Environmental outcomes of kiwifruit orcharding:
Implications for Industry?

Henrik Moller, Catriona MacLeod, Corey Bragg, Peter Carey, Guinevere Coleman, Solis Norton, Jayson Benge

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Environment update

- Birds and bird-friendly branding ... an example of the ARGOS approach
- Soils
- Intensification and energy efficiency
- A new weed, biodiversity and land use survey partnership with Zespri and Environment Bay of Plenty

ARGOS Bird surveys

Grant Blackwell, Catriona Macleod, Corey Bragg

Survey	Kiwifruit	Sheep-Beef	Dairy
1	2004/05	2004/05	2006/07
2	2006/07	2007/08	
3	2009/10	2009/10	
Guinny Coleman†	2008/09		

† Year round surveys

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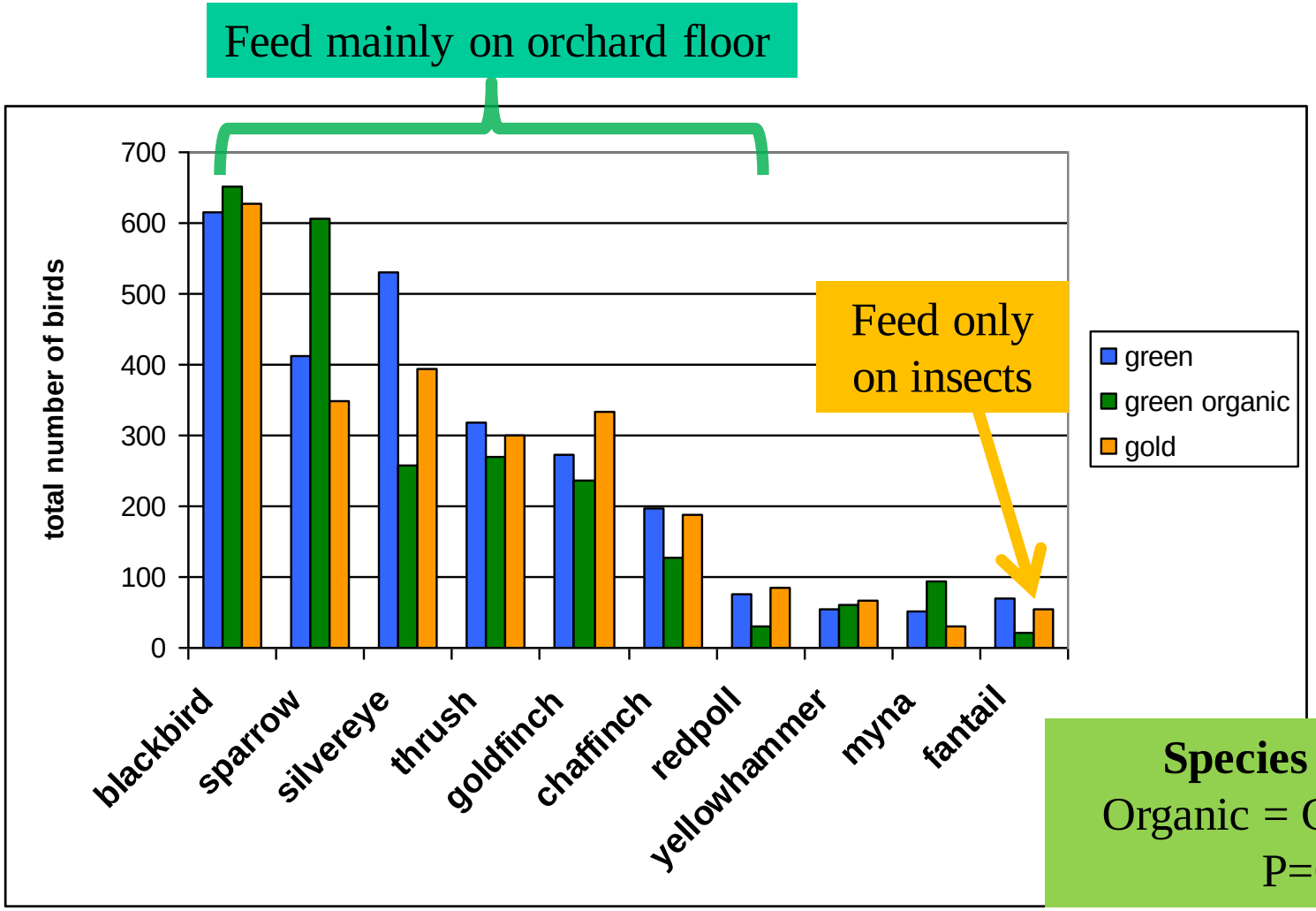
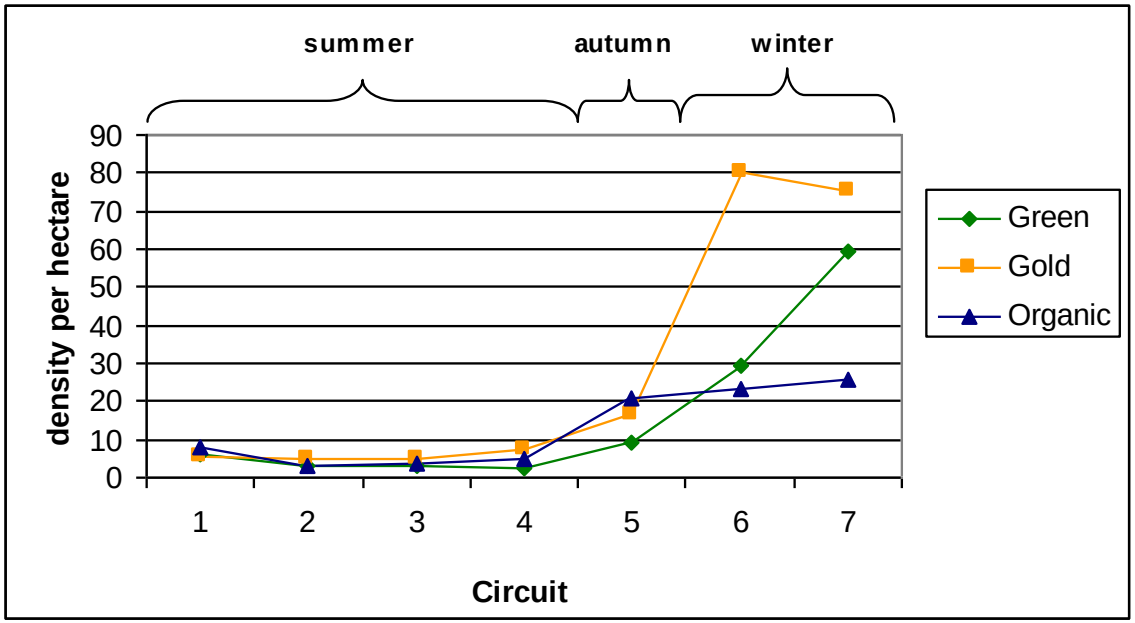


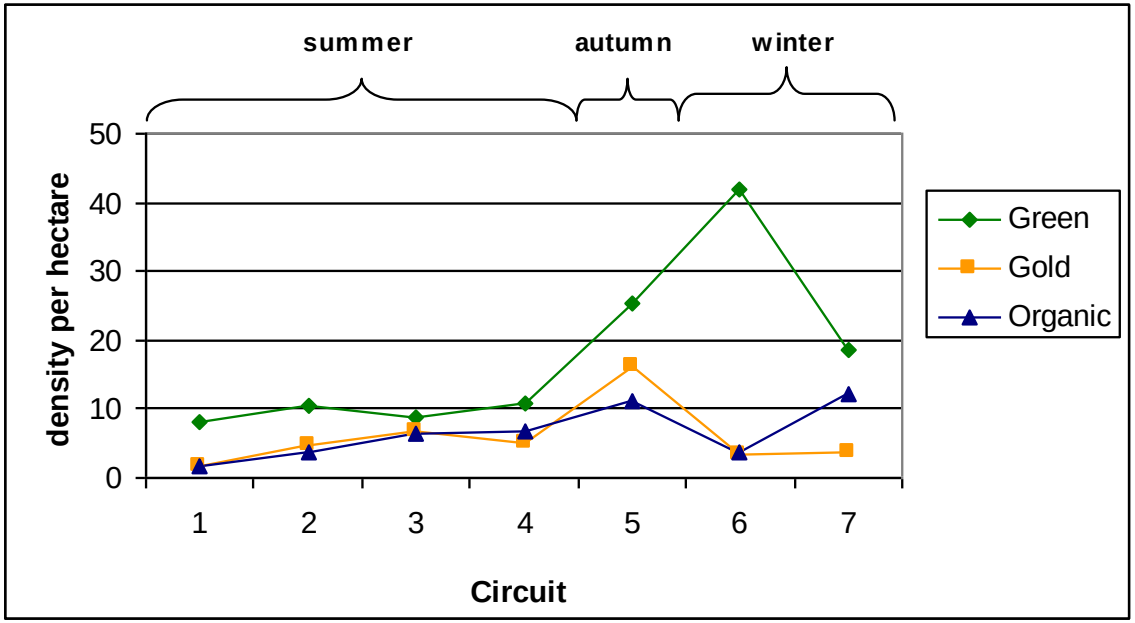
Species Richness
Organic = Gold > Green
P=0.04

Total number of birds counted for the ten most common species. Counts pooled over seven circuits (summer, autumn and winter).

Flocking species

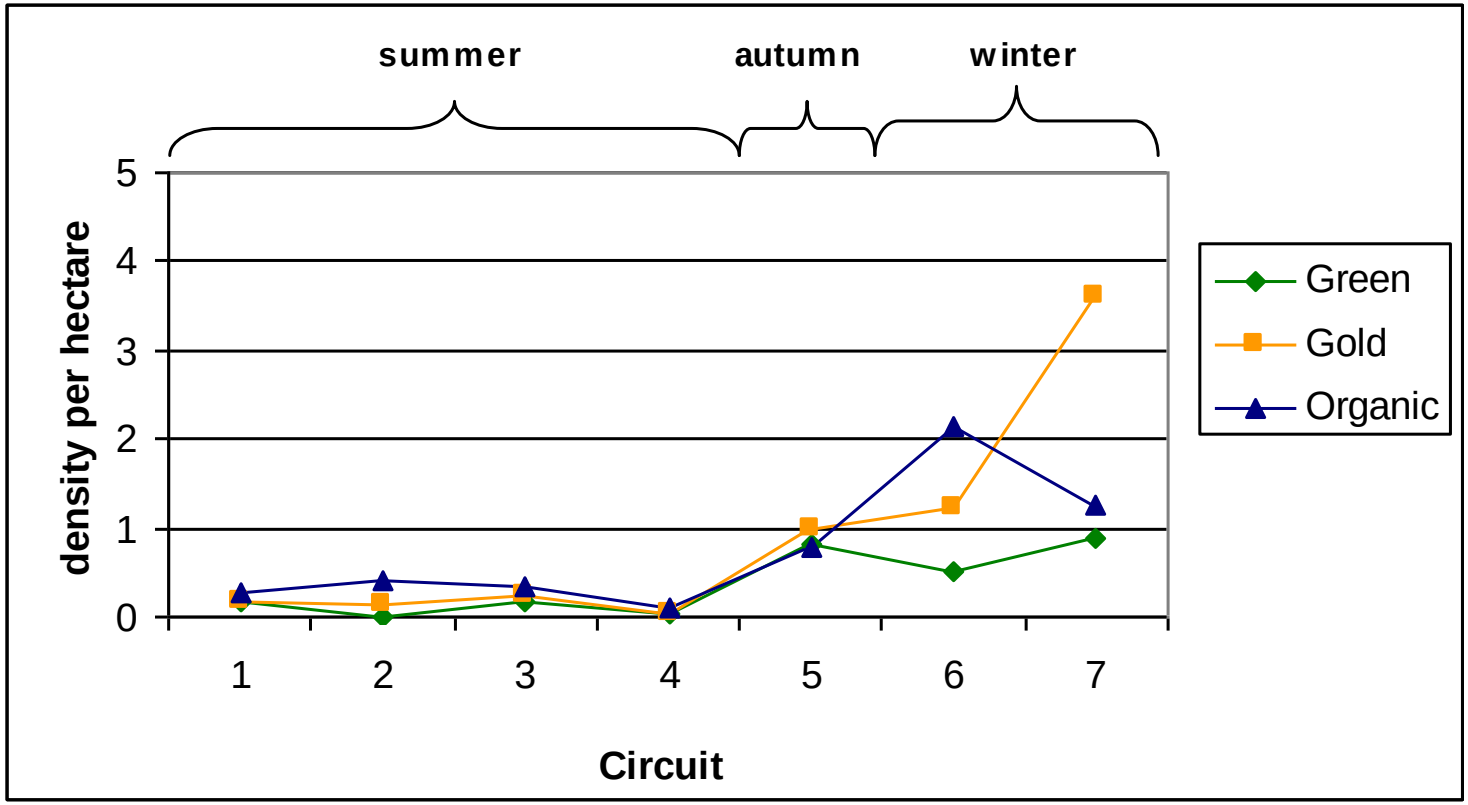


Silvereyes
7-14 fold seasonal fluctuation



House sparrows
2-4 fold seasonal fluctuation

Fantail – our ‘Flagship’ and ‘Indicator’ species

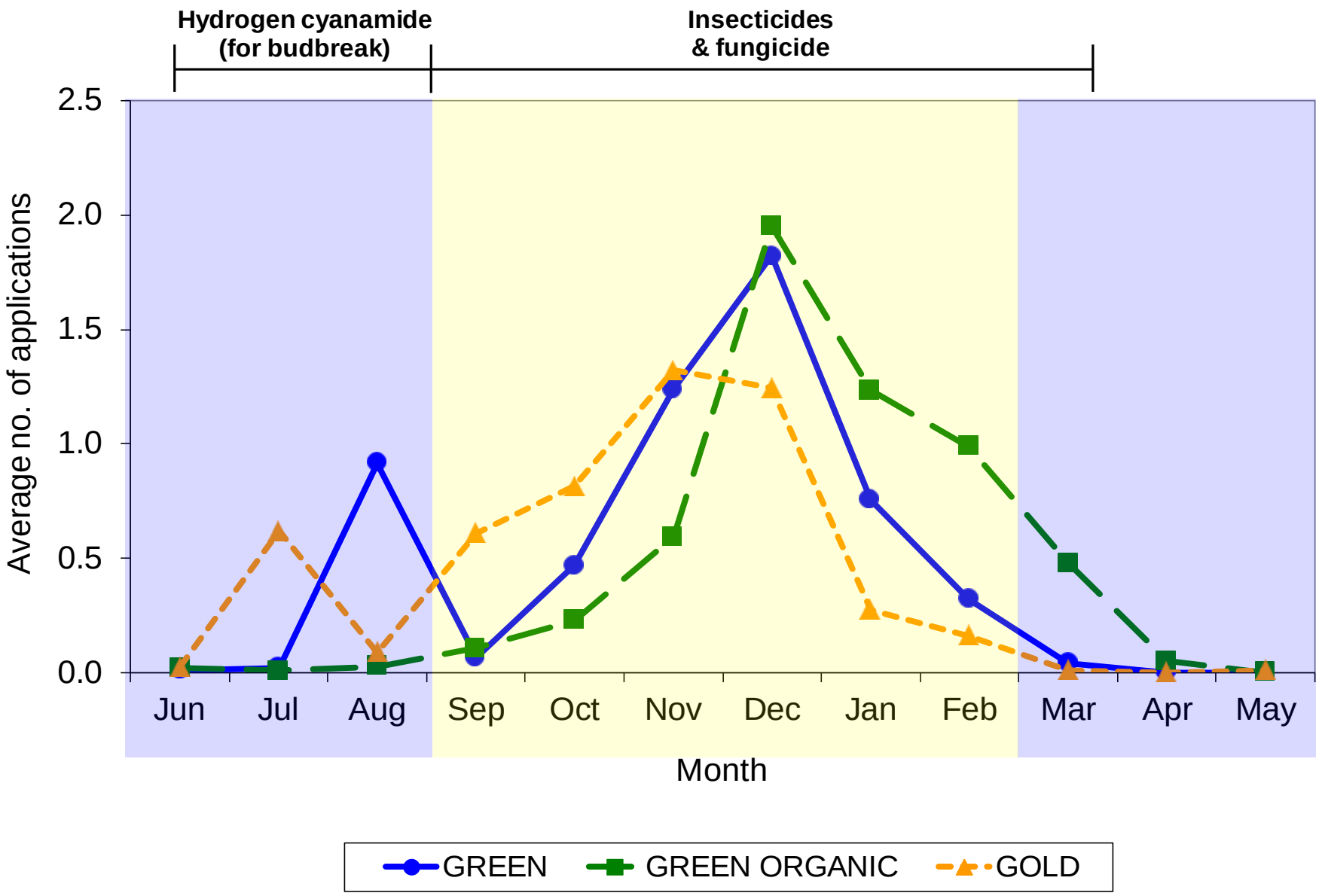


Abundance (Fantails per ha) in:

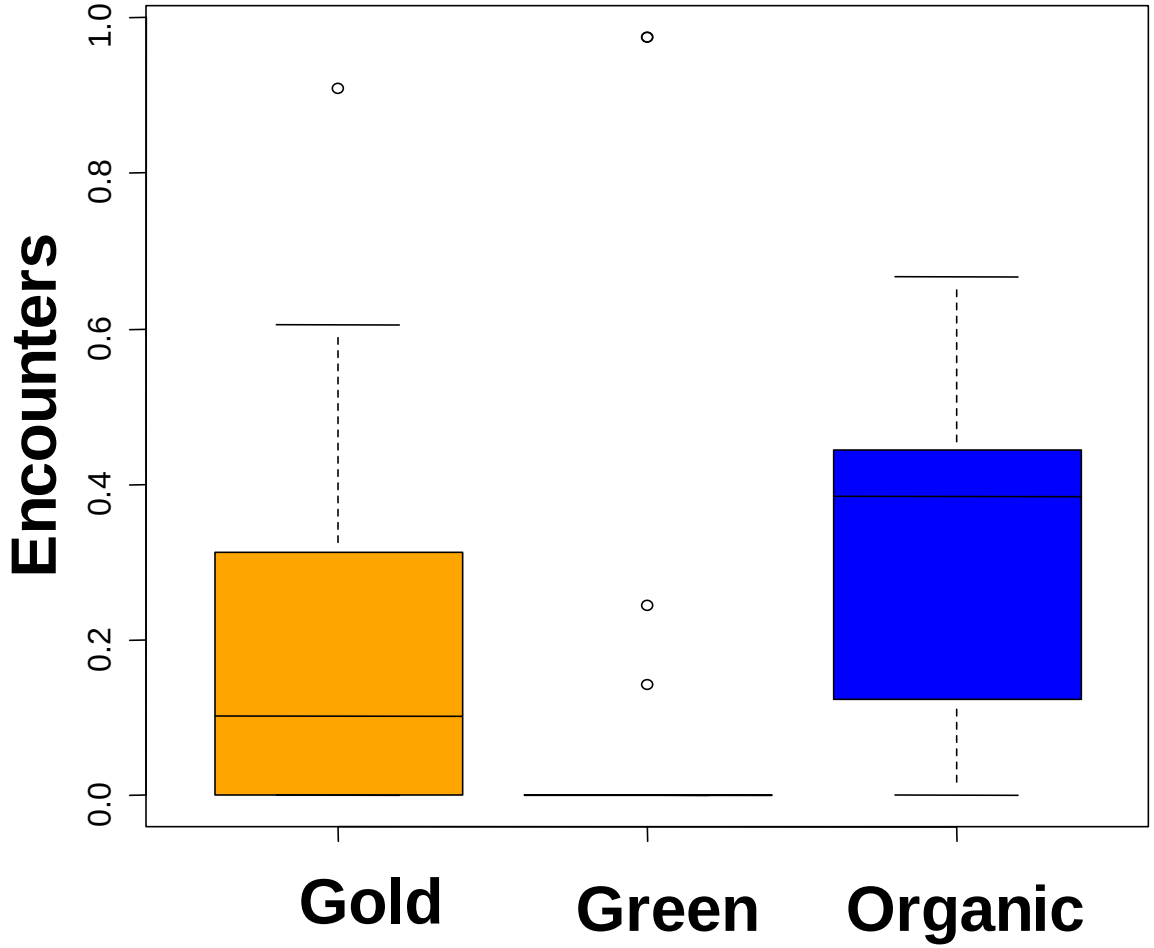
- Summer: 0.19 (0.1-0.3)
- Winter : 1.36 (0.9-1.9)

} 6 fold seasonal fluctuation

Orchard spraying



Fantail encounter rate during the summer/breeding season



Fantail encounters P = 0.01

No evidence of difference in feeding rates between panels P > 0.05

Implications for industry

- Bird monitoring methods perfected and firm baselines are in place for future trend analysis
- Now ready to model links of bird diversity and abundance to orchard management practice, financial performance and orchardist's 'orientations'
- Organics (and sometimes Gold) have higher species richness and abundance of birds

Implications for industry

- Limited breeding of insectivores on orchards, though marginally more on organics
  - Probably insecticide applications create a push factor
  - Fantail (and warblers?) key 'indicator species' and a 'flagship species'
  - Can Kiwifruit growing be further modified to expand breeding opportunities?
- Many bird species being supported by KF orchards in winter, so contributing to landscapes metapopulation
- Prospect of a 'bird tick' label for marketing?

"Do you see a benefit from having a label for export kiwifruit which tells consumers something about the environment in orchards?"
ARGOS panel (n = 27)

	Green	Organic	Gold
Yes & Maybe	78%	100%	100%
No	0%	0%	0%
Don't Know	22%	0%	0%

"Do you see a benefit from having a specific bird label?" ARGOS panel (n = 26)

	Green	Organic	Gold
Yes & Maybe	77%	22%	50%
No	0%	67%	38%
Don't Know	22%	11%	13%

Implications for industry

- Locals are sceptical of the value of a ‘bird tick’
- Key research questions:
  - But what would the consumers think?
  - What would its economic value be?
  - What would it cost to have a bird tick?
- How can ARGOS help get the message across?

Implications for industry

- Organic growers are content that their label/accreditation signals the bird and environmentally friendly credentials
- All growers are behind value of environmental verification – an important part of Zespri's social capital! Potential here for growing the environmental care

Effect of Kiwifruit Systems on Soil Properties

Peter Carey, Jayson Benge
and Solis Norton

... earlier contributions from Jeff Reid,
Andrea Pearson & Henrik Moller

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ARGOS Soil surveys

Survey	Kiwifruit	Sheep-Beef	Dairy converting
1	2004	2003	2005
2	2006	2006	2007
3	2010/*11*	*2011*	

Differences in Soil Properties Between Kiwifruit Systems

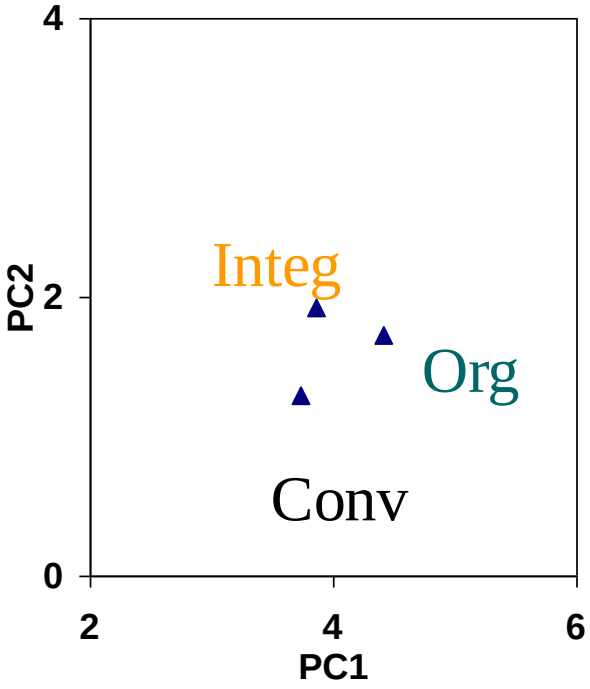
2004-6	Chemical fertility				Soil organic matter				
	pH	Ols-P	Sulp-S	CEC	C	N	C/N	AMN-N	Org-S
		mg P/kg	mg S/kg	cmol/kg	%	%	ratio	mg N/g SN	mg S/kg
Green	6.5	40	18	18	5.1	0.43	12.1	24	7.6
Gold	6.4	45	20	19	5.6	0.47	11.9	27	9.8
Organic	6.7	32	14	20	5.7	0.47	12.1	23	7.9
Signif.	***	*	*	**	*	*	*	***	**

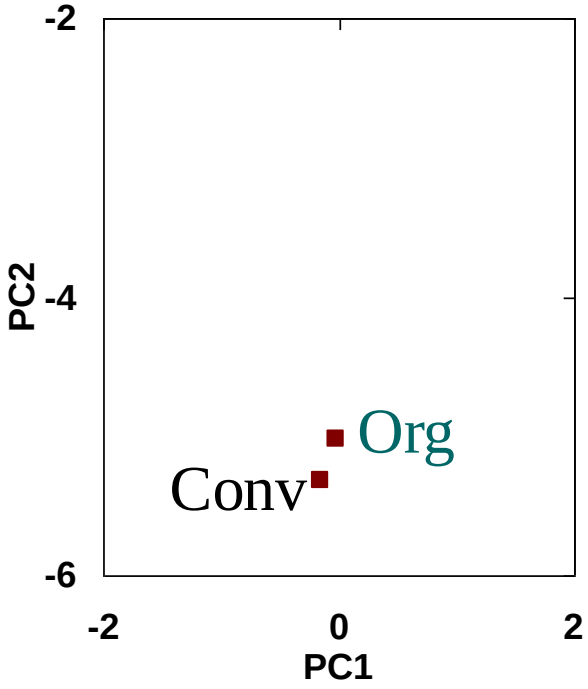
2004-6	Soil physical condition				Soil biology				
	SBD	Porosity	Aggregation	WHC (%)	Sol-C	SMB-C	SMC-N	Met-Q	EW
	g/cm^3	% of good and excellent scores		g/cm^3	mg C/g soil-C		mg N/g N		$\#/m^2$
Green	0.82	48	86	50	2.6	7.3	21	53	74
Gold	0.78	48	77	55	2.7	7.2	21	48	73
Organic	0.75	70	91	59	2.4	7.7	26	50	131
Signif.	***	*	*	**	*ns*	*ns*	***	*ns*	*

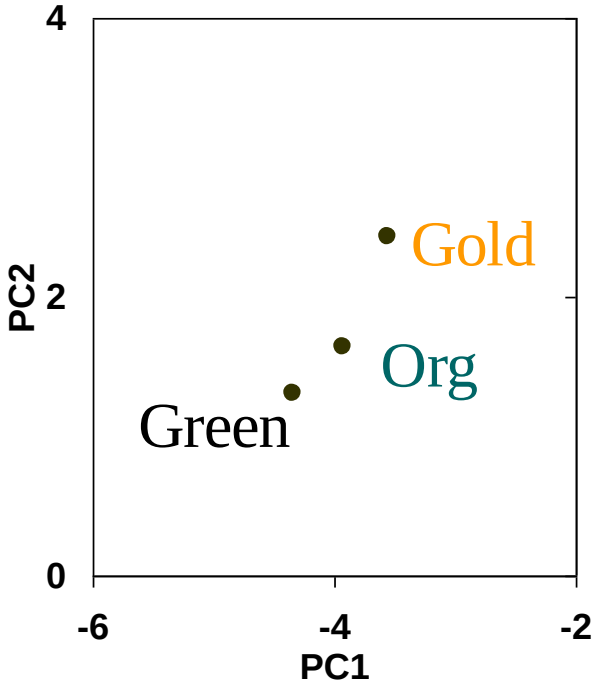
Similarity of Management Systems

Energy use/ha

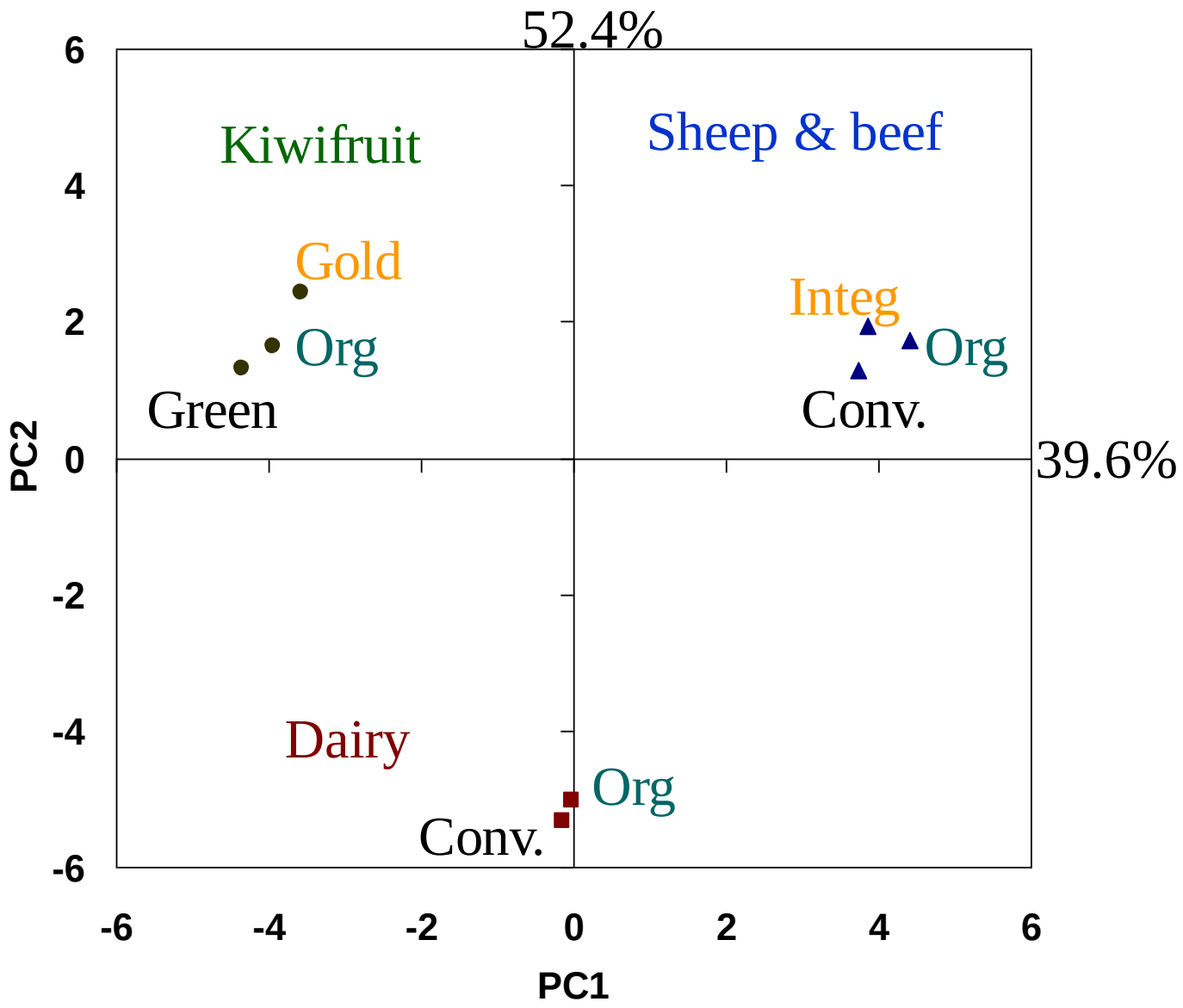
Sheep & Beef ➡ Dairy ➡ Kiwifruit







Similarity of Sectors



Implications for industry

- Soil generally in good health
- Firm baselines in place to monitor trends
- Internationally excellent panel comparison in place
- Can now model links to production and orchardists' orientations and financial performance
- Organics broadly 'more healthy' and more biologically active soils ... this is achieved with less energy/fertiliser inputs ... *a marketable difference!*

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Comparing energy intensity and efficiency of production between panels of kiwifruit orchards

Calculating energy intensity and efficiency: why bother?

- More intensive horticulture that relies on ecological and energy subsidies may not be sustainable
- Less intensive horticultural systems are likely to be more resilient to shocks imminent in coming decades
- Energy return on investment (EROI) is a method for modeling the **efficiency** of production for a wide variety of systems which is growing in international popularity
- We extend the work of Barber and Benge (2006)

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Methods

- Convert physical quantities to an energy value
  - Determine energy content of kiwifruit
  - Energy embodied in fertiliser, agrichemicals etc
- Create an Energy Return On Investment (EROI) ratio:
  - Energy in kiwifruit : energy in fertiliser, agrichemical, electricity, buildings & vine support structures, and vehicles
  - Assume 20yr and 15yr lifespan for buildings and vehicles
- 36 orchards in 12 clusters
- 2002/03 – 2007/08

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Energy content of kiwifruit

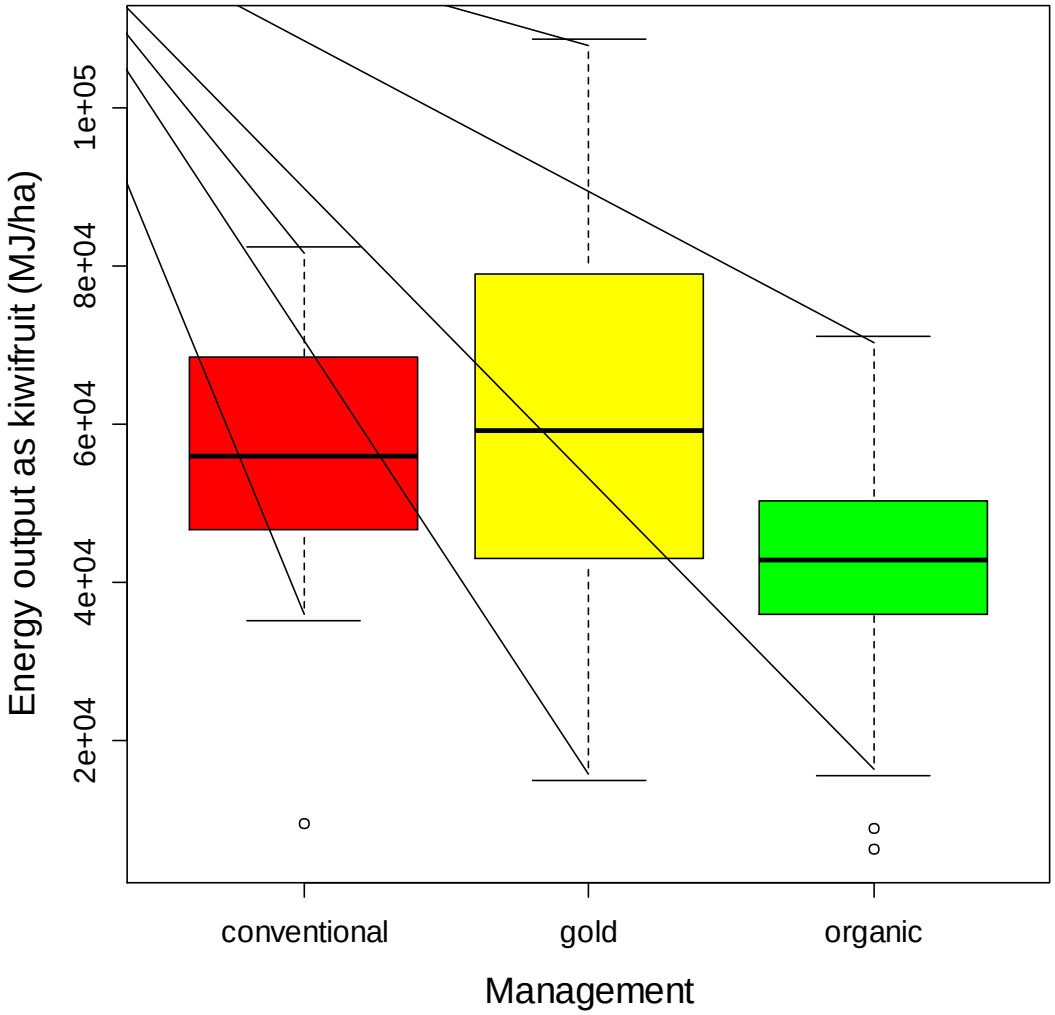
Five data sources were reviewed, and their raw data collated and combined in a 'boot strapping' analysis to determine the energy content of kiwifruit.

Hayward variety: 241kJ/100g (95%CI 232 – 251)

Hort16A variety: 235 kJ/100g (95%CI 229 – 241)

These values were combined with tray weights for each tray size and number of trays to obtain energy output as kiwifruit

Energy output as kiwifruit



<u>Energy output (GJ/ha/yr)</u>

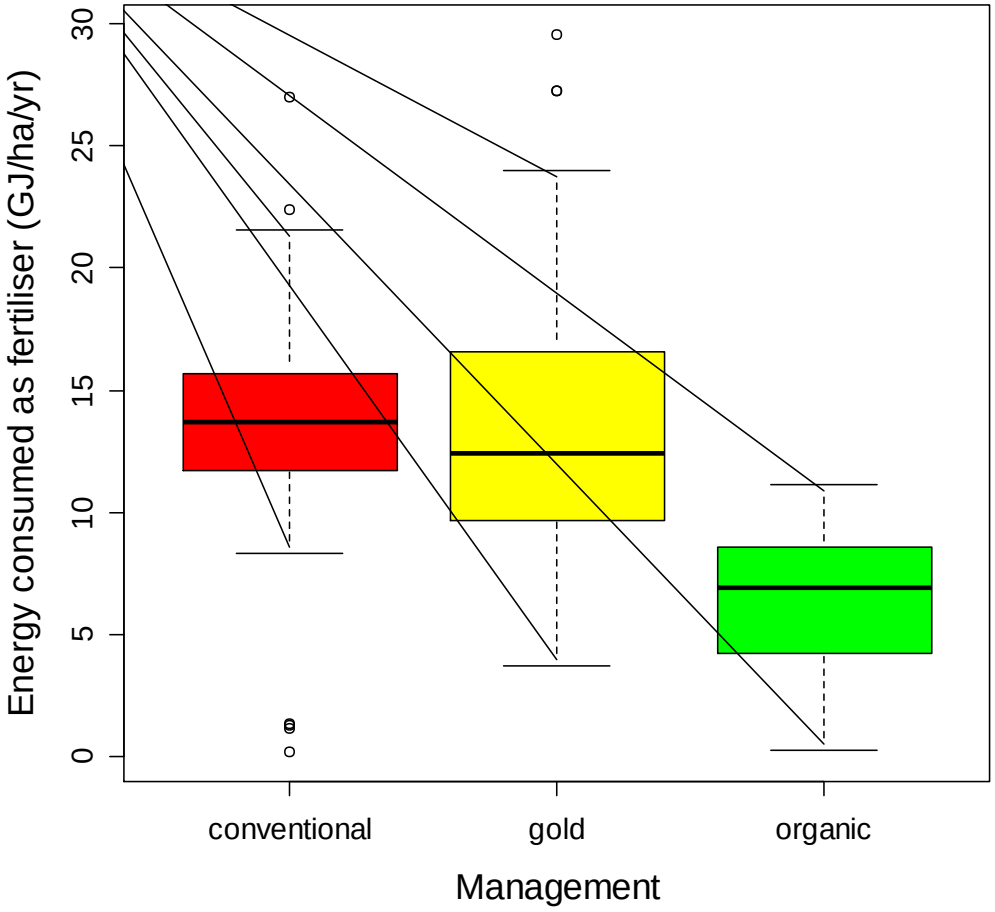
Organic: 42.8 (95%CI 34.7 – 50.9)

Conv: 58.0 (95%CI 50.0 – 66.0)

Gold: 60.5 (95%CI 52.6 – 68.4)

Organics 84% of Conv output.

Energy in fertiliser



Energy in fertiliser (GJ/ha/yr)

Organic: 6.4 (95%CI 5.0 – 7.8)

Conv: 13.1 (95%CI 11.7 – 14.5)

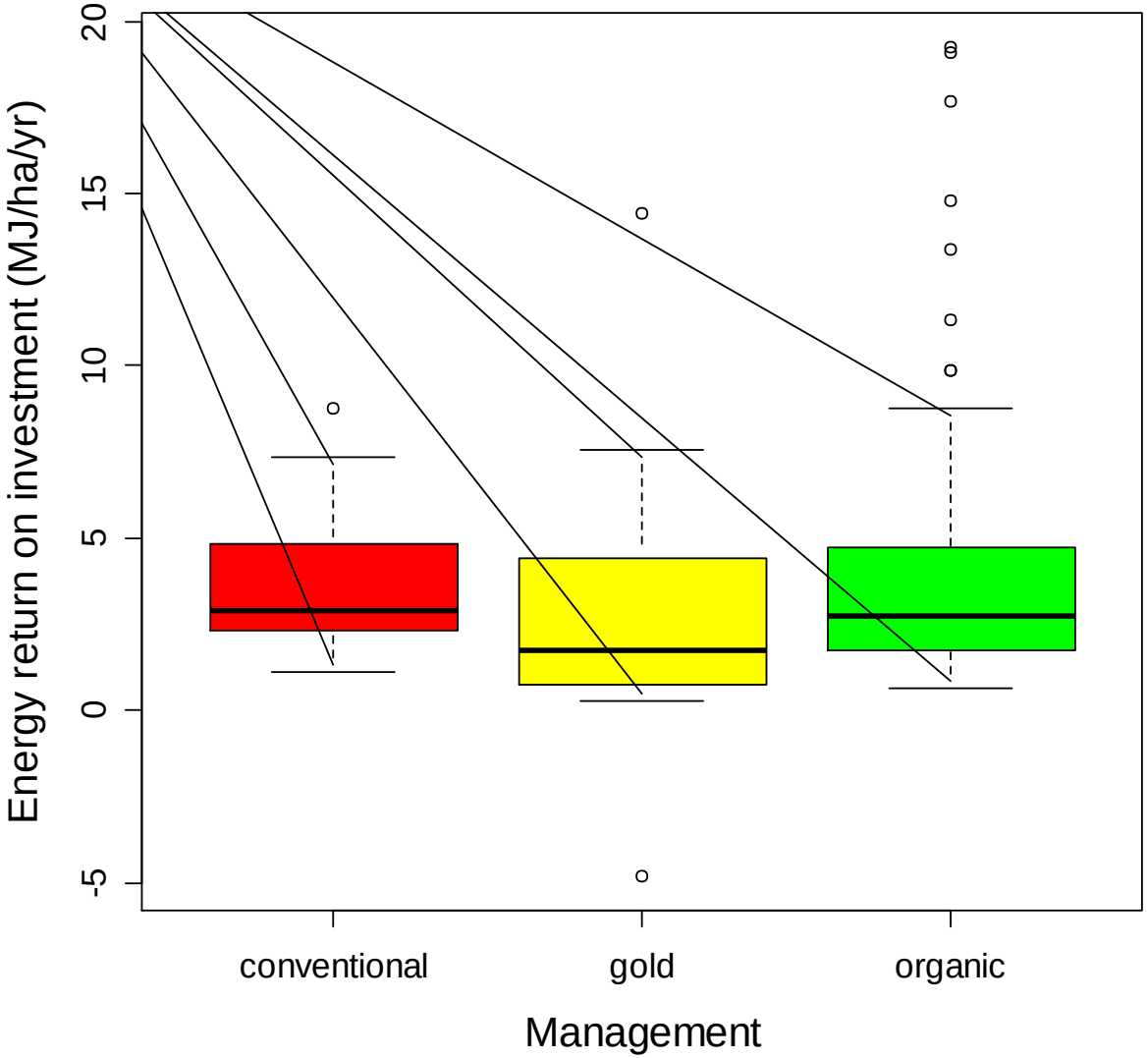
Gold:13.6 (95%CI 12.1 – 15.0)

Organics 49% of Conv. consumption

Fertiliser elements

- The greatest difference in energy consumption as fertiliser components between the Organic and Conventional groups was for nitrogen and magnesium.
- Energy consumed as potassium and sulphur was also lower in the Organic group
- Energy consumed as phosphorous and calcium was similar between the groups

Energy Return On Investment



- One unusually high and one unusually low EROI in the Gold group
- Several unusually high values for the Organic group indicate outstanding production efficiency

Energy Return On Investment summary statistics

	n	Mean	SE	1st quartile	Median	3rd quartile
Conventional	36	3.47	0.29	2.36	2.90	4.85
Organic	40	4.67	0.68	1.73	2.76	4.69
Gold	50	2.72	0.48	0.76	1.74	4.39

- In general, investing one MJ of energy in kiwifruit production yields 2 – 4 MJ of Kiwifruit
- There is no evidence that EROI varies between panels

Implications for industry

- A highlight of this study is the benchmark energy content for kiwifruit … *it will have several other applications*
- EROI values will be overestimated to some degree since some energy inputs should be included but are difficult to quantify, for example
  - Human labour
  - Composting inputs

Implications for industry

- Organic orchards clearly have lower output but also have some lower inputs, indicating lower intensity (less inputs & outputs per ha)
- No evidence that EROI differs between the Organic and Conventional groups so no evidence that Organic is more efficient
- However….the seven outliers of highly efficient production by the Organic group warrant further investigation … an example of changing emphasis on within panel variation

Implications for Industry

- Energy consumption is driven primarily by fertiliser use, especially nitrogen and potassium
- The key to improved efficiency and reduced environmental footprint is therefore in reducing fertiliser input
- Tentative evidence that the growers are over-fertilising

Implications for Industry

- **Key research Question**: By how much can fertiliser input be reduced, without compromising:
  - economic bottom lines?
  - whole industry production targets?
  - long-term soil health?
- Meso-scale field trials in all three panels
  - ARGOS 3 priority?
  - Prior modelling of risk from existing data

Implications for Industry

- Demonstrating move to further lower environmental footprint, save energy, mitigate climate change and improve efficiency … probably with little financial loss
- Peak oil, steadily rising energy prices and energy shocks will favour organic bottom lines, efficiency and ecological footprints

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- Environment Bay of Plenty