MIDAS SENSITIVITY ANALYSIS

Michael Young 28/6/18

Contents

Introduction

MIDAS is a complex linear model that re-optimises the management and resource allocation of the whole farm each time the scenario is altered. For an accurate conclusion to be drawn from these results the model operator must have a good understanding of how and why the farm has been optimised in a particular way. This requires an understanding of the interactions between different parts of the farm.

The aim of this project is to quantify farm relations, to help improve the interpretation of results from MIDAS.

Method

Sensitivity analysis's can be performed using MIDAS to examine how a particular aspect of the farm system affects the profit at different levels. In this analysis proportion of the farm cropped is used as the sensitivity.

The standard profit line for increasing crop area is curved with the maximum profit somewhere around the middle due to the interactions within the farming system (particularly due to the relationship between livestock operation and cropping operation).

Two methods were used to quantify these interactions,

1) Remove all the interactions from the model (all out), meaning the change in profit for different sensitivity levels was equal. Then add the interaction of interest back into the model and compare the profit.
2) Leave all the interactions in the model (all in) and just remove the one of interest and compare the profits at each sensitivity level.

Materials

To conduct this project the Great Southern version of MIDAS was used, although we expect these relationships to be similar in other regions there will be slight variations due to factors such as rainfall, soil type and farm size.

Analysis

Stubble Grazing

Stubble grazing causes a non-linear relationship between crop percent and profit because there is an interaction between crop grown and feed available for sheep. Removing stubble grazing from 'all in' farm slightly reduces the profit, having the greatest effect at 80% crop, of just under $16000. A big chunk of this loss is due to an increase in the supplementary feeding (approximately $10 000), because it is still more economical than reducing the stocking rate.

Adding stubble grazing into the 'all out' farm, shows a greater profit difference than above, suggesting that the gains from stubble grazing are reduced when all farm interactions are optimised. The big difference still occurs at the 80% crop. This time the supplementary feed remains similar but the number of sheep changes, at 80% crop with stubble grazing included, the model runs 500 more ewes. This is because stubble grazing reduces supplementary feeding over summer, so it becomes

profitable to feed more in Autumn to maintain a high stocking rate.

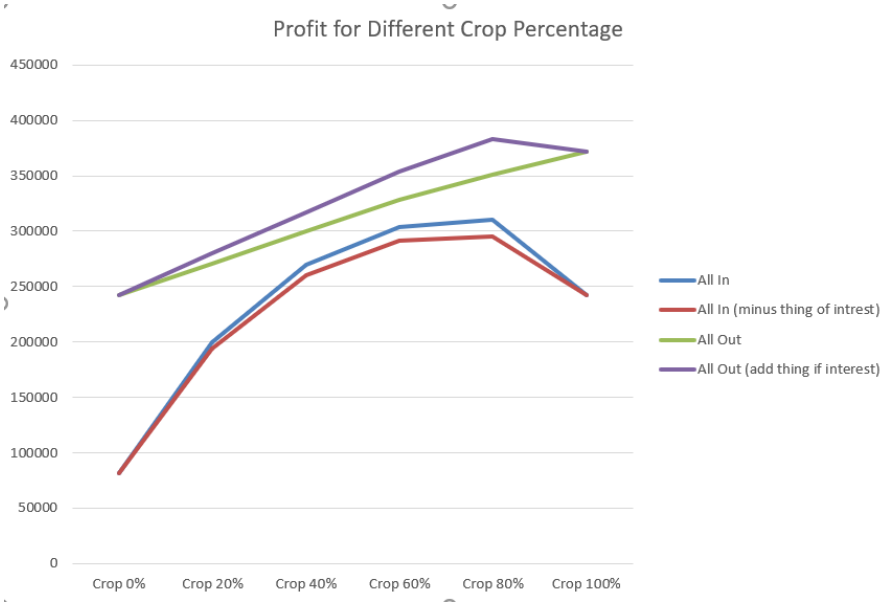

Figure 1: Value of stubble grazing interaction, at different cropping percentages on the whole farm profit. For a farm with no interactions represented (green) and a farm with all the interactions represented (red).

Pasture on Crop Paddocks

Removing pasture consumption on crop paddocks from the 'all in' farm reduces the profit most at 80% crop by $18000. Removing pasture consumption reduces the stocking rate, showing the value of early pasture consumption on paddocks that are going to be cropped.

Adding pasture consumption on crop paddocks to the 'all out' farm increases the profit most at 80% crop, by $28000. The ewe number increases by around 900 which is accompanied by an increase in the supplementary feeding, showing that free feed available during autumn has a significant influence on the stocking rate and hence supplementary feeding during summer.

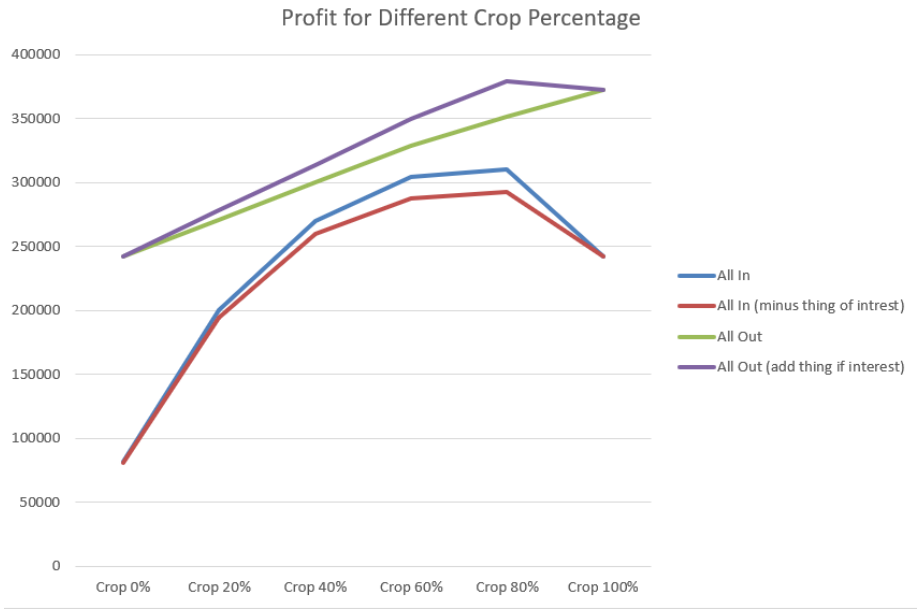

Figure 2: Value of pasture consumption on cropping paddocks, at different cropping percentages on whole farm profit. For a farm with no interactions represented (green) and a farm with all the interactions represented (red).

Grazing technology - chaff piles and green crop grazing

Removing grazing technology from the 'all in' farm, has a negative impact on livestock profitability. There is a significant the reduction in sheep numbers, which is accompanied by a reduction in supplementary feed. Most of this effect is due to the elimination of crop grazing which provides relatively cheap, high quality feed early in the season.

Adding technology to the 'all out' farm increases the profits significantly, it has the greatest effect at 40% crop, increasing the profit by more than $50000. Allowing grazing technology increases the number of livestock by up to 2000, this also comes with a slight increase in the supplementary feed.

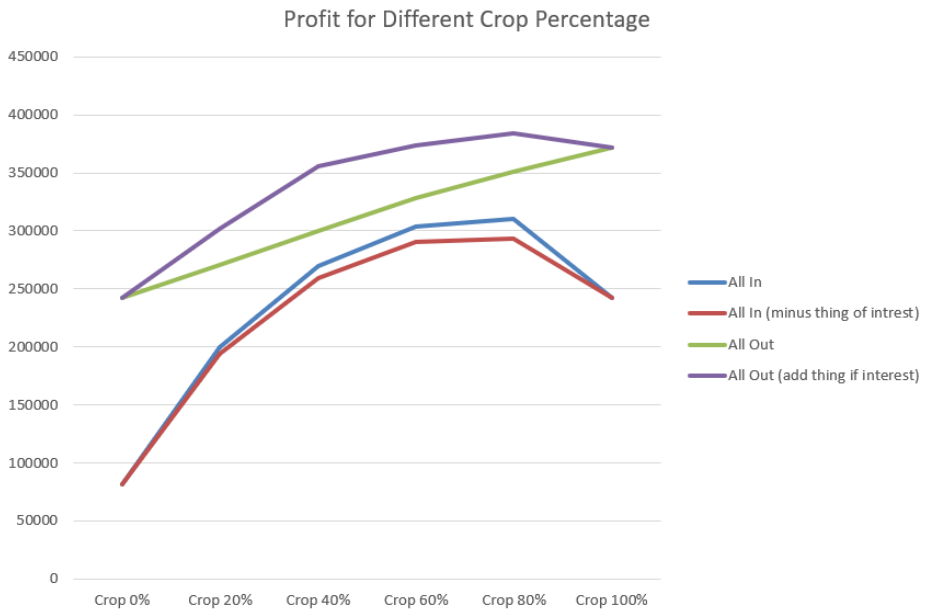

Figure 3: Value of grazing technology, at different cropping percentages on whole farm profit. For a farm with no interactions represented (green) and a farm with all the interactions represented (red).

Machinery

Crop gear is usually fixed to one, meaning the farm must own its own cropping equipment. If you remove this option forcing the 'all in' farm to hire a contractor during seeding and harvest it slightly increases its profit ($10 000). The greatest effect is at 0% crop because sheep cannot utilise the machinery to the same extent that cropping can. An interesting thing is even the 'all in' farm, which is forced to own cropping equipment, is still hiring a contract seeder because labour becomes a limiting factor. This is because it is more profitable to contract seed and get the crop sown than seed it yourself and incur a late sowing yield penalty.

Forcing the 'all out' farm to own its own crop equipment, increases the profit (max $6000) when the crop percent is greater than 20. This is because the 'all out' farm doesn't incur a late sowing penalty, making it profitable to own your own gear.

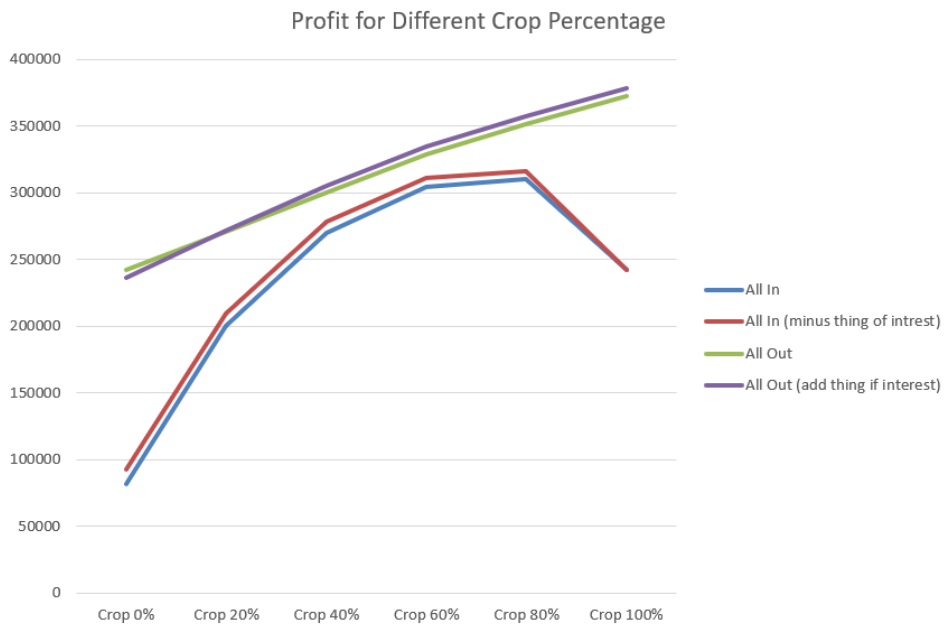

Figure 4: Value of owning your own cropping equipment, at different cropping percentages on whole farm profit. For a farm with no interactions represented (green) and a farm with all the interactions represented (red).

Rotation

Eliminating the option for the model to optimise the rotation (only rotations allowed were, continuous pasture and cereal, cereal, lupin, canola) significantly reduces the profit for the 'all in' farm, because it eliminates a big part of the interaction between the livestock and cropping operations. Sheep numbers are not affected by this change, but the value of grain sold decreases by up to $70 000. This is due to the farm being forced to crop continuously on poorer soil types, which would usually not occur.

Including different rotations in the 'all out' farm increased the profit because it was able to adjust the amount of each crop being grown. This is important because the model has the flexibility to match high paying crops with good soil types.

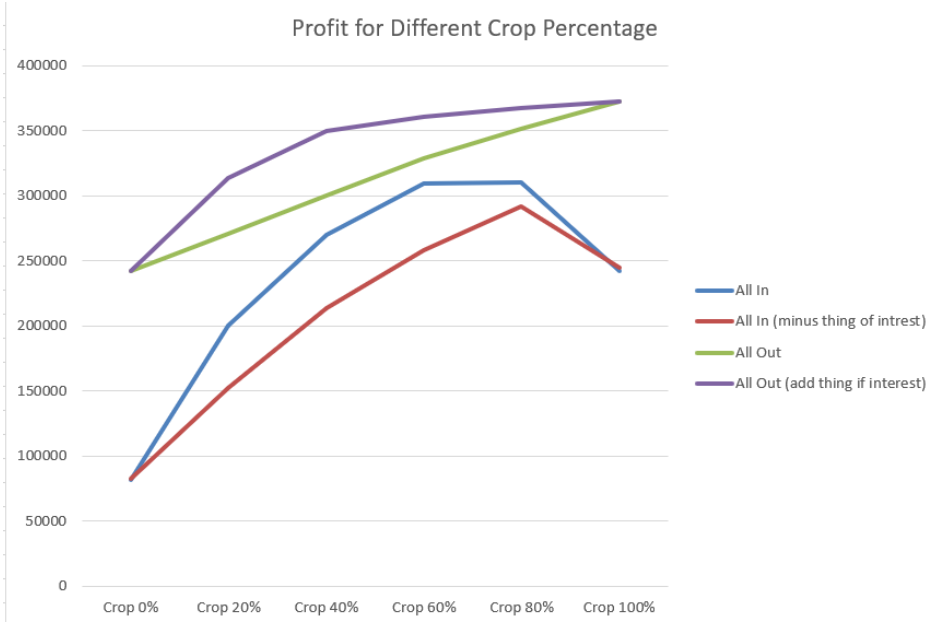

Figure 5: Value of rotation, at different cropping percentages on whole farm profit. For a farm with no interactions represented (green) and a farm with all the interactions represented (red).

Soil Type

To represent a typical farm the model is forced to have a certain amount of three different soil types. Removing this constraint from the 'all in' farm allows the model to use the best soil across the whole farm, which increases pasture growth and produces higher yielding crops. The effects have a slightly greater impact at higher crop percentages suggesting that soil quality is slightly more important for cropping enterprise than the sheep enterprise.

Adding this constraint to the 'all out' farm has the opposite effect, because it forces the farm to use some lower quality soils.

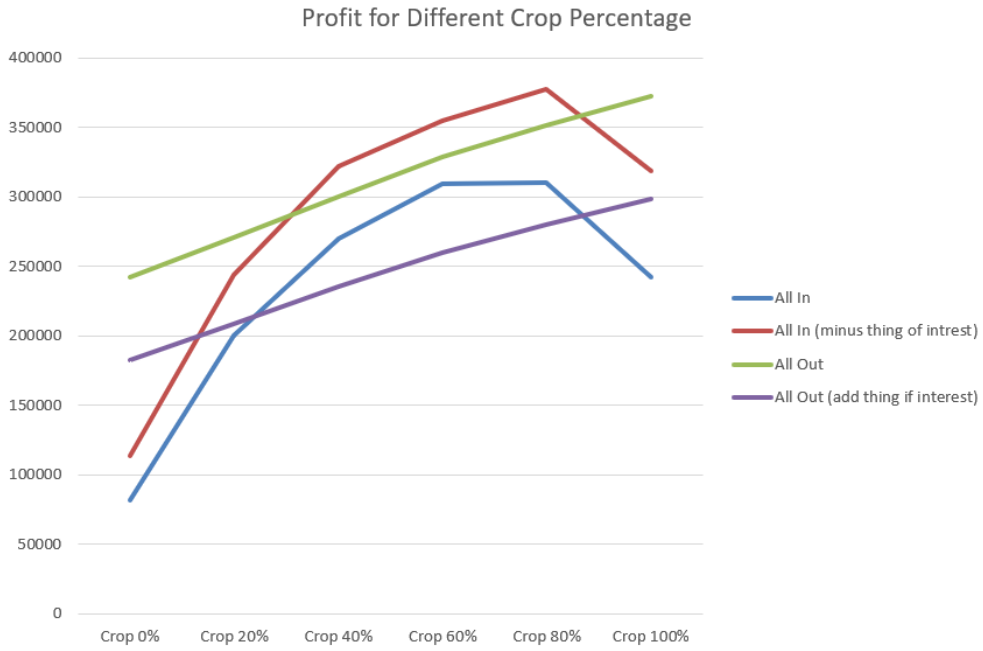

Figure 6: Value of soil type, at different cropping percentages on whole farm profit. For a farm with no interactions represented (green) and a farm with all the interactions represented (red).

Delayed Seeding Yield Penalty

Removing the delayed sowing yield penalty from the 'all in' farm has a small effect on profit ($4000). The gain is small because the farm is still contract seeding due to limited labour.

In the 'all out' farm there is no effects of yield penalty because the entire crop is being 100% contract seeded which doesn't occur any yield penalty.

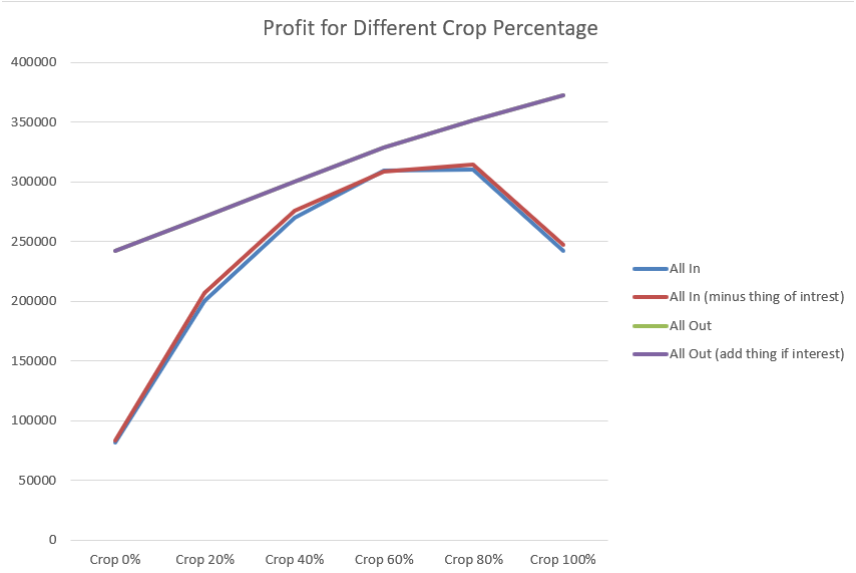

Figure 7: Value of delayed sowing penalty, at different cropping percentages on whole farm profit. For a farm with no interactions represented (green) and a farm with all the interactions represented (red).

Supplementary Feed

Forcing the farm to buy all its supplementary feed and sell all its grain instead of having the option to feed livestock using harvested grain has a minimal impact on profit, reducing it by $2 000.

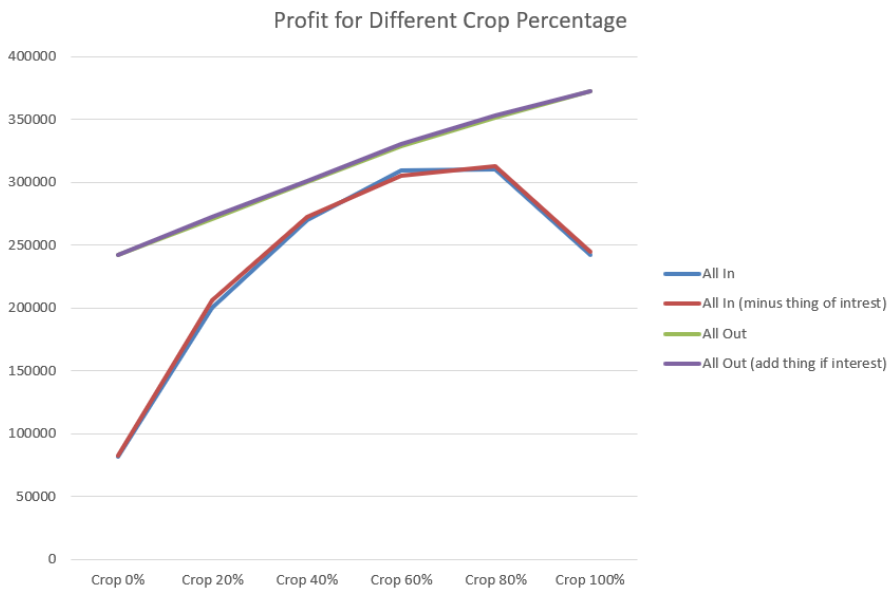

Figure 8: Value of producing supplementary feed on the property, at different cropping percentages on whole farm profit. For a farm with no interactions represented (green) and a farm with all the interactions represented (red).

Labour

Making labour free for the 'all in' farm has a significant impact on profit increasing it by up to $120 000. It has most effect when crop percentage is low due to the labour intensity of the livestock operation. When labour is free the model runs more sheep and a similar amount of crop.

'All out' with the addition of labour costs has an increasing effect on profit as cropping percent decreases. The interesting thing is that the access to free labour doesn't have any effect on the farm management; the increase in profit is due to a reduction in wages paid. This means that labour is not the most limiting farm factor.

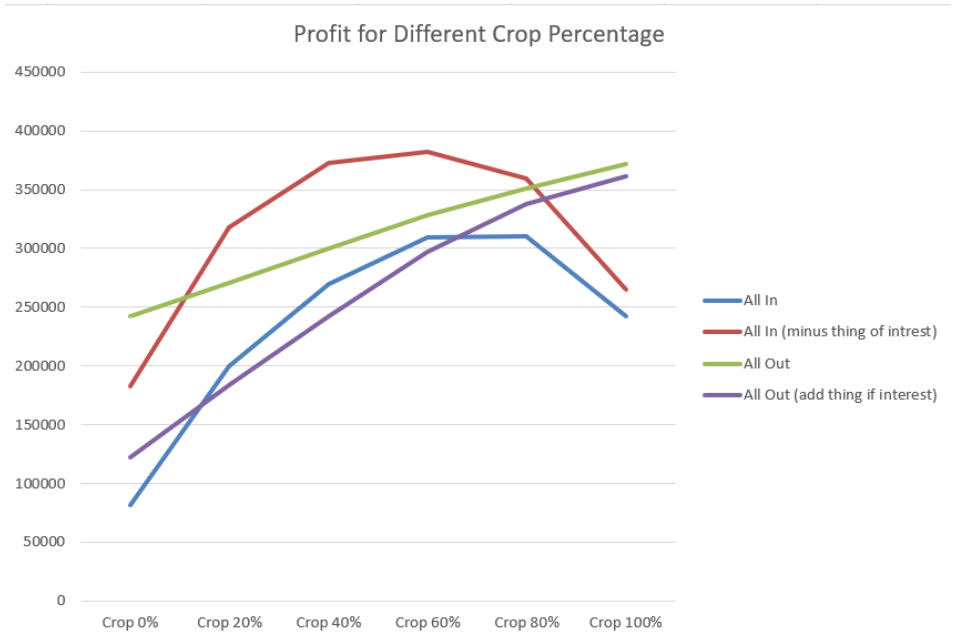

Figure 9: Value of labour, at different cropping percentages on whole farm profit. For a farm with no interactions represented (green) and a farm with all the interactions represented (red).

Errors

To eliminate the delayed sowing yield penalty in the 'all out' farm, a constraint in the model was removed, which also removed the need for the farm to pay for contract seeding. The effect of this is that the profit line is steeper than in reality, hence the farm is making slightly more profit at higher cropping percentages than at lower cropping percentages.

Some of the relationships in the model have a small effect and may not have been analysed in this report.

Conclusion

The report has analysed a number of farm relationships that are represented in MIDAS and using the two different reporting methods each relationship has been quantified.

Soil type, rotation, grazing technology and labour have the greatest interaction with farm profit at different cropping percentages. This is because each factor interacts differently with both the cropping and/or livestock depending on the amount of farm devoted to the particular operation.