Using legumes to maximise profits in cotton systems

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SUMMARY

- Most profitable systems include legumes.
- The most profitable system per hectare was a continuous cotton-vetch system.
- The most profitable systems per megalitre were the cotton-faba bean and cotton-vetch-wheat systems.
- Changes in lint or N fertiliser prices do not substantially affect gross margins.
- Applying more or less N fertiliser than required will impact significantly on gross margins.
- The N added by the legume crops more than paid for the production of the legume crop.

Cotton profits are increased by including legumes in cotton cropping systems. In earlier research, vetch was shown to be the best legume for N fixation, and it is now grown commercially as part of the cropping system on some farms in most cotton growing regions.

After nine years of research on a cropping systems experiment conducted at the Narrabri Australian Cotton Research Institute, growing vetch as a green manure crop provided not only substantial nutritional benefits to cotton and improved soil structure, but also gave a greater economic return. This article reports the economic benefits of incorporating legumes into cotton cropping systems.

The cropping system experiment included five systems. Each system was evaluated at the end of a two-year cycle:

- Continuous cotton (C-C) — cotton was planted each year with a fallow over winter.
- Continuous cotton–vetch (CVCV) — cotton was planted each year and vetch was grown in winter and incorporated back into the soil before cotton was sown.
- Cotton-wheat (CW~) — wheat was planted after cotton. Once the wheat is harvested there is a nine or 10 month fallow.
- Cotton-wheat-vetch (CWV) — similar to the cotton-wheat system, except the fallow was shorter and vetch was planted between January and April and incorporated before cotton sowing.

Field of faba bean, fallow and oats.

- Cotton-faba bean (CF~) — faba bean was sown after cotton. After faba bean grain was harvested, stubble was incorporated back into the soil and the soil fallowed for nine or 10 months.

The rotation crops were not fertilised or irrigated. The variable costs associated with each crop were determined via information from the NSW Department of Primary Industries (*www.dpi.nsw.gov.au*) and local businesses (CGS, CropJet Aviation and Wesfarmers).

Gross margins were assessed by using the following prices (a price sensitivity analysis is shown later):

- Cotton — lint $500 per bale; fuzzy seed $176 per tonne;
- Wheat — grain $150 per tonne;
- Faba bean — grain $220 per tonne;
- Input of N from the legumes was priced at the cost of N fertiliser — $0.89 per kg.

Comparison of these five cropping systems indicated that legume based systems produced higher gross margins than non-legume (fallow) systems (Table 1).

Our data shows that:

- Cotton yields were higher in vetch systems.
- Continuous cotton produced lower yields than rotation systems.
- Legume systems required zero to little N fertiliser to produce optimum economic yields whereas non-legume systems required more N fertiliser.
- Gross margins were higher for legume based systems for both $/ha and $/ML.
- All costs associated with growing and incorporating legume crops ($76 per hectare) were offset by allowing for the input of N fixed by the legumes ($130 per hectare).

Gross margins ($ per hectare)

In the continuous cotton system, the gross margins per hectare increased 23 per cent with the addition of vetch into the cropping system. In the cotton-wheat system, the addition of vetch increased the gross margin per hectare by 12 per cent.

Profits were increased through higher yields and lower variable costs associated with not having to purchase or apply N — it was added by the vetch. So, for growers with limited land, the best option to maximise economic profit would be the continuous cotton-vetch system as it has the highest gross margin per hectare.

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TABLE 1: Average yields, N fertiliser requirements and gross margins for four cropping cycles (eight years, two years each cycle) in a systems experiment at Narrabri

System	Ave. yield bales per ha	Optimum N fert rate kg/ha	Gross margin $/ha	Gross margin $/ML
C–C	6.52	104	$3,356 (2)	$280 (5)
CVCV	7.13	41	$4,131 (1)	$344 (4)
CW~	7.60	93	$2,315 (5)	$386 (3)
CWV	7.82	0	$2,615 (4)	$436 (2)
CF~	7.83	0	$2,627 (3)	$438 (1)

Gross margin ($ per megalitre)

In the continuous cotton system, the gross margins per megalitre increased by 23 per cent with the addition of vetch into the cropping system. In the cotton-wheat system, the addition of vetch increased the gross margin per megalitre by 13 per cent.

But the cotton-faba bean system was the most profitable system per megalitre. Faba bean produced grain for harvest and also fixed N. Faba bean produced higher yields than wheat crops, plus the reduced need for N fertiliser by subsequent crops allowed this system to give greater returns than the cotton-wheat system.

The cotton-faba bean system was only slightly better than the cotton-wheat-vetch system, due to lower variable costs associated with less planting and cultivation costs and higher grain yields. So farmers with limited water can maximise profit by adopting the cotton-faba bean system.

FIGURE 1: Effect of cotton prices on gross margin

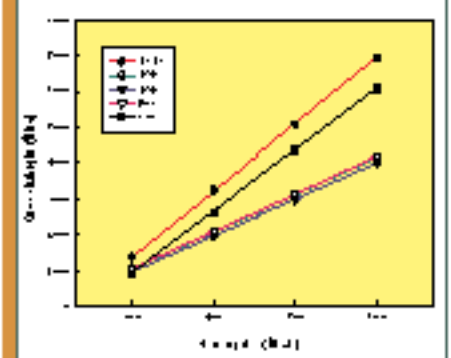
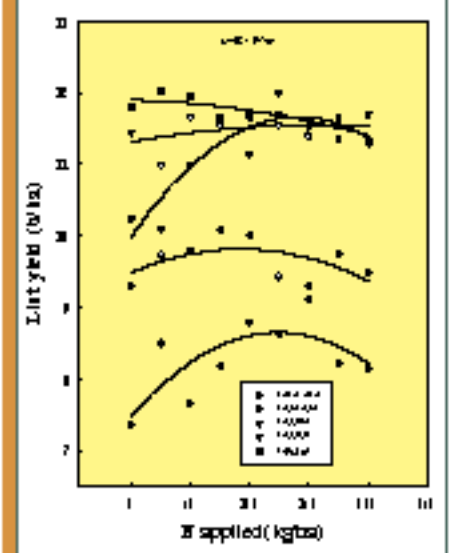


FIGURE 2: Nitrogen response curves



Faba beans.

Affect of changing cotton prices on gross margins

A sensitivity analysis showed that there was a substantial difference in gross margin per hectare between continuous cotton systems and rotation systems (Figure 1) as there was cotton planted each year in the continuous cotton system. But there were no significant differences in gross margin between each system within these two groups.

Nitrogen fertiliser rates

The rate at which N is applied can have a major impact on yield and therefore gross margin ($/ha), so it is important to apply the optimum rate of fertiliser that will achieve maximum return. The response to N fertiliser was determined by applying N at various rates between 0 and 200 kg N per hectare and assessing lint yields of each rate in each cropping system to find the optimum N rate (Figure 2).

The optimum is found when the marginal ($) return of lint equals the marginal cost of nitrogen. That is, for each additional kg of N you apply (this costs $0.89), you need to recover at least $0.89 worth of lint (0.4 kg).

Figure 3 shows that the application of N fertiliser to the wheat-vetch and faba bean systems has a negative affect on gross margin as they already had enough N to produce maximum yields. Applying more nitrogen reduced the gross margin.

In the continuous cotton-vetch system, applying a small amount of N can improve the gross margin but applying excessive N can reduce gross margin by up to eight per cent. Adding N to back-to-back cotton increased gross margin by up to 15 per cent at the economic optimum N rate, but applying N beyond this point decreased gross margin by seven per cent.

The effect of price changes on optimum N fertiliser rates

The NutriLOGIC decision support system identifies the optimum N fertiliser rate given the pre-sowing soil nitrate levels. But the optimum N fertiliser rate will vary with the cost of N fertiliser and price of cotton.

How do N fertiliser and cotton price changes affect the optimum N fertiliser rate of a crop? If the price of N increases, then the optimum N fertiliser rate will decrease. Also, as the price of cotton increases, the optimum N rate should increase.

The optimum N rate suggested by NutriLOGIC is quite robust. For example, increasing lint price from $300 to $500 (67 per cent increase) produces only a 12 per cent increase in the optimum N rate. And increasing N fertiliser costs from 90c to $1.50 (68 per cent increase) reduces optimum N fertiliser rate by only seven per cent.

CONCLUSIONS

The best option for growers to achieve a high return with minimal land would be to grow continuous cotton, with a vetch green manure crop each winter. This will increase yield, require less nitrogen and increase gross margin by about 23 per

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Vetch.

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FIGURE 3: Gross margins for five cropping systems, indicating the optimum N rate

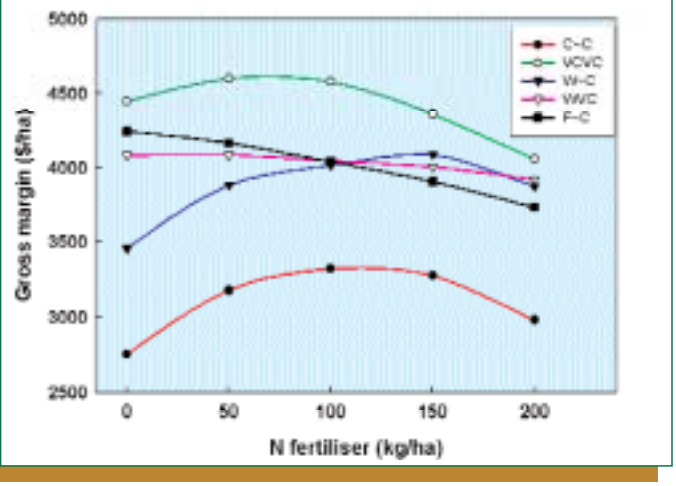

FIGURE 4: The effect of price changes on the optimum N fertiliser rate