Short-term rotations using the forage legume Lablab have a place in Central Queensland farming systems

K.McCosker[1], S.Buck[2], A. Schwarz[3], P.Durkin[4], and R.Kelly[5]

[1] Queensland Department of Primary Industries, Emerald, Qld.
[2] Queensland Department of Primary Industries, Biloela, Qld.
[3] *Kilane*, Springsure, Qld.
[4] *Silverton*, Theodore, Qld.
[5] Queensland Department of Primary Industries, Toowoomba, Qld.

ABSTRACT

Soil nitrogen fertility decline is a problem for the farmers of Central Queensland (CQ). Nitrogen fertilisers are now widely used, but an erratic climate means that economic returns are not always achieved. Two farmer groups in CQ have ongoing experiments to make economic comparisons between a lablab/cereal rotation and conventional grain cropping regimes. At Fernlees, a sequence of lablab/sorghum/wheat is being compared with wheat/sorghum/chickpea on a low fertility open downs soil. At Theodore, an unfertilised lablab/sorghum rotation is being compared with continuous fertilised sorghum. Results after three seasons indicate that the nitrogen benefit to subsequent crops plus returns from a ley legume phase can offset the opportunity cost of not growing a grain crop on a low fertility soil.

KEY WORDS

Nitrogen, lablab, rotation, Central Queensand, fertility.

INTRODUCTION

Declining soil nitrogen fertility has been identified as a serious threat to the sustainability of the grains industry in Central Queensland (CQ) (5). Much of the cropping land of CQ consists of relatively shallow (typically 60-80cm to decomposing basalt) black cracking clays that have been farmed continuously for 30-40 years. These are referred to as open downs soils. Soil organic matter has been exploited to the point where a typical open downs soil has an organic carbon content of less than 0.8% and a total N content of about 0.75% (G.Millar, unpublished data).

Farmers in CQ have 3 options for managing this run-down land:

- Use nitrogen fertiliser
- Grow pasture leys with forage legumes
- Returning land to grazing use

Many farmers in the region are using N fertiliser successfully in their system. However, the costs and risks associated with applying fertiliser are significant, especially under the erratic rainfall conditions experienced in CQ.

Previous studies in CQ have indicated that short-term (single season) pasture leys with annual legumes can supply sufficient soil N to meet the requirements of a following cereal crop, and that longer (2-3 year) ley phases with perennial legumes can provide soil N and grain yield benefits in following crops for several years after termination of the ley (3). Armstrong et al. (1,2) identified the annual *Lablab purpureus* as the species most suitable for short term rotations with cereal crops. Lablab has been popular with CQ farmers and graziers for some years because it is large-seeded and able to be sown with conventional planting equipment, is a vigorous seedling which tolerates the CQ summer well, and is able to produce a relatively high yield (3-6t dry matter/ha) of good quality forage quite quickly (4).

Farmers participating in the Sustainable Farming Systems for CQ project decided that this knowledge needed to be proven under commercial conditions before adoption of the practice could be widespread.

The idea of legume leys is an attractive one, as the majority of farms in the region are mixed enterprises that grow grain and beef. However, legume leys are typically viewed as an expensive option, with most growers believing the cost of not growing a grain crop will outweigh the potential benefit of a ley. A group of farmers from the Gindie and Fernlees district (approximately 50km south of Emerald) initiated an experiment in 1997 to compare a short term lablab rotation with a 'best practice' grain cropping system using N fertiliser. Another group of farmers from the Theodore area has a similar ongoing experiment to compare an unfertilised lablab – grain sorghum rotation with continuous grain sorghum and annually applied N fertiliser. This paper focuses on the economic data obtained to date and the implications for N management within CQ farming systems.

MATERIALS AND METHODS

The cooperating farmers conduct both experiments, on-farm, using commercial equipment. Cattle at both sites are individually weighed at entry and exit of the lablab during the grazing phase, with liveweight values assigned by local stock agents. The Fernlees experiment is on the Schwarz family property, *Juanita*, and the Theodore site is on the Durkin family property, *Silverton*.

Juanita, Fernlees

The experiment is situated on two paddocks that are side by side. The area was originally one paddock, farmed for 50 years, which was split 11 years ago into areas of 122ha and 32ha. The larger area now supports the continuous grain treatments, and the smaller paddock the grazed lablab/cereal rotation. Both paddocks grew fertilised wheat in the winter of 1997. The lablab rotation area had a single crop of lablab followed by sorghum and wheat. There are 2 replicates of three N fertiliser sub-treatments (0, 35 and 70kg N/ha) which are included during cereal phases of both treatment areas.

Silverton, Theodore

This experiment compares a continuous grain sorghum regime (9ha) with an adjacent area (71ha) which accommodates a grazed lablab/grain sorghum rotation. The continuous sorghum treatment area includes 2 replicates of four sub-treatments of annually applied N fertiliser (0, 30 and 60kg N/ha and a variable rate based on soil tests and yield targets). Both treatment areas are under a controlled traffic, zero tillage management regime.

RESULTS AND DISCUSSION

Table 1 contains a summary of some key measurements to date at the *Juanita* site. Gross margins are presented as simple measurements of gross paddock (treatment) income for particular phases of the experiment. Crop yields and values are means of two replicates. Gross margins include all variable costs and interest on livestock capital and do not include labour.

At *Juanita* the 1998 wheat crop was downgraded due to weather damage, such that grain from all treatments was graded as Feed. Grain value declined by up to $80/t, which had the effect of depressing anticipated treatment gross margins by up to $227/ha. Grazing cattle on the lablab crop resulted in net paddock income of $152/ha, surpassing the *actual* income realised by the fertilised grain treatments. The 1999 grain sorghum crop in both treatment areas had sub-optimal plant establishment due to heavy and continued rainfall, which may have prevented it reaching it's full potential. The unfertilised sorghum grown in the lablab rotation area produced the highest net income, resulting in a cumulative gross margin for the lablab rotation after the initial two years of the experiment that was 11.5% higher than any of the continuous grain treatments. Interestingly, the unfertilised sub-treatment ranked second, with N35 and N_{70} treatments third and fourth respectively.

Table 1: Summary of treatment yields, nitrogen cost, and gross margins at *Juanita*, Fernlees, 1997-2000.

		Continuous Grain			Lablab Rotation
	N treatment:	Zero N	35kg N/ha	70kg N/ha	Zero N
1997/8	Crop:	Wheat	Wheat	Wheat	Lablab (2750kg/ha dry matter)
	Yield: Protein %:	2.61t/ha 12.0	2.830t/ha 12.4	2.472t/ha 13.2	1.9kg/ha/day liveweight gain[A]
	N cost @ 81c/kg N:	$0.00	$28.38	$56.76	$0.00
	Gross Margin $/ha:	**$152.62**	**$142.28**	**$84.54**	**$152.00**
1999	Crop:	Sorghum	Sorghum	Sorghum	Sorghum
	Yield: Protein %:	1.817t/ha 8.0	2.098t/ha 9.4	2.326t/ha 10.6	2.14t/ha 8.8
	N cost @ 78c/kg N:	$0.00	$27.31	$54.62	$0.00
	Gross Margin $/ha:	$124.97	$125.76	$121.25	$157.00
Cumulative Gross Margin:		**$277.59/ha**	**$268.04/ha**	**$205.79/ha**	**$309.00/ha**
2000	Crop:	Chickpea	Chickpea	Chickpea	Wheat
	Yield: Protein %:	1.25t/ha	1.25t/ha	1.25t/ha	1.73t/ha 8.35
	N cost $/ha:	$0.00	$0.00	$0.00	$0.00
	Gross Margin $/ha:	$383.70	$383.70	$383.70	$132.70
Cumulative Gross Margin:		**$661.29/ha**	**$651.74/ha**	**$589.49/ha**	**$441.70/ha**

[A] Individual animals gained 0.69kg/day for 64 days. Stocking rate 2.78 beasts/ha. Mean value at entry 96c/kg (245.8kg), mean value at exit 103c/kg (290.1kg).

Wheat was grown in the lablab rotation area in 2000, as farmers wanted to know if the observed N benefit to the 1999 sorghum would persist, and to what extent. The continuous grain area was cropped with chickpea that proved quite profitable, such that the cumulative gross margins for all of the continuous grain treatments surpassed the unfertilised lablab rotation after the third year of the trial. The wheat grown without fertiliser in the lablab rotation area was grossly N deficient. Previous studies in CQ (3) have indicated that a single season of lablab may supply N to 2 or 3 following cereal crops. There may have been some degree of N supply but the absence of wheat in the continuous grain area precludes any comparison or conclusion. The amount of N fixed during a legume ley is largely dependent on the crop biomass (6). The 97/98 lablab crop was low yielding (by CQ standards) due to poor seasonal conditions. Farmers involved in the project plan to grow lablab again this summer in the hope of growing a more typical crop.

Most open downs soils in CQ are very responsive to additional nitrogen. However, this experiment provides a measure of the risk assumed by farmers using N fertiliser under the erratic climatic conditions experienced in CQ (in this instance weather damaged 98 wheat, poor establishment 99 sorghum). Farmers using N fertiliser are exposed to this risk because of drought, weather damage, or lack of planting opportunities. Inclusion of lablab/cereal rotations in the farming system may address sustainability concerns, and provide a means of reducing exposure to risk associated with climate. Soil nitrogen gained in the lablab rotations in these experiments has come at no cost, as there has been no loss made relative to any of the fertilised grain treatments.

The lablab/sorghum rotation at *Silverton* has also performed above expectations (Table 2). This site has a deeper and more fertile soil than Fernlees, but is still regarded locally as run-down, and is usually N responsive. However, the most profitable treatments at *Silverton* have been those without N fertiliser, ie. continuous grain with zero N, and the lablab rotation. Again, this is a system where N fertiliser is applied to maximise yield potential in better seasons. However, in many seasons the cost of N fertiliser may be greater than the economic benefit resulting from it's use. A system that includes lablab – grain rotations may not offer the same high-end potential as a fertilised system, but it seems likely that it would also not offer the same degree of downside risk in a dry season, or in a season where other factors negatively influence the crop yield and value (eg. inadequate plant populations, insects, weather damage). An ideal system may utilise a lablab rotation, while maintaining the ability to apply tactical N fertiliser rates when seasonal conditions are very favourable.

Table 2: Summary of treatment yields, nitrogen cost, and gross margins at *Silverton*, Theodore, 1998-2000.

		Continuous Grain				Lablab Rotation
	N treatment:	Zero N	30kg N/ha	60kg N/ha	Budget N	Zero N
1998	Crop:	Sorghum	Sorghum	Sorghum	Sorghum (N_{46})	Lablab
	Yield: Protein %:	2.2t/ha 11.4	1.57t/ha 11.7	1.85t/ha 11.3	2.1t/ha 12.0	1.9kg/ha/day liveweight gain[B]
	N cost @ 84.5c/kg N:	$0.00	$25.35	$50.70	$39.00	$0.00
	Gross Margin	**$131.29**	**$42.94**	**$45.59**	**$82.29**	**$167.03**

	$/ha:					
1999	Crop:	Sorghum	Sorghum	Sorghum	Sorghum (N_{46})	Sorghum
	Yield: Protein %:	3.8t/ha 8.0	4.2t/ha 9.0	4.3t/ha 8.9	4.3t/ha 8.9	3.2t/ha 9.8
	N cost @ 71.5c/kg N:	$0.00	$21.45	$42.90	$33.00	$0.00
	Gross Margin $/ha:	$285.59	$308.10	$297.64	$307.54	$219.65
	Cumulative Gross Margin:	**$416.88**	**$351.04**	**$343.23**	**$389.83**	**$386.68**
2000	Crop:	Sorghum	Sorghum	Sorghum	Sorghum (N_{78})	Lablab
	Yield: Protein %:	2.1t/ha 9.2	2.1t/ha 9.8	2.4t/ha 10.1	2.1t/ha 10.0	4.17kg/ha/day liveweight gain[C]
	N cost @ 63c/kg N:	$0.00	$18.91	$37.82	$49.30	$0.00
	Gross Margin $/ha:	$105.09	$86.18	$97.27	$55.79	$132.87
	Cumulative Gross Margin:	**$521.97**	**$437.22**	**$440.50**	**$445.62**	**$519.55**

[B] Individual animals gained 0.66kg/day for 61 days. Stocking rate 2.88 beasts/ha. Mean value at entry 95c/kg (342.5kg), mean value at exit 105c/kg (383kg).

[C] Individual animals gained 1.18kg/day for 36 days. Stocking rate 3.53 beasts/ha. Mean value at entry 139c/kg (360.8kg), mean value at exit 139c/kg (403.3kg).

Future work within the CQ Sustainable Farming Systems project aims to determine the impact of lablab rotations on the farming system at a level beyond paddock scale, in terms of variations in capital structure and changes in whole-of-farm cash flow.

CONCLUSION

Lablab can supply adequate soil nitrogen for a following cereal crop in Central Queensland, but this is unlikely to be sufficient for a further cereal crop. Single season lablab needs to be grown before each cereal crop if it is to be relied upon as a source of nitrogen for cereal cropping.

The opportunity costs associated with the ley legume phase are offset by the benefits of increases of soil nitrogen to subsequent cereal crops. This source of nitrogen may have significant advantages for CQ farmers in terms of reducing climate risk associated with using N fertiliser (which requires financial outlay prior to cropping).

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