Economic performance of modified farming systems in Central West NSW

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Take home message

- Ley (Lucerne) pasture based farming systems provided the best gross margins during the moderate and dry seasons at Trangie. Grain crops post pasture phase performed well compared to cropping only systems
- Incorporating more legumes (+50%) in a cropping sequence recorded the highest gross margins during the wetter seasons (2020–2022)
- Ley pasture systems reduced farming system input costs during the drier seasons, decreasing economic risk, while achieving high relative system income.

Introduction

Central West NSW is a highly valuable agricultural producing region. The region is home to a range of industries, both irrigated and rain fed. It contains a variety of soil types and characteristics, that along with changing climatic conditions can impact agricultural production.

Growers face challenges from declining soil fertility, increasing herbicide resistance, and increasing soil-borne pathogens in their farming systems. To meet these challenges and to maintain farming system productivity and profitability the Queensland Department of Agriculture and Fisheries (DAF), New South Wales Department of Primary Industries (NSW DPI) and Commonwealth Scientific and Industrial Research Organisation (CSIRO) are collaborating to conduct an extensive field-based research program. The research is focused on developing farming systems to better use the available rainfall to increase productivity and profitability, aiming to answer the question:

"Can systems performance be improved by modifying farming systems in the northern region?"

In 2014 research began in consultation with local growers and agronomists to:

- Identify the key limitations, consequences, and economic drivers of farming systems in the northern region;
- Assess farming systems and crop sequences that can meet the emerging challenges; and
- Develop the systems with the most potential for use across the northern region.

Experiments were established at seven locations, including a large factorial experiment managed by CSIRO at Pampas near Toowoomba, and locally relevant systems being studied at six regional centres at Emerald, Billa Billa, Mungindi, Spring Ridge, Narrabri and Trangie (two sites characterised by either a red or grey soil type).

This report focuses on the economic performance of the modified systems at Trangie situated at the NSW DPI Trangie Agricultural Research Centre located in Central West NSW. The region is known for its high-performance winter crops and variable soil types suit a diversity of systems including dual purpose crops and grazing pastures alongside broadacre cropping. There are two experimental sites

at Trangie, one on a hard setting red soil and the other on a self-mulching grey clay (soil characteristics in Table 1).

Trangie farming system modifications and descriptions

The key system modifications under examination involve changes to:

- Crop intensity – the proportion of time that crops are growing which impacts on the proportion of rainfall captured and transpired by crops and fallow efficiency. This is being altered by changing soil water thresholds that trigger planting opportunities. Moderate intensity systems (*Baseline* which represents common practice) have a moderate soil water threshold of 50% full profile. The lower intensity systems require a profile >80% full before a crop is sown and higher value crops are used when possible.
- Increased legume frequency – crop sequence whereby every second crop is a legume, with the aim of reducing fertiliser N inputs and to improve long-term soil fertility.
- Increased crop diversity – crop choice aims to select 50% of crops that are resistant to root lesion nematodes (preferably two crops in succession) and crops with similar in-crop herbicide mode of action cannot be grown consecutively. The aim is to test systems where the mix and sequence of crops are altered to manage soil-borne pathogens and weeds in the cropping system.
- Nutrient supply strategy – by increasing the fertiliser allocation to achieve 90% of yield potential for that crop compared with 50% of yield potential. The aim is to boost background soil fertility, increase N cycling and maximise yield in favourable years.
- Ley pasture – Lucerne was specifically selected as the ley pasture system at the Trangie sites as the system is representative of the mixed grain/livestock enterprise of many farm businesses in central NSW.

System gross margin analysis

Economic analysis was undertaken to compare systems at both sites, using actual input rates for fertiliser and pesticides, which were costed at standardised prices. The ten-year median port prices less freight and grading/bagging cost where appropriate (i.e. pulses) for the various crops were wheat = $265, barley = $266, chickpea = $644, faba bean = $433, canola = $568 and field pea = $368 per tonne.

The pasture margins were valued as cattle live weight gain, with 50% pasture utilisation and 10 to 1 as fed feed conversion for stocking rate calculations. Long-term Meat Livestock Australia (MLA) annual prices were used to determine income at $6.10 per kg cwt, a dressing percentage of 50% with variable production costs equal to $75 per beast.

Site characteristics

The red soil site is hard-setting chromosol containing ~60% sand, 20% clay and ~15% silt. The pH is slightly acidic with low organic carbon (Table 1).

The second site is based on a self-mulching grey vertosol, containing 50% clay, 35% sand and 15% silt. The soil contains 0.3% more organic matter than the red soil and is slightly alkaline in pH.

Table 1. Trangie soil characteristics at the Red and Grey soil sites.

Site	Depth (cm)	BD (g/cm^3)	OC (%)	Colwell-P (mg/kg)	BSES-P (mg/kg)	Colwell-K (mg/kg)	Sulphur (mg/kg)	EC (dS/m)	pH_{Ca}	pH_w
Red	0–10	1.58	1.02	30	53	427	7.3	0.035	5.3	6.2
	10–30	1.61	0.43	9	15	268	5.0	0.021	6.0	6.8
Grey	0–10	1.42	1.48	50	62	506	10	0.09	7.6	8.4
	10–30	1.47	0.70	6	10	235	16	0.11	7.7	8.6

System cropping sequence

Due to the system planting triggers and rules, cropping sequences have diversified over the last 7 years. The grower's practice (*Baseline*) systems contained wheat and barley as pillar crop choices, with canola and chickpea as the break crops. A consideration for all systems was the dry seasons leading up to the 2018/2019 drought, where crop productivity was limited and below average. Once the drought broke in 2020, crop choice and intensity increased for all systems (Table 2). Field peas, canola and faba beans were sown within the modified systems.

Table 2. Trangie Red soil and Grey soil sites cropping sequence

	2016	2017	2018	2019	2020	2021	2022
Red soil							
Baseline	wheat	wheat	barley	canola	wheat	barley	chickpea
Higher nutrient	wheat	wheat	barley	canola	wheat	barley	chickpea
Higher legume	wheat	chickpea	barley	field pea	wheat	chickpea	wheat
Higher diversity	wheat	chickpea	field pea	wheat	canola	barley	chickpea
Lower intensity	wheat	fallow	barley	fallow	canola	wheat	chickpea
Ley pasture	lucerne	lucerne	lucerne	fallow	wheat	canola	wheat
Grey soil							
Baseline	wheat	wheat	barley	fallow	canola	wheat	barley
Higher nutrient	wheat	wheat	barley	fallow	canola	wheat	barley
Higher legume	wheat	chickpea	barley	fallow	faba bean	wheat	chickpea
Higher diversity	wheat	chickpea	field pea	fallow	wheat	canola	chickpea
Lower intensity	wheat	fallow	barley	fallow	canola	wheat	chickpea
Ley pasture	lucerne	lucerne	fallow	fallow	wheat	canola	wheat

Results

System performance

Of the five systems containing only a cropping sequence, the *Baseline, Higher nutrient* and *Higher legume* systems recorded the highest yield and gross margin across the seven years of research (Table 3). While there are benefits to selecting systems based on cropping diversity, smaller breeding programs may limit yield potential when directly compared to mainstream crop choices. As the project continues and disease and weed legacies develop, the *Higher diversity* system goal is to have greater sustainability and higher yield potential than low-diversity (monoculture) farming systems.

Ley pasture systems accumulated high system gross margins on both soil types. The economic performance of the pasture systems was valued using cattle live weight gain over the duration of the pasture. The pasture phase for both sites occurred during 2016–2019 the driest recorded period. During this period, it produced the highest gross margins for both sites compared to systems with only crops. On average, the pasture systems were $696/ha better than the next best performing system over this period, which struggled to produce grain crops consistently in the dry conditions. The economic advantage continued throughout the drought and into the cropping phase from 2020 to 2022 (Figure 1).

Table 3. Productivity and gross margins of the Trangie farming systems for 7 seasons, 2016–2022.

	Red soil		Grey soil	
System	**System yield (t/ha)**	**System GM ($/ha)**	**System yield (t/ha)**	**System GM ($/ha)**
Baseline	19.3	4272	20.1	4782
Higher nutrient	21.1	4840	18.4	3908
Higher legume	20.5	5311	17.2	4955
Higher diversity	14.6	3263	11.6	3467
Lower intensity	15.2	3954	12.9	3229
Ley pasture*	12.7	5379	11.6	5312

Note: *Ley pasture system yield values are only grain yields and do not include 7.9 t/ha of lucerne on the Red soil and 4.3 t/ha of lucerne on the Grey soil

Economic evaluation

Implementing various system rules resulted in a range for the total cropping costs of $1,369/ha at the Red soil site and $808/ha at the Grey soil site (Table 4). Input costs such as herbicides and sowing seed were big outliers for the *Higher diversity* and *Higher legume* systems compared to the other systems. The implication with systems containing high value grains and niche crops is input costs can be high compared to a cereal based sequence. Growers need to account for these costs and any risks that crops may have in variable conditions.

System modifications such as applying higher amounts of fertiliser as in the *Higher nutrient* system result in greater cropping costs, at Trangie Red a ~$330/ha increase in fertiliser costs has resulted in ~$900/ha additional income, however at Trangie Grey we have not seen the same positive response. Other changes such as reducing cropping intensity and/or implementing a ley pasture phase reduced long term system costs. Lowering costs is particularly beneficial in drier seasons where productivity is limited. Reducing system costs during drier seasons lowered the economic risk for the farming system.

Table 4. Farming system costs at Trangie Red soil and Grey soil sites (2016–2022)

Site	System	Expenses ($/ha)			
		Total system	Herbicides	Seed	Fertiliser
Red soil	***Baseline***	1862	630	288	452
	Higher nutrient	2212	666	282	782
	Higher legume	2133	674	401	359
	Higher diversity	2567	914	516	246
	Lower intensity	1959	872	270	305
	Ley pasture	1198	290	208	353
Grey soil	***Baseline***	1509	635	185	285
	Higher nutrient	1742	671	179	501
	Higher legume	1521	606	294	212
	Higher diversity	1478	492	280	178
	Lower intensity	1189	609	130	148
	Ley pasture	934	265	193	154

System performance in wet and dry seasons

Seasonal conditions in the northern grains region are highly variable and improving system performance across various conditions improves long-term sustainability. There were two distinct phases of economic returns for the project. A drier period between 2015 and 2019, where systems averaged ~$400/ha per year (Figure 1), largely made up of good returns from 2016's winter crop. As the seasons improved between 2020 and 2022, system returns increased to ~$1000/ha per year. When the *Ley pasture* system returned to a cropping phase the system successfully produced high value crops, allowing it to maintain its advantage during the drier seasons.

One system that showed variance in the dry and wetter seasons, was the *Higher legume* system. The system had moderate gross margins during the dry phase, but once rainfall increased it became one of the better performing systems. Between 2020 and 2023, the *Higher legume* accumulated the greatest system gross margin on both soil types at Trangie. The higher grain value of legumes and high grain yields resulted in high system performance.

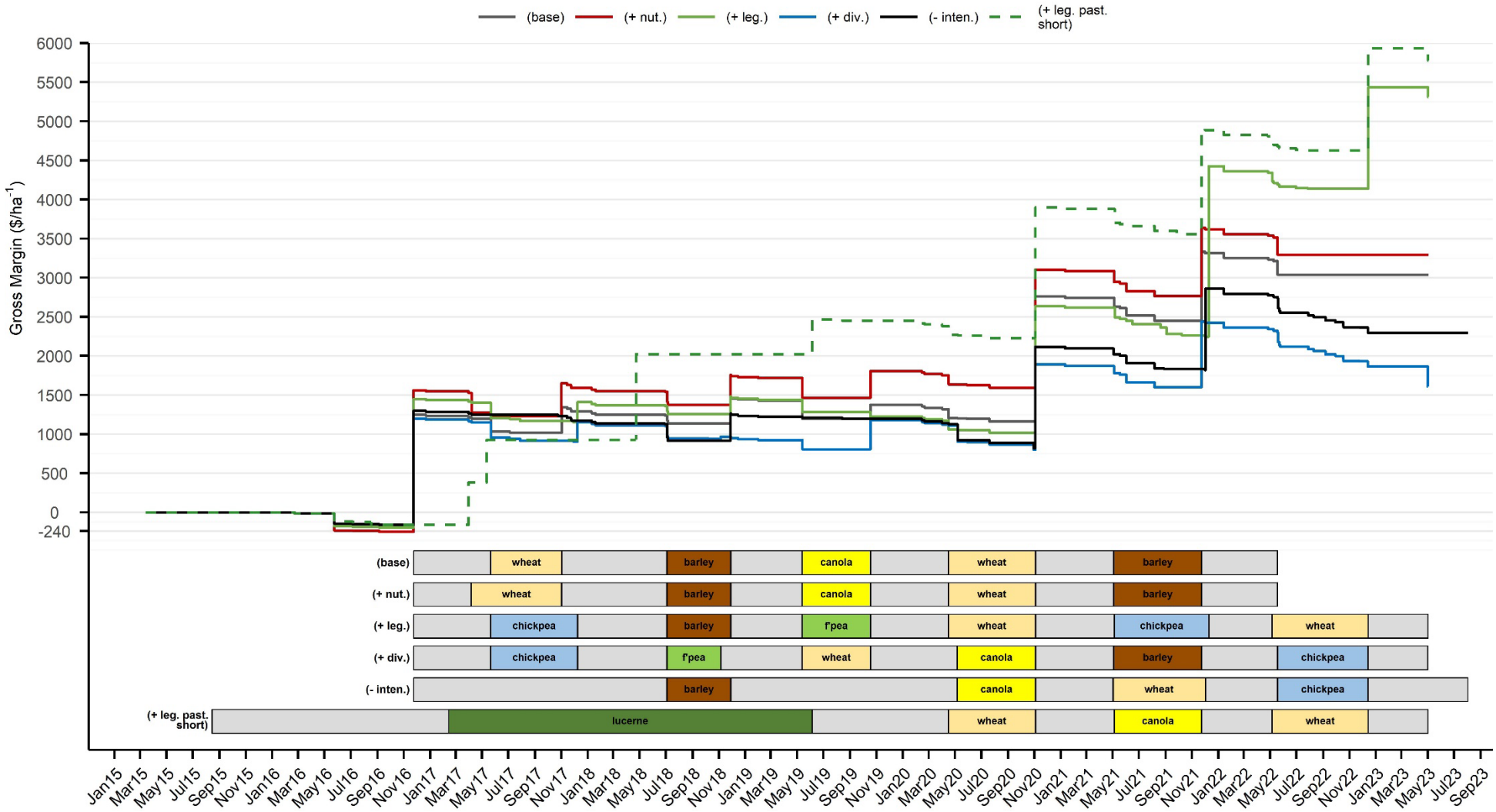

Figure 1. Trangie Red soil site time course system gross margin.

Base = Baseline, + nut = Higher nutrient, + leg = Higher legume, + div = Higher diversity, - inten = Lower intensity and + leg. Past. Short = Ley pasture.

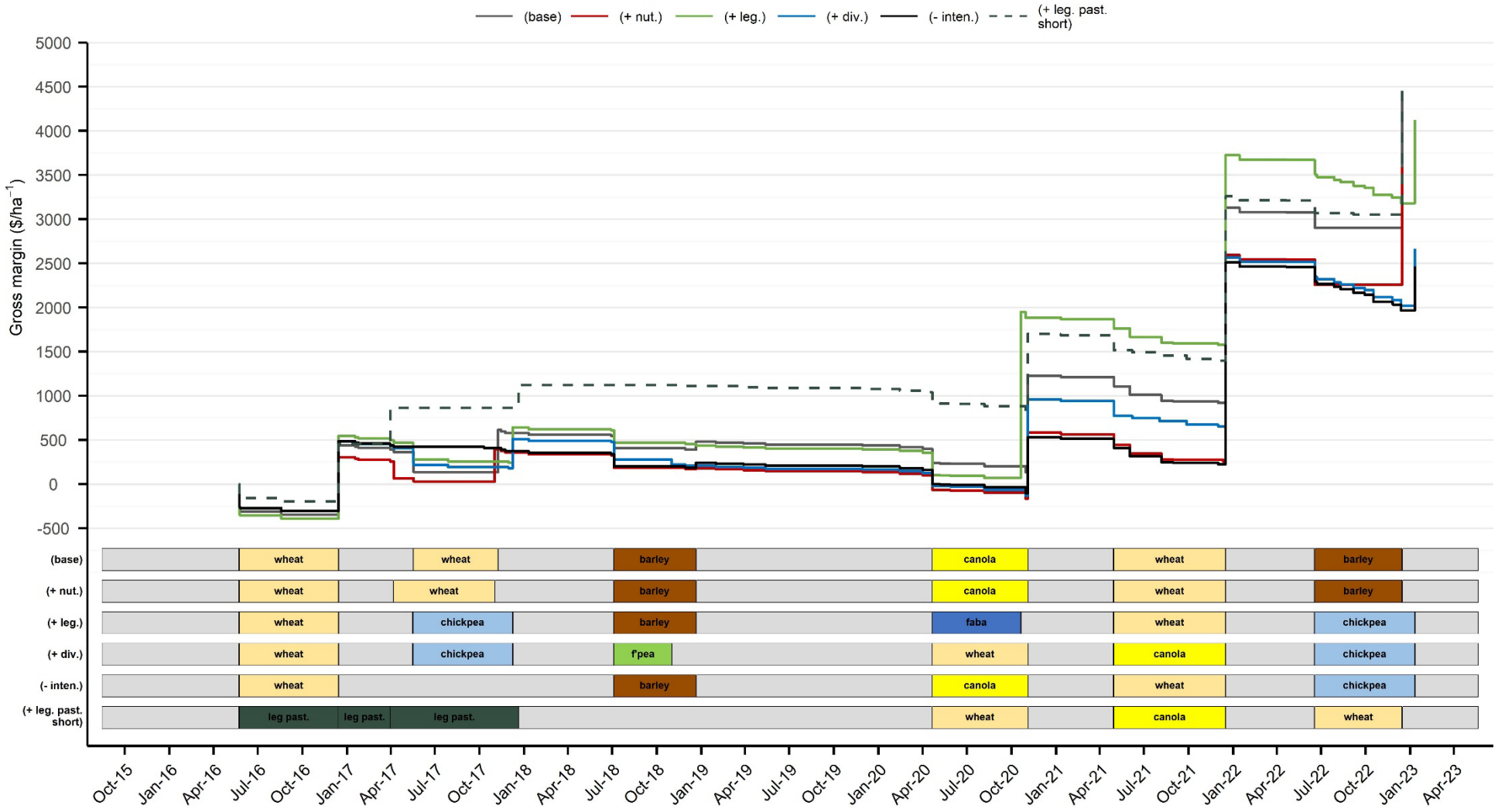

Figure 2. Trangie Grey soil site time course system gross margin.

Base = Baseline, + nut = Higher nutrient, + leg = Higher legume, + div = Higher diversity, - inten = Lower intensity, and + leg. past. short = Ley pasture.

Conclusion

The project showed that modifying farming systems led to economic benefits for growers located in central west NSW. The systems containing a short-term pasture phase had the highest gross margin returns with relatively low input costs. The Ley pasture system also performed well when phased back into cropping production at the Red and Grey soil sites. Applying this system as part of the rotation would allow growers to maintain cashflow during extended dry periods where achieving profitable grain production is challenging. Further studies will continue to investigate other system legacies over the next two seasons.

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