To under-sow or not? A decision support tool to determine the most profitable method of pasture establishment

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Abstract
A new decision support tool (DST) is under development to enable users to determine whether it is more profitable to establish a perennial pasture alone or under-sowing with cover-crops in the uniform rainfall zone of southern NSW (450-650 mm). The DST operates under the premise that a pasture is to be sown in a particular paddock in the coming year. A simple underlying model focuses on the profitability of each pasture sowing method at the end of the pasture phase, including all variable costs and income. The DST enables the user to input a range of information including costs of establishment and income from both grain and livestock. Exploratory analyses with the under-sowing tool for the uniform rainfall zone of southern NSW show that pastures established by under-sowing can be more profitable under different scenarios even when only half as productive as a straight-sown pasture due to the returns from the cover-crop. Pastures established by under-sowing tend to be more profitable when the grain yield is greater than 2.5 T/ha or grain price is greater than \$180/T. Pastures sown without a cover crop were more profitable when there was the potential for high stocking rates with high stock returns and a longer pasture phase (> 4 years). Future developments of the model will seek to include climate variability for specific sites to enable producers to determine the risk of under-sowing in their locality.

Key Words
Cover-crops, gross margin, mixed farming system

Introduction
Pasture establishment in the cropping zone has commonly occurred by sowing the pasture species under a cover crop. Research and extension information on under-sowing is available from the last 80 years with many recommending that under-sowing should not be used to establish pastures due to a higher rate of failure and less productive pastures (Moodie 1936; Smith and Argyle 1964; Peart and Scott 1969; Cregan 1985; Dear 1986). Considering this, a recent survey has revealed that within the uniform rainfall cropping zone of southern NSW that 83% of farmers regularly under sow (Li *et al.* 2010). Generally farmers use under-sowing because the grain yield covers the cost of sowing the pasture. Most research has focused on pasture density and biomass production of the different establishment methods but has not sought to demonstrate increased livestock productivity that could outweigh income from grain production due to a cover crop. This DST seeks to bring the costs and incomes for the pasture phase to inform producers whether under-sowing is the right method of establishment for them.

Methods
Model development
The DST has been created in an MS Excel file with a user-friendly display where users can input their own data and determine which sensitivity graphs they want to be displayed.
The underlying calculation for the DST is the net income from under-sowing (US) pasture establishment method minus the net income from straight-sowing (SS) the pasture for the length of the pasture phase (eqn 1).
(Grain income + US stock income - US variable cost) - (SS stock income – SS variable cost) eqn 1.
Where
Grain income = grain yield × grain price
US stock income = stocking rate × \$/DSE × (pasture years - 1) × US relative effect
SS stock income = stocking rate × \$/DSE × (pasture years - 1)
US variable cost = cost of establishing grain crop and pasture by under-sowing
SS variable cost = cost of establishing straight sown pasture

The value for $/DSE has been determined from NSW DPI budgets and is the net income from livestock and includes costs for stock and pasture management. The years are for the length of the intended pasture phase minus the establishment year where grazing is limited. The DST does not calculate pasture production *per se* but rather calculates the differences in stocking rates for the different establishment options, which we assume is related to pasture production. The under-sowing relative effect is the proportion of production of an under-sown pasture compared to a straight sown pasture with 0 being no production and 1 being equal production.

Model inputs

An important component of the model is the capacity for the user to change a range of inputs to match their enterprise. The inputs in the DST include expected grain yield, grain price, stocking rate and stock earnings, establishment costs, the length of the pasture phase and relative effect that under-sowing has on pasture production.

Table 1. Parameters and input data for Decision Support Tool

Crop Income	Grain Price	$180/T
	Grain Yield	2.5 T/ha
Livestock Income	Stocking Rate	10 DSE/Ha
	$/DSE	$25/DSE
Costs	US establishment cost	$200/Ha
	SS establishment cost	$120/Ha
Years of Pasture	Years	4
Reduced pasture production	US relative effect (0-1)	0.5
due to under-sow		

Model outputs

The DST provides a single number to estimate which method of pasture establishment is more profitable. If the returned value is positive then greater profitability is obtained from under-sowing. In comparison if the value is negative, directly sowing the pasture would be more profitable. A number of sensitivity graphs are provided to determine what factors change the result.

Results

Using the values in Table 1 applied in equation 1 gives a value of -$5.00 which indicates that straight sowing the pasture is more profitable for the length of the pasture phase (Figure 1). The DST comments that this value is “too close to call” and for the user to determine which will be more profitable. With the costs in Table 1, the point of equilibrium for the sowing methods in relation to grain yield is at 2.5 t/ha (Figure 2a). Higher grain yield would lead to under-sowing being more profitable than straight sowing the pasture. Similarly, an increase in grain price will lead to under-sowing becoming the most profitable option (Figure 2b). Increases in stocking rate or stock price will favour establishment of pastures by straight sowing (Figure 2c, d). The length of the pasture phase is a strong determinant of profitability for each sowing method with pasture phases greater than four years tending to be more profitable with straight sowing (Figure 2e). The under-sowing relative factor was highly significant in determining the success of each sowing method (Figure 2f). Increasing this relative factor leads to increases in profitability of the under-sowing method.

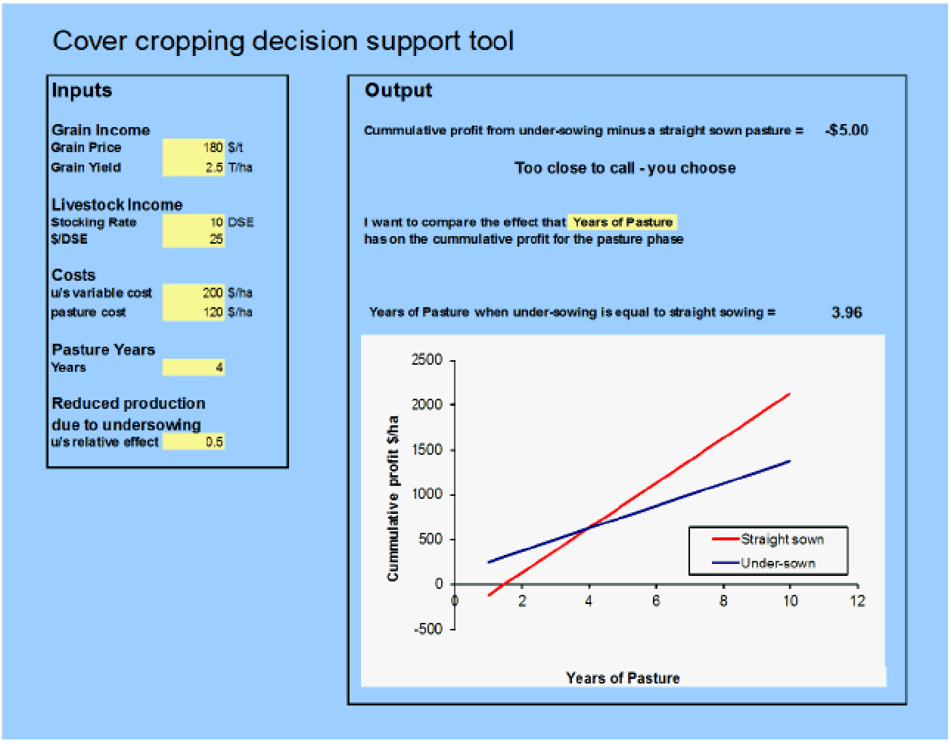

Figure 1. The user interface of the decision support tool using the input data from the materials and methods (Table 1).

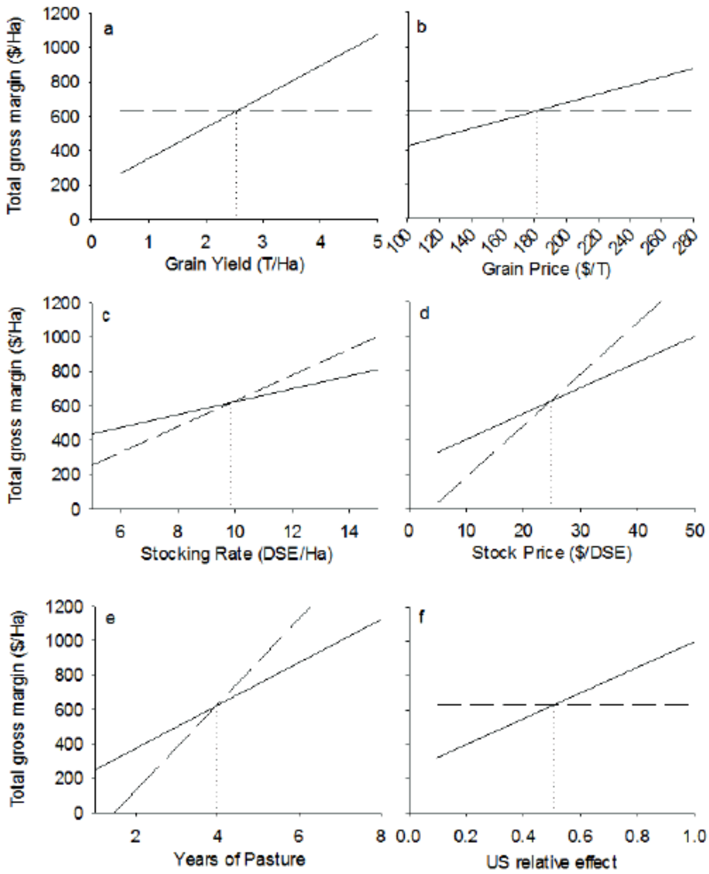

Figure 2. Sensitivity graphs of total gross margins for the pasture phase for a range of parameters based on original analysis. Parameters include a) cover crop grain yield, b) grain price, c) stocking rate, d) stock price, e) length of pasture phase and f) under-sow relative effect. Solid line – under-sow establishment, dashed line - straight sowing and dotted line – point of intersection.

Discussion

The primary purpose of the DST is to enable users to include all necessary inputs into the decision making process on whether to establish pasture by the under-sowing method. This model allows users to input their own data to determine what is more profitable. The graph on the user interface enables the user to determine how sensitive each parameter is to variation.

There are some difficulties with the DST. It is not a biological model as it does not predict pasture production for a certain set of parameters. This is particularly important for determining the value of the US relative value. It is likely there would be different perceptions of the under-sowing effect but the limited data tends to indicate that the reduction in pasture growth results in a relative value of between 0.5-0.8. This can have a large influence on the DST. The other difficulty regarding the model is in relation to pasture establishment failure. The model does not determine whether there has been a pasture failure. Currently there is no published data that recommends when pasture failure has occurred or when pastures should be re-sown. The DST is currently being showcased to producers to determine their interest in the model and whether it corresponds to what they observe. It will be important to simplify some inputs such as $/DSE as these are difficult for the individual farmer to quantify. Incorporating climate data into the model will enable specific sites to determine over a large number of seasonal years whether under-sowing is more profitable or not.

Conclusion

The DST enables users to identify whether under-sowing is more profitable for their farming situation. The range of sensitivity graphs helps determine how sensitive a particular parameter is. Grain yields greater than 2.5 t/ha with grain prices greater than $180/t will tend to improve the profitability of under-sowing. Alternatively increases in stocking rates and prices will result in straight sowing pasture being more profitable. The length of the pasture phase and the cover crop relative effect are also significant factors in the profitability of each pasture establishment method.

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