm. Wheat gross margins were high enough to generate profit in 75% of years, whereas pulse yields were high enough to generate profits in 55% of years (Figure 3). In the second analysis, where overhead costs were $62,700 or $52/ha, wheat was profitable in 75% of years and pulses were profitable in 35% of years (Figure 4). The difference between Mallee Research Station data and district average data, showed the increased risk associated with growing pulse crops compared to cereal crops, especially for district average pulse yields.

Figure 4. Gross Margin for wheat and field pea for 10 different season types based on district average yields and costs



Discussion

This study has highlighted how data used in economic analysis affects the conclusions reached. When relatively high crop yields from experimental plots were used as inputs for economic analysis, intensive crop rotations were more profitable than traditional pasture-fallow-wheat rotations (Wimalasuriya, 1998). Similarly when research station data was used, intensive crop rotation were favoured (Figure 1). However, when data more typical of local farming was used, more intensive cropping was less profitable (Figure 2) and more risky than traditional rotations.

Wimalasuriya (1998) suggested that high intensity cropping is a profitable option in the Mallee. A peas-wheat-lupins-wheat increased equity from 88% to 550% over a ten year period compared to an increase from 88% to 120% for a pasture-fallow-wheat rotation. However, plot yields used in the analysis were significantly higher than district average. Average wheat, field pea and lupin yields in the wheat-field pea wheat-lupin rotation were approximately 50% higher than the district average yields. Also, pasture inputs on plots were significantly higher than used by farmers, whereas crop inputs were comparable with farmer inputs. This meant that economic results for low intensity rotations with pasture were unfavourable. Other factors not accounted for in the analysis were plant and labour required to adopt more intensive crop rotations.

Since research plots can overestimate yield, the data from the research station paddock records were considered more realistic when comparing farm systems. However, research station paddock yields were higher (approximately 20%) than the district average, which is probably a result of management and site effects. Wheat and pulses were grown on the most favourable cropping soils on the Mallee Research Station whereas district average yields are collected from a wider range of soil types, some less favourable than the research station. It would be expected that inputs could be sub optimal for some farmers paddocks compared with the Mallee Research Station, again explaining the lower average yields.

In this analysis, more intensive cropping required a large increase in working capital ($60,000 or 50%). This was a result of the higher costs of wheat, pea and lupin crops ($90/ha, $147/ha and $160/ha respectively) compared to livestock grazing pasture (annual cost of approximately $30/ha). The results indicate that even when intensive cropping is a profitable option, it requires a large capital outlay that imposes a financial risk on the farm if crop yields are not achieved. The return on extra capital invested was 12.5%.

At the highest level of crop intensity (77% of the farm), the optimal number of ewes was 70. In reality, a farmer would probably not run this flock size and would agist sheep on the farm when required. Agisting stock on the farm would return financial benefits, especially if the farmer agisting the stock was required to maintain fences, shearing sheds and yards. However it is not expected that fixed costs such as labour and depreciation on shearing sheds would change. This is because the farm is run by a single operator and casual labour for shearing and crutching were accounted for as a variable cost. If the net returns from changing from 70 ewes to agisting stock totalled $8,000, this would increase the return on extra capital invested to 25%.

The risk of growing pulses was further explored by modelling gross margins of field pea and wheat crops for ten different season types. Over this time, pulse crops returned a lower gross margin than wheat crops. Pulses were profitable in 55% of years based on research station data and 35% of years based on district average yields.

The low profitability of pulse crops in the rotation could be improved by increasing returns, decreasing costs or increasing crop yield. Improvements in crop yield come from plant breeding, improvements in agronomy and only growing pulses on the better soil types. Pulse returns could be improved by using crops that are suitable for human consumption which generally attract premiums over pulse products used for animal consumption such as some field peas and lupin varieties. Canola is another potential crop to increase cropping intensity in the Mallee due to its high value, but economics of this change have not been explored.

On the other hand, flexible livestock systems could be developed that exploit excess feed availability in spring and summer. Stocking rates of current systems (permanent flocks) are restricted by low feed availability in autumn and winter.

The results suggest that high intensity cropping is not economically viable in the central Mallee region of Victoria (300-350mm). A similar result would be expected for the northern Mallee, which has lower rainfall (less than 300mm of annual rainfall) and lower pulse yields. It is expected that intensive cropping would be profitable in the southern Mallee region due to higher rainfall (greater than 350mm of annual rainfall) and higher crop yields.

Conclusion

The PRISM model indicated that intensifying cropping increased farm profit by 33% in the central mallee region of Victoria, if crop yields were 20% above the district average. Using pulse crops to increase cropping intensity increases financial risk on the farm when crops do not yield higher than the district average. This was evident when farm profit decreased by 86% when district average yields were achieved in a high intensity crop system.

Pulse crops were more risky than wheat crops because they were profitable 55% of the time whereas wheat was profitable 75% of the time. Decreasing the yield of pulse and wheat crops by 20%, meant that pulse crops were only profitable 35% of the time but little effect on wheat. Increasing pulse returns by increasing yields, increasing prices or decreasing costs will improve the returns from pulses. Alternatives such as canola may improve the profitability of intensive cropping.

Realistic yields and costs were required to analyse the potential for increased cropping in the central Mallee region. Paddock scale data from the research station and farmer data collected by statistical surveys (ABARE 95) gave more realistic results than research plot data.

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