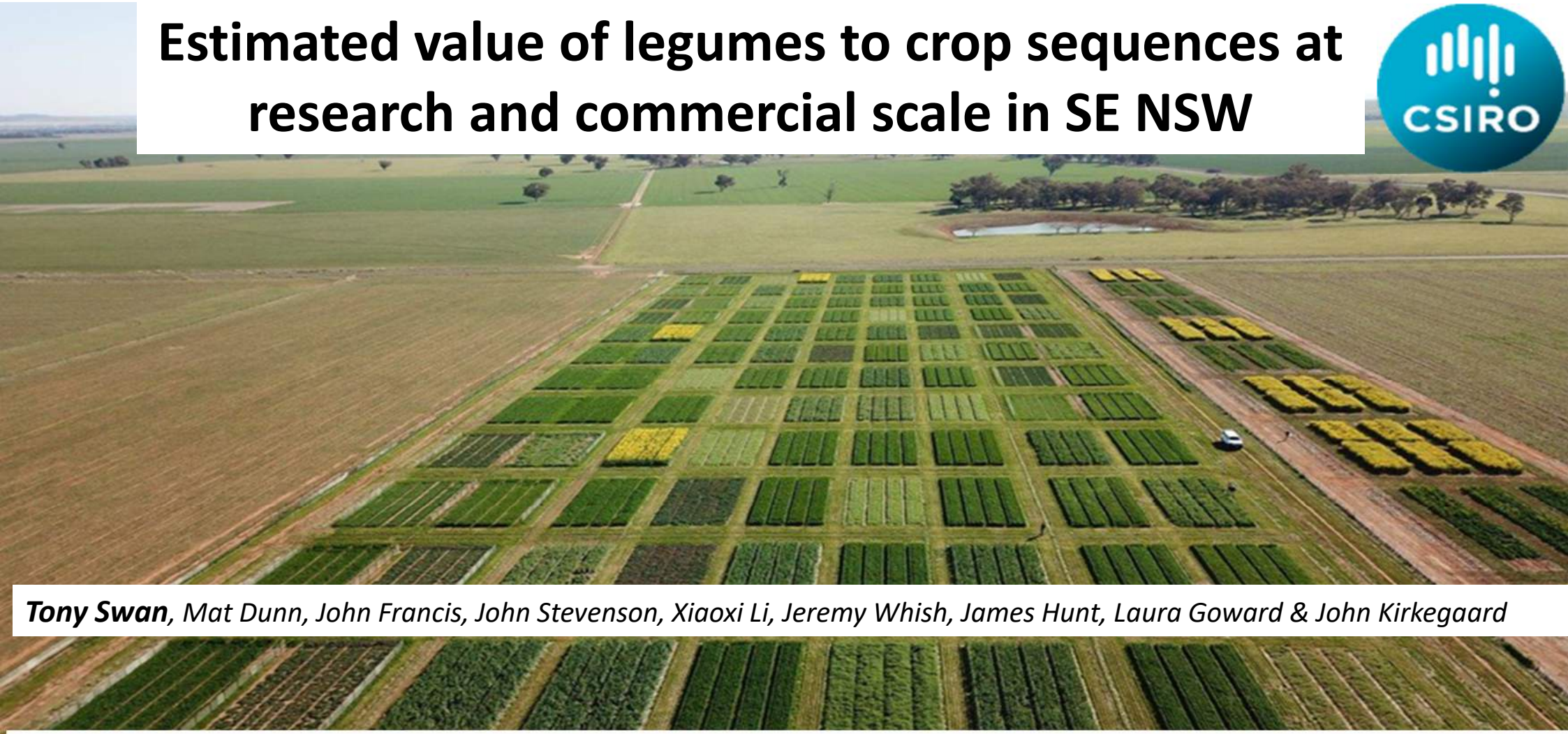
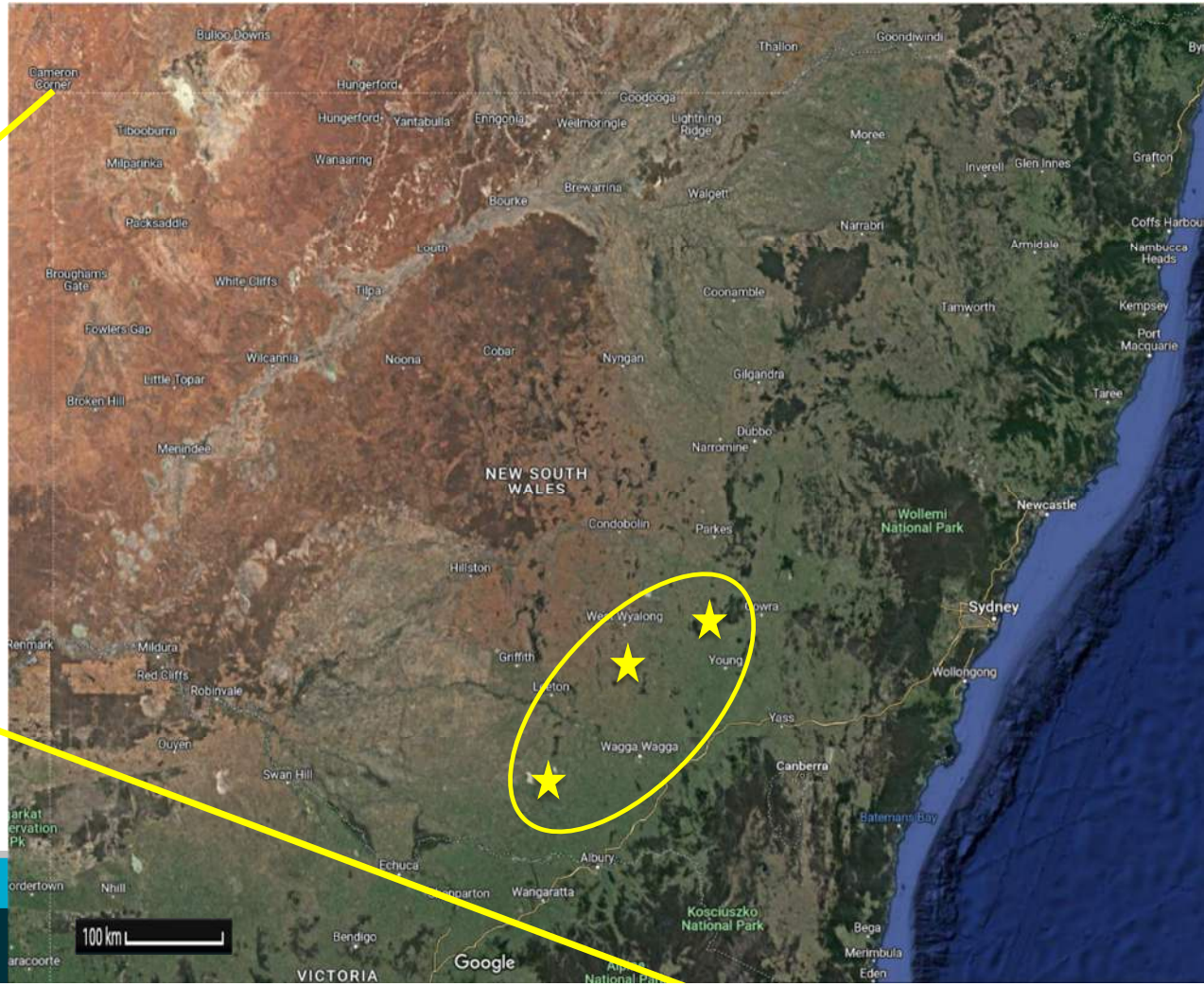
Estimated value of legumes to crop sequences at research and commercial scale in SE NSW



***Tony Swan**, Mat Dunn, John Francis, John Stevenson, Xiaoxi Li, Jeremy Whish, James Hunt, Laura Goward & John Kirkegaard*

New South Wales < Experimental Area



Experiment Information 2014-23

Exp't	Location, Soil & Years	Opener Type	Treatment	Crop sequence	Nitrogen Strategy
1	**Temora NSW Red Chromosol 2014-17**	**Tine & Disc**	**Baseline High N**	**Wheat - Wheat - Canola RR**	**High**
			Diversified Mix	**Wheat - Barley - Vetch - Canola**	**Low**
2	**Greenethorpe NSW** Red Kandosol 2018-23	Tine only			
3	**Urana NSW** Brown Vertosol 2018-23	Tine only			

Experiment Information 2014-23

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1	**Temora NSW** Red Chromosol 2014-17	Tine & Disc	Baseline High N	Wheat - Wheat - Canola RR	High
			Diversified Mix	Wheat - Barley - Vetch - Canola	Low
2	**Greenethorpe NSW** **Red Kandosol** **2018-23**	**Tine only**	**Baseline High N**	**Wheat - Wheat - Canola**	**High**
			Baseline Low N		**Low**
			Diversified Mix	**Wheat - Vetch - Canola**	**Low**
			Diversified Low Value (LV)	**Wheat - Faba bean - Canola**	**Low**
	Urana NSW Brown Vertosol 2018-23	Tine only			

Experiment Information 2014-23

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			Diversified Mix	Wheat - Barley - Vetch - Canola	Low
2	**Greenethorpe NSW** Red Kandosol 2018-23	Tine only	Baseline High N	Wheat - Wheat - Canola	High
			Baseline Low N		Low
			Diversified Mix	Wheat - Vetch - Canola	Low
			Diversified Low Value (LV)	Wheat - Faba bean - Canola	Low
3	**Urana NSW Brown Vertosol 2018-23**	**Tine only**	**Baseline Low N**	**Wheat - Barley - Canola**	**Low**
			Diversified Mix	**Wheat - Vetch - Canola**	**Low**
			Diversified Low Value (LV)	**Wheat - Faba bean - Canola**	**Low**

Experiment 1
System, N, Yield & Economics
2014-2017

Diverse 3-year: Fababean - Canola - Wheat

System	Crop 2014-17	Crop Yield Tine (t/ha)	Crop Yield Disc (t/ha)	Average 4-yr Gross Margin ($/ha/year)	Avg 4-yr Profit:Cost Ratio (ROI)	Avg 4-yr Nitrogen Fertiliser (kg/ha/yr)	Cost Fertiliser N as percentage of Gross Margin (%)
Baseline (High N)	Canola	2.6	2.6				
	Wheat 1	4.0	4.0				
	Wheat 2	3.7	3.8				
Diverse Mix (Low N)	Vetch	3.9	3.7				
	Canola	2.4	2.4				
	Wheat	3.8	3.9				
	Barley	4.9	4.8				

No significant difference in crop yield using disc or tine

Experiment 1
System, N, Yield & Economics
2014-2017

Diverse 3-year: Fababean - Canola - Wheat

System	Crop 2014-17	Crop Yield Tine (t/ha)	Crop Yield Disc (t/ha)	Average 4-yr Gross Margin ($/ha/year)	Avg 4-yr Profit:Cost Ratio (ROI)	Avg 4-yr Nitrogen Fertiliser (kg/ha/yr)	Cost Fertiliser N as percentage of Gross Margin (%)
Baseline (High N)	Canola	2.6	2.6	$454			
	Wheat 1	4.0	4.0				
	Wheat 2	3.7	3.8				
Diverse Mix (Low N)	Vetch	3.9	3.7	$484			
	Canola	2.4	2.4				
	Wheat	3.8	3.9				
	Barley	4.9	4.8				

Higher GM

Experiment 1
System, N, Yield & Economics
2014-2017

Diverse 3-year: Fababean - Canola - Wheat

System	Crop 2014-17	Crop Yield Tine (t/ha)	Crop Yield Disc (t/ha)	Average 4-yr Gross Margin ($/ha/year)	Avg 4-yr Profit:Cost Ratio (ROI)	Avg 4-yr Nitrogen Fertiliser (kg/ha/yr)	Cost Fertiliser N as percentage of Gross Margin (%)
Baseline (High N)	Canola	2.6	2.6	$454	0.83		
	Wheat 1	4.0	4.0				
	Wheat 2	3.7	3.8				
Diverse Mix (Low N)	Vetch	3.9	3.7	$484	0.98		
	Canola	2.4	2.4				
	Wheat	3.8	3.9				
	Barley	4.9	4.8				

Less Risky

Experiment 1
System, N, Yield & Economics
2014-2017

Diverse 3-year: Fababean - Canola - Wheat

System	Crop 2014-17	Crop Yield Tine (t/ha)	Crop Yield Disc (t/ha)	Average 4-yr Gross Margin ($/ha/year)	Avg 4-yr Profit:Cost Ratio (ROI)	Avg 4-yr Nitrogen Fertiliser (kg/ha/yr)	Cost Fertiliser N as percentage of Gross Margin (%)
Baseline (High N)	Canola	2.6	2.6	$454	0.83	111	
	Wheat 1	4.0	4.0				
	Wheat 2	3.7	3.8				
Diverse Mix (Low N)	Vetch	3.9	3.7	$484	0.98	72	
	Canola	2.4	2.4				
	Wheat	3.8	3.9				
	Barley	4.9	4.8				

39kg less synthetic N

Experiment 1
System, N, Yield & Economics
2014-2017

Diverse 3-year: Fababean - Canola - Wheat

System	Crop 2014-17	Crop Yield Tine (t/ha)	Crop Yield Disc (t/ha)	Average 4-yr Gross Margin ($/ha/year)	Avg 4-yr Profit:Cost Ratio (ROI)	Avg 4-yr Nitrogen Fertiliser (kg/ha/yr)	Cost Fertiliser N as percentage of Gross Margin (%)
Baseline (High N)	Canola	2.6	2.6	$454	0.83	111	24%
	Wheat 1	4.0	4.0				
	Wheat 2	3.7	3.8				
Diverse Mix (Low N)	Vetch	3.9	3.7	**$484**	**0.98**	**72**	**15%**
	Canola	2.4	2.4				
	Wheat	3.8	3.9				
	Barley	4.9	4.8				

Higher GM

Less Risk

39kg less synthetic N

9% less

Experiment 2 & 3 System, N & Economics 2018-2023

Diverse 3-year: Fababean - Canola - Wheat

Experiment System	Crop Sequence X Nitrogen strategy (Low or High)	Average 6-yr Gross Margin ($/ha/year)	Avg 6-yr Profit:Cost Ratio (ROI)	Avg 6-yr Nitrogen Fertiliser (kgN/ha/yr)	Cost Fert N percentage of Gross Margin (%)
2. Baseline	Canola - Wheat - Wheat (High N)				
2. Baseline	Canola - Wheat - Wheat (Low N)				
2. Diverse Mix	Vetch - Canola - Wheat (Low N)				
2. Diverse LV	Faba - Canola - Wheat (Low N)				

Experiment 2 & 3 System, N & Economics 2018-2023

Diverse 3-year: Fababean - Canola - Wheat

Experiment System	Crop Sequence X Nitrogen strategy (Low or High)	Average 6-yr Gross Margin ($/ha/year)	Avg 6-yr Profit:Cost Ratio (ROI)	Avg 6-yr Nitrogen Fertiliser (kgN/ha/yr)	Cost Fert N percentage of Gross Margin (%)
2. Baseline	**Canola - Wheat - Wheat (High N)**	$1076	1.13	**119**	20%
2. Baseline	**Canola - Wheat - Wheat (Low N)**	$1069	1.22	77	14%
2. Diverse Mix	**Vetch - Canola - Wheat (Low N)**				
2. Diverse LV	**Faba - Canola - Wheat (Low N)**				

Experiment 2 & 3 System, N & Economics 2018-2023

Diverse 3-year: Fababean - Canola - Wheat

Experiment System	Crop Sequence X Nitrogen strategy (Low or High)	Average 6-yr Gross Margin ($/ha/year)	Avg 6-yr Profit:Cost Ratio (ROI)	Avg 6-yr Nitrogen Fertiliser (kgN/ha/yr)	Cost Fert N percentage of Gross Margin (%)
2. Baseline	**Canola - Wheat - Wheat (High N)**	$1076	1.13	**119**	20%
2. Baseline	**Canola - Wheat - Wheat (Low N)**	$1069	1.22	77	14%
2. Diverse Mix	**Vetch - Canola - Wheat (Low N)**	$812	0.96	41	15%
2. Diverse LV	**Faba - Canola - Wheat (Low N)**	**$1150**	**1.31**	**36**	**6%**

Experiment 2 & 3 System, N & Economics 2018-2023

Diverse 3-year: Fababean - Canola - Wheat

Experiment System	Crop Sequence X Nitrogen strategy (Low or High)	Average 6-yr Gross Margin ($/ha/year)	Avg 6-yr Profit:Cost Ratio (ROI)	Avg 6-yr Nitrogen Fertiliser (kgN/ha/yr)	Cost Fert N percentage of Gross Margin (%)
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2. Diverse Mix	Vetch - Canola - Wheat (Low N)	$812	0.96	41	15%
2. Diverse LV	Faba - Canola - Wheat (Low N)	**$1150**	**1.31**	**36**	**6%**
3. Baseline	**Canola - Wheat - Barley (Low N)**	$812	1.02	**72**	20%
3. Diverse Mix	**Vetch - Canola - Wheat (Low N)**	$606	0.86	34	13%
3. Diverse LV	**Faba - Canola - Wheat (Low N)**	**$987**	**1.32**	**29**	**7%**

Scaling up to a Whole Farm Analysis

All about logistics, efficiency & ROAM

Courtesy: Barry Haskins

Exp 1: Whole Farm Scenario-Assumptions

Scenario	Tractor 1	Tractor 2	Seeder	Row space	Seeder speed + fuel usage	Labour units
A. 3000 ha	330hp 800 hrs/yr $313K	250hp 260 hrs/yr $236K	a. 12m flexi-coil $220K b. 12m disc $300K	300mm	a. 10 km/hr (46 L/hr) b. 12 km/hr (40 L/hr)	2 units $115K x 1 $70K x 1
B. 5000 ha	**450hp** **$428K**	**330hp** **$313K**	**a. 18m flexi-coil** **$290K** **b. 18m disc** **$370K**	**300mm**	**a. 10 km/hr (69 L/hr)** **b. 12 km/hr (60 L/hr)**	**3.5 units** **$115 K x 1** **$70 K x 1** **$66 K x 1.5**
C. 3000 ha (2018)	330hp $313K	250hp $236K	a. 12m parallelogram $350K b. 12m disc $350K	300mm 190mm	a. 8.75 km/hr (46 L/hr) b. 11 km/hr (46 L/hr)	2 units $115 K x 1 $70 K x 1

Land value = $6175/ha, **Asset value**: Scenario 1 to 3 $6913-60/ha

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B. 5000 ha	**450hp** **$428K**	**330hp** **$313K**	**a. 18m flexi-coil** **$290K** **b. 18m disc** **$370K**	**300mm**	**a. 10 km/hr** **(69 L/hr)** **b. 12 km/hr** **(60 L/hr)**	**3.5 units** **$115 K x 1** **$70 K x 1** **$66 K x 1.5**
C. 3000 ha (2018)	330hp $313K	250hp $236K	a. 12m parallelogram $350K b. 12m disc $350K	300mm 190mm	a. 8.75 km/hr (46 L/hr) b. 11 km/hr (46 L/hr)	2 units $115 K x 1 $70 K x 1

Land value = $6175/ha, **Asset value**: Scenario 1 to 3 $6913-60/ha

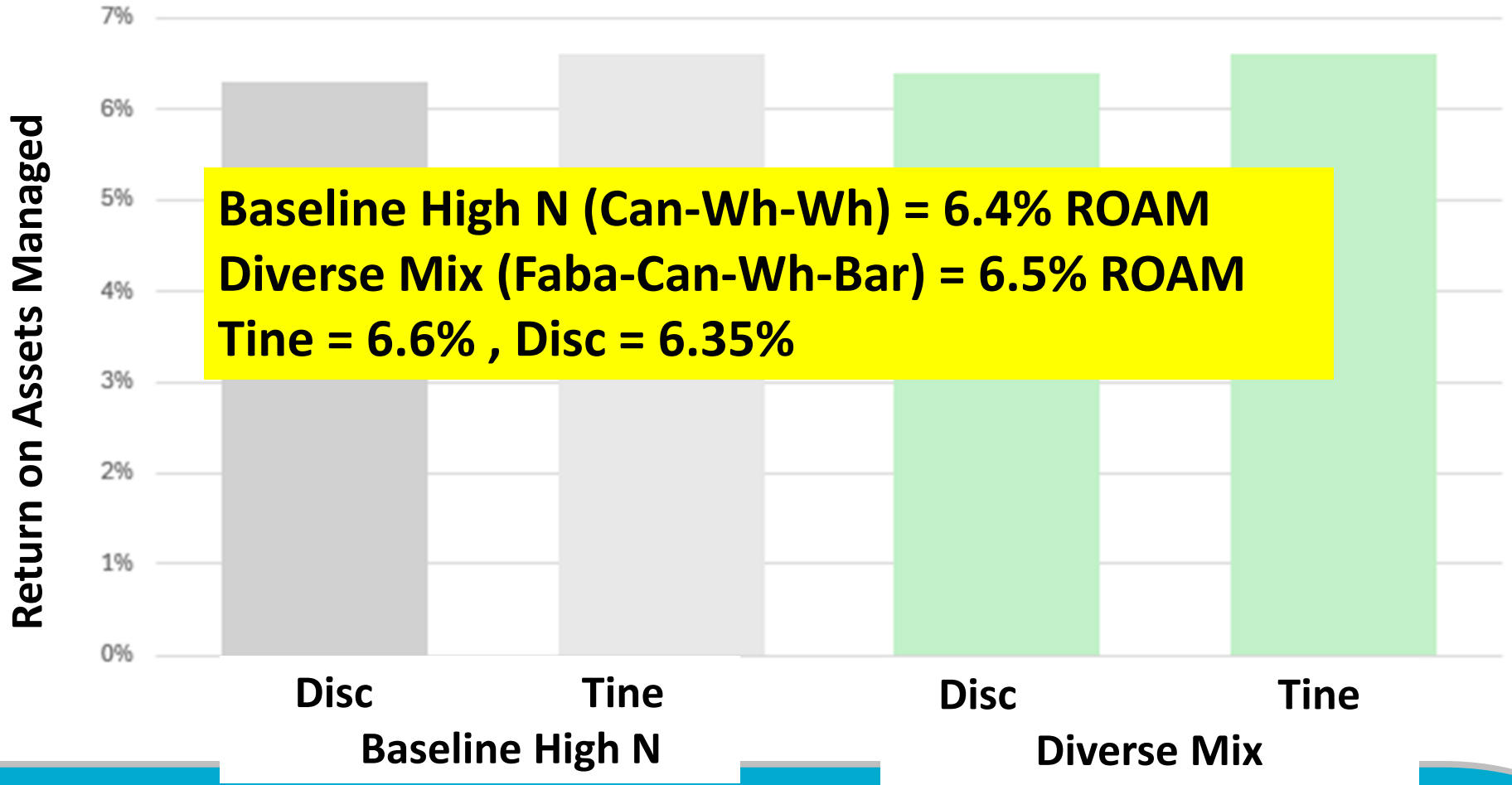
Total income, expenses & EBIT for the 5000ha property

Management Strategy	Opener	Gross Income	Enterprise expenses	Gross Margin	Overhead Costs	EBIT ($)	Depreciation
Baseline (High N)	**Tine**	**$5,017,791**	**$2,135,510**	$2,882,281	$596,448	**$2,285,833**	$151,550
Diverse Mix	**Tine**	**$4,855,398**	**$1,988,236**	$2,867,161	$579,884	**$2,287,278**	**$134,982**
Baseline (High N)	**Disc**	$4,908,716	$2,122,471	$2,786,245	$601,858	**$2,184,387**	$156,960
Diverse Mix	**Disc**	$4,794,992	$1,994,340	$2,800,652	$584,582	**$2,216,070**	**$139,680**

Total Income, expenses and EBIT at 5000 ha scale

Management Strategy	Opener	Gross Income ($/ha)	Whole Farm Average EBIT ($/ha)	Exp't Average EBIT
Baseline High N	Tine	$1,004	$447	$454/ha
Baseline High N	Disc	$982		
Diverse Mix	Tine	$971	$450	$477/ha
Diverse Mix	Disc	$959		

What does this mean for ROAM at 5000 ha?



Baseline High N (Can-Wh-Wh) = 6.4% ROAM
Diverse Mix (Faba-Can-Wh-Bar) = 6.5% ROAM
Tine = 6.6% , Disc = 6.35%

Moving forward at the Whole Farm Level in 2023-24

What does it cost increase pulse intensity?

Corporate Property size: 10,000 ha

Current crop rotation: **4-year rotation = Fababean-Canola-Wheat-Barley**

Proposed crop rotation: **3-year rotation = Fababean-Canola-Wheat**

Aim: Increase Return on Assets Managed (ROAM)

What does it cost to increase pulse intensity at whole farm level?

4-year rotation (Faba-Can-Wh-Bar) to 3-yr (Faba-Can-Wh)
Can we increase ROAM?

			Avg 10-yr Gross Margin (GM) for each crop			
Scenario (1 to 4)	**ROAM**	**Avg 3 or 4 yr GM ($/ha/yr)**	**Fababean GM ($/ha/yr)**	**Canola GM ($/ha/yr)**	**Wheat GM ($/ha/yr)**	**Barley GM ($/ha/yr)**
1. Base Model (F-C-W-B)	**5.69%**	**$979**	$160	$1,313	$1,326	$1,117

What does it cost to increase pulse intensity at whole farm level?

4-year rotation (Faba-Can-Wh-Bar) to 3-yr (Faba-Can-Wh)
Can we increase ROAM?

			Avg 10-yr Gross Margin (GM) for each crop			
Scenario (1 to 4)	**ROAM**	**Avg 3 or 4 yr GM ($/ha/yr)**	**Fababean GM ($/ha/yr)**	**Canola GM ($/ha/yr)**	**Wheat GM ($/ha/yr)**	**Barley GM ($/ha/yr)**
1. Base Model (F-C-W-B)	5.69%	$979	$160	$1,313	$1,326	$1,117
2. 1 +higher faba price(storage)	**6.71%**	**$1064**	$499	$1,313	$1,326	$1,117

Pulse price volatility

Requirements:

Scenario 2: Grain storage = add 7000T grain bunker @ $1.5M

What does it cost to increase pulse intensity at whole farm level?

4-year rotation (Faba-Can-Wh-Bar) to 3-yr (Faba-Can-Wh)
Can we increase ROAM?

			Avg 10-yr Gross Margin (GM) for each crop			
Scenario (1 to 4)	**ROAM**	**Avg 3 or 4 yr GM ($/ha/yr)**	**Fababean GM ($/ha/yr)**	**Canola GM ($/ha/yr)**	**Wheat GM ($/ha/yr)**	**Barley GM ($/ha/yr)**
1. Base Model (F-C-W-B)	5.69%	$979	$160	$1,313	$1,326	$1,117
2. 1 + higher faba price(storage)	6.71%	$1064	$499	$1,313	$1,326	$1,117
3. 2 + extra resources	**6.30%**	$1109	$680	$1,313	$1,326	$1,117

Requirements:

Scenario 3: Grain storage + plant & infrastructure (1 seeder, 1 sprayer, 1 header, 1 x chaser bin + labour) = $5.5M)

Capital $ for resources

What does it cost to increase pulse intensity at whole farm level?

4-year rotation (Faba-Can-Wh-Bar) to 3-yr (Faba-Can-Wh)
Can we increase ROAM?

			Avg 10-yr Gross Margin (GM) for each crop			
Scenario (1 to 4)	**ROAM**	**Avg 3 or 4 yr GM ($/ha/yr)**	**Fababean GM ($/ha/yr)**	**Canola GM ($/ha/yr)**	**Wheat GM ($/ha/yr)**	**Barley GM ($/ha/yr)**
1. Base Model (F-C-W-B)	**5.69%**	**$979**	$160	$1,313	$1,326	$1,117
2. 1 + higher faba price(storage)	6.71%	$1064				$1,117
3. 2 + extra resources	6.30%	$1109				$1,117
4. 3 + 3 yr rotation (no barley)	**6.60%**	**$1137**	$680	$1,313	$1,412	NA

0.91% ROAM

Requirements:

Scenario 4: Grain Storage, Infrastructure, labour + manage 3 crops. approx. 3300ha of each crop annually

Practicalities integrating a legume at a Whole Farm Scale

Challenges include:

- **Market volatility of the legume grain**
- **Grain storage**
- **Additional plant & infrastructure & labour**
- **Higher level of skill to do well**
- **Disease susceptibility**
- Soil type specific
- Requires inoculation
- More care needed when handling

Take home messages

- **Compared to C-W systems, diverse systems with legumes:**

  - More profitable
  - Reduce inorganic fertiliser
  - Reduce risk
  - Reduce weed and diseases
  - Robust in the longer term

- **Scaling Up to Whole Farm (logistics, efficiency, ROAM)**
  - Match scale of farm to labour/plant/equipment units
  - Price volatility/Storage/Capital resources/Operator skill!

Thank you from the Project Teams 2014-23

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Xiaoxi Li
Laura Goward
Gabe Brown
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Impact of maximising whole farm efficiency!

Farm Scale	Labour units	Total Assets	Overhead Expenses	Enterprise Expenses	Machinery Costs	EBIT	ROAM
Area		($/ha)	($/ha)	($/ha)	($/ha)	**($/ha)**	**(%)**
1500 ha	1	$7651	$182	$416	$146	**$323**	**4.2%**
3000 ha	2	$6913	$135	$392	$101	**$393**	**5.7%**
Difference ($/ha)			$47	$24	$45	**-$70**	**-1.5%**

Higher Assets + lower EBIT = Reduced ROAM

18% Reduction in profit
25% Reduction in Profitability

Trying to speed up the harvesting process!
Harvest Stubble High: Stripper Front & Disc System


Photo: Courtesy Greg Condon Grassroots Agronomy


Photo: Courtesy Greg Condon Grassroots Agronomy

Draper height: 10% ↓ in speed per 10cm ↓ harvest height

Stripper front: 50-70t/hr = ↓ cost $/t or /ha & ↑ efficiency

(*Francis 2018: 15% time saving & 12% cost saving-Stripper vs Draper high*)

Sequence extremely important: W-B-Pulse-C

- Keeping stubble in the system to ↓ erosion ↓ evaporation
- Sowing less antagonistic crop into stubble (P into B, C into P)
- Pulse after cereals: ↑ humus - pulse breaks down cereal stubble
- ↓ weeds over summer
- ↓ disease (two double breaks)

W-B-C = issues: Stubble breakdown, insects, Canola emergence, pre-em herbicides & ↑ synthetic N is required!

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Practicalities of integrating a legume into the whole farm

Advantages

- Biological nitrogen fixation
- Disease break
- Weed control
- Diversifies marketing
- Robust seedlings (large seed)
- Lower cost
- Reduces harvest time pressures
- Forces pH amelioration
- Improved water use efficiency

Disadvantages

- **Market volatility of the legume grain**
- **Higher level of skill to do well**
- **Additional plant & infrastructure**
- **Grain storage challenges**
- **Disease susceptibility**
- Soil type specific
- Requires inoculation
- More care needed when handling