Lessons in Sustainability from the Glenlea Long-Term Rotation Study

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Linking Organic Knowledge
OACC
Organic Agriculture Centre of Canada

UNIVERSITY OF MANITOBA

The Glenlea Study Site

- Near Winnipeg, MB
- Soil type: Rego Black Chernozem
- 12% sand, 32% silt, 55% clay, 5.5% OM
- Precipitation:
  535 mm
- GDD:
  1755 (>5 C)

Treatments and Rotations

Early years (1992-2003)

- 3 rotations
  - Forage-grain: wheat – alfalfa – alfalfa - flax
  - Green manure-grain: wheat - clover green manure - wheat – flax
  - Grain only: wheat – pea – wheat – flax
- 4 systems
  - Organic, conventional
  - Fertilizer and no herbicide, herbicide and no fertilizer
- Flax test crop every four years

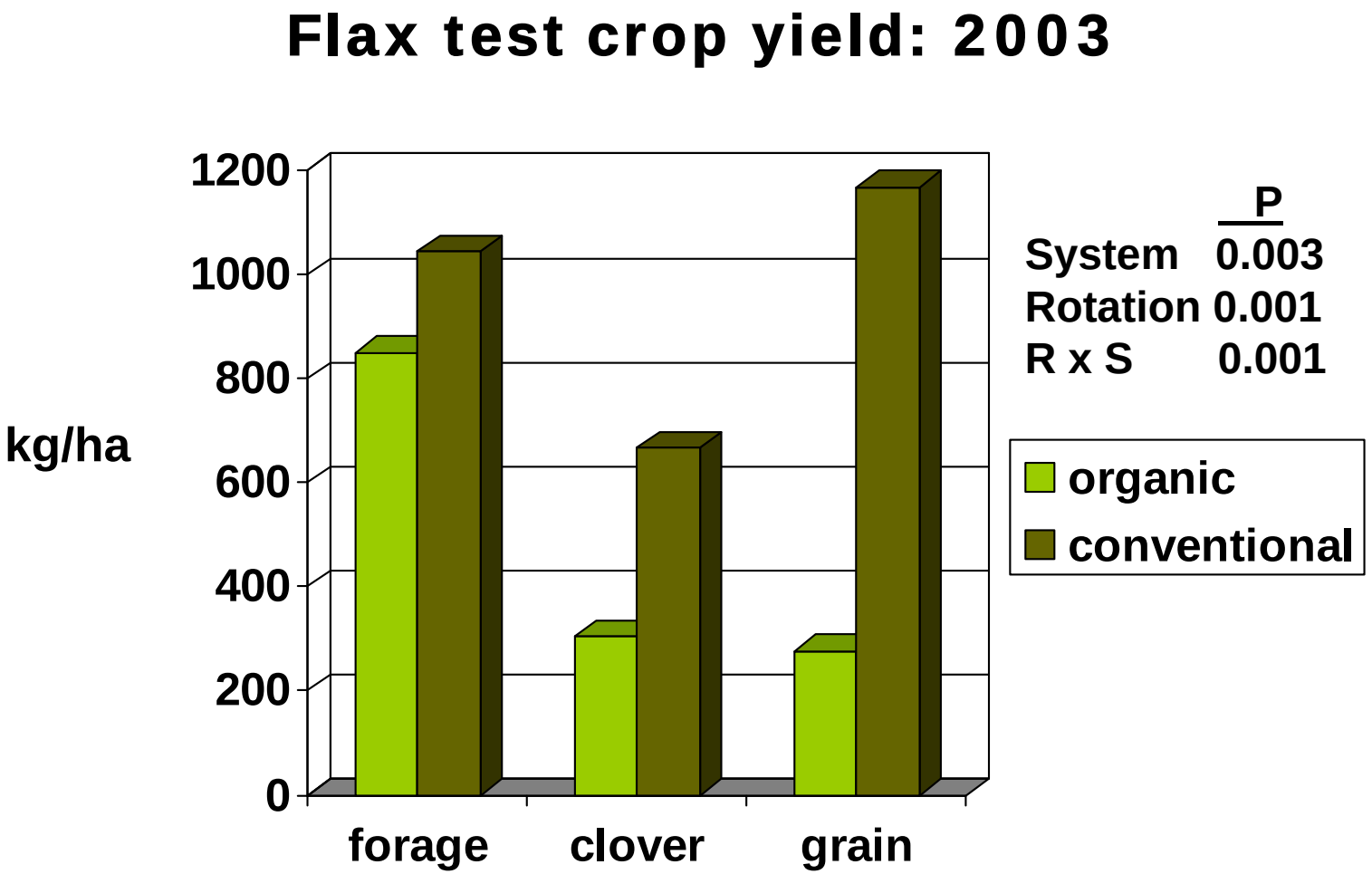
Measurements

- Crop yields
- Soil fertility
- Weeds
- Soil erodibility
- Energy use and carbon emissions
- Economics
- Mycorrhiza
- Carabid beetles (biodiversity)
- Nematodes (biodiversity)
- Disease
- Grain nutrient content

Research Results: 1992-2003

- Crop yields
- Soil fertility
- Weeds

Crop Yields: 1992-2003



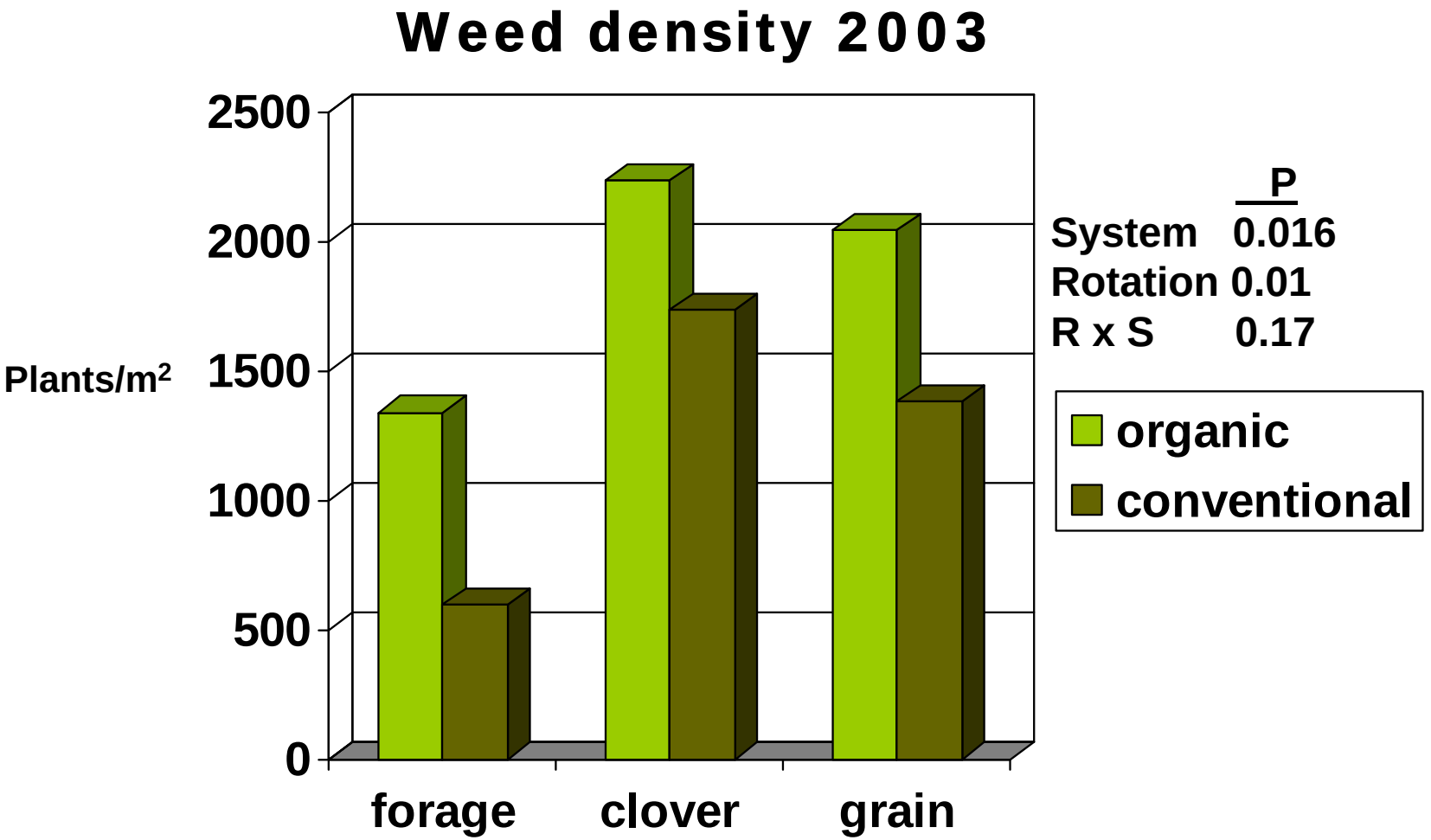
Soil Fertility: 1992-2003

Soil nutrient status in 2003 (kg/ha)

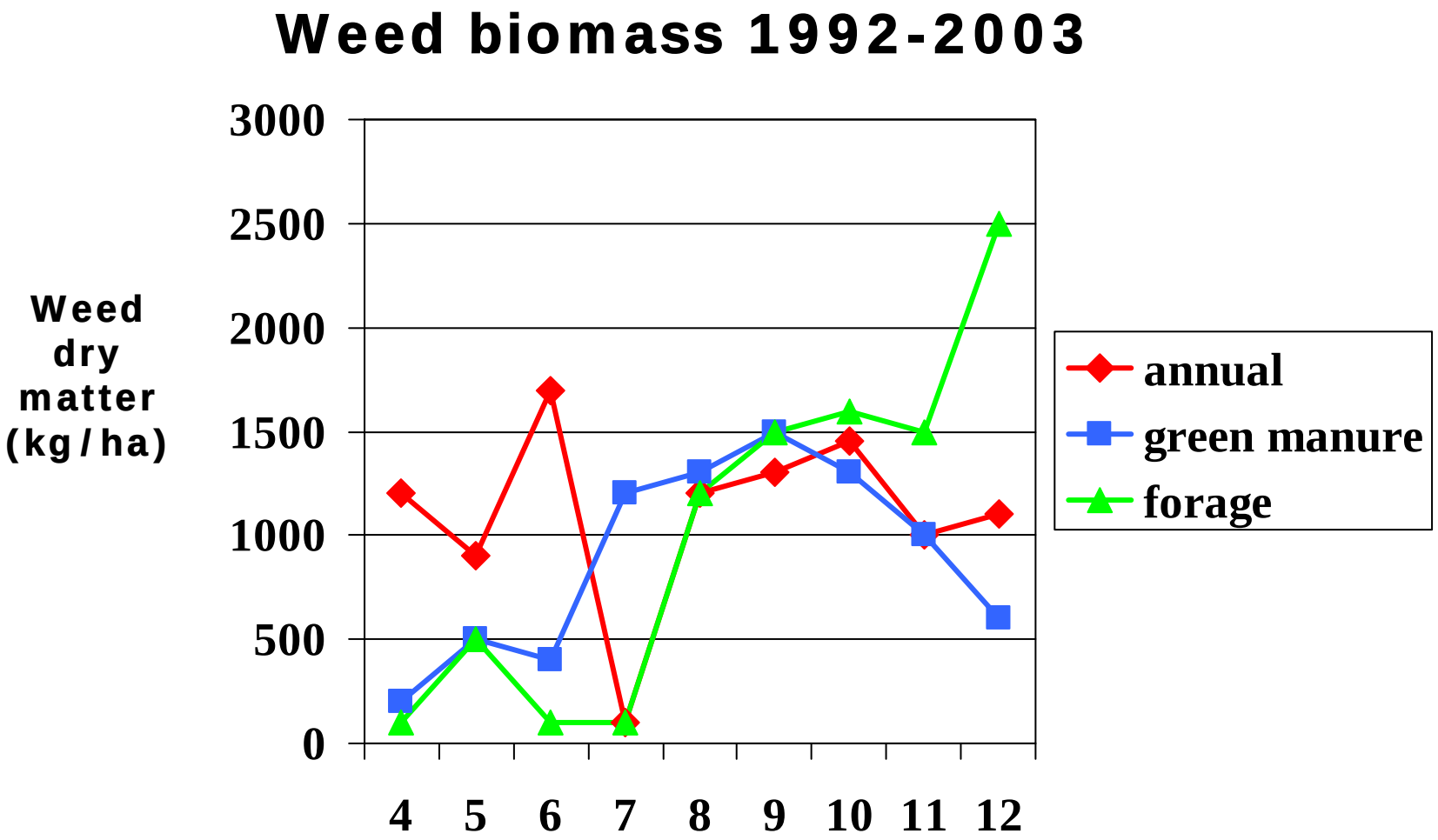
Rotation	System	N	P	K	S
Grain-only	Conventional	32	46	1316	141
	Organic	22	33	1312	86
Green manure – grain	Conventional	29	24	1169	87
	Organic	31	37	1116	76
Forage – grain	Conventional	81	42	1140	63
	Organic	37	11	1073	26

After 12 years, nutrient levels adequate in all treatments EXCEPT organic forage system.

Weeds: 1992-2003



Weeds: 1992-2003



Lessons: 1992-2003

- Forages in rotation increase organic flax yields…

  …for a while

  - After 12 years
    - Weed pressure was high
    - Soil P was depleted
- Annual rotation had adequate soil nutrients but had poor yields in organic

Treatments and Rotations

Currently (2004 and on)

- 2 systems
  - Organic and conventional
- 2 rotations
  - Grain – forage: Flax – alfalfa – alfalfa – wheat
    - With and without composted livestock manure
  - Grain only:
    - Organic: Flax – oat – green manure (fababean) – wheat
    - Conventional: Flax – oat – pulse (soybean) – wheat
- Fully phased (all crops grown every year)

Research Results: 2004-2007

- Crop yields
- Weeds
- Soil fertility
- Mycorrhiza
- Grain mineral content

Crop Yields: 2004-2007

Two organic flax crops in 2005

Flax-oat-fababean-wheat

Flax-alfalfa-alfalfa-wheat

Better performance in forage-grain rotation

- **More N available**
- **Less weed competition**

Weeds: 2004-2007

Weed density in wheat in 2006 (seeded late April)

	Wild oat	G. foxtail	BY grass	RRP	WM	LQ	LT	TLS	Stink weed	WB	DandIn	C. thistle
					Grain only rotation							
Org	27	27	42	1	155	1	56	3	61	5	1	4
Conv	4	8	11	98	19	4	435	1	101	1	0	0
					Grain-forage rotation							
Org	16	781	338	0	382	6	12	4	12	12	1	25
Conv	6	209	370	258	103	12	66	4	50	18	0	0


Under low available soil P
•Flax OK
•Red root pigweed POOR
•Wild mustard POOR

Weeds: 2004-2007

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Two years of alfalfa hay not enough to control Canada thistle

Soil Fertility: 2004-2007

- Focus on P
- Look at less available pools of P in soil
- How plants access that P

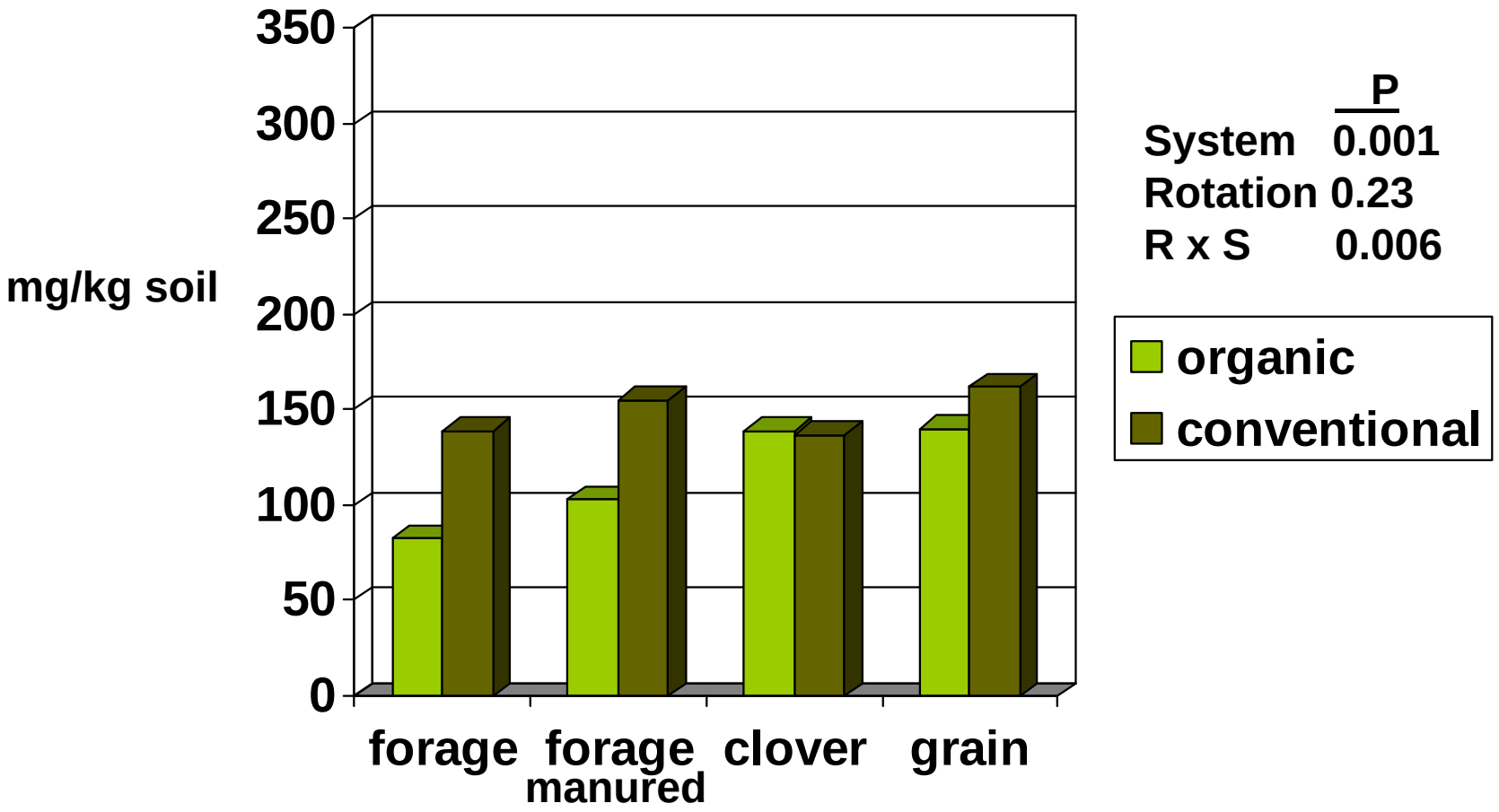
M.Sc. Student

Cathy Welsh

“Available” P: Glenlea 2005

Water, sodium bicarbonate and sodium hydroxide extractable P

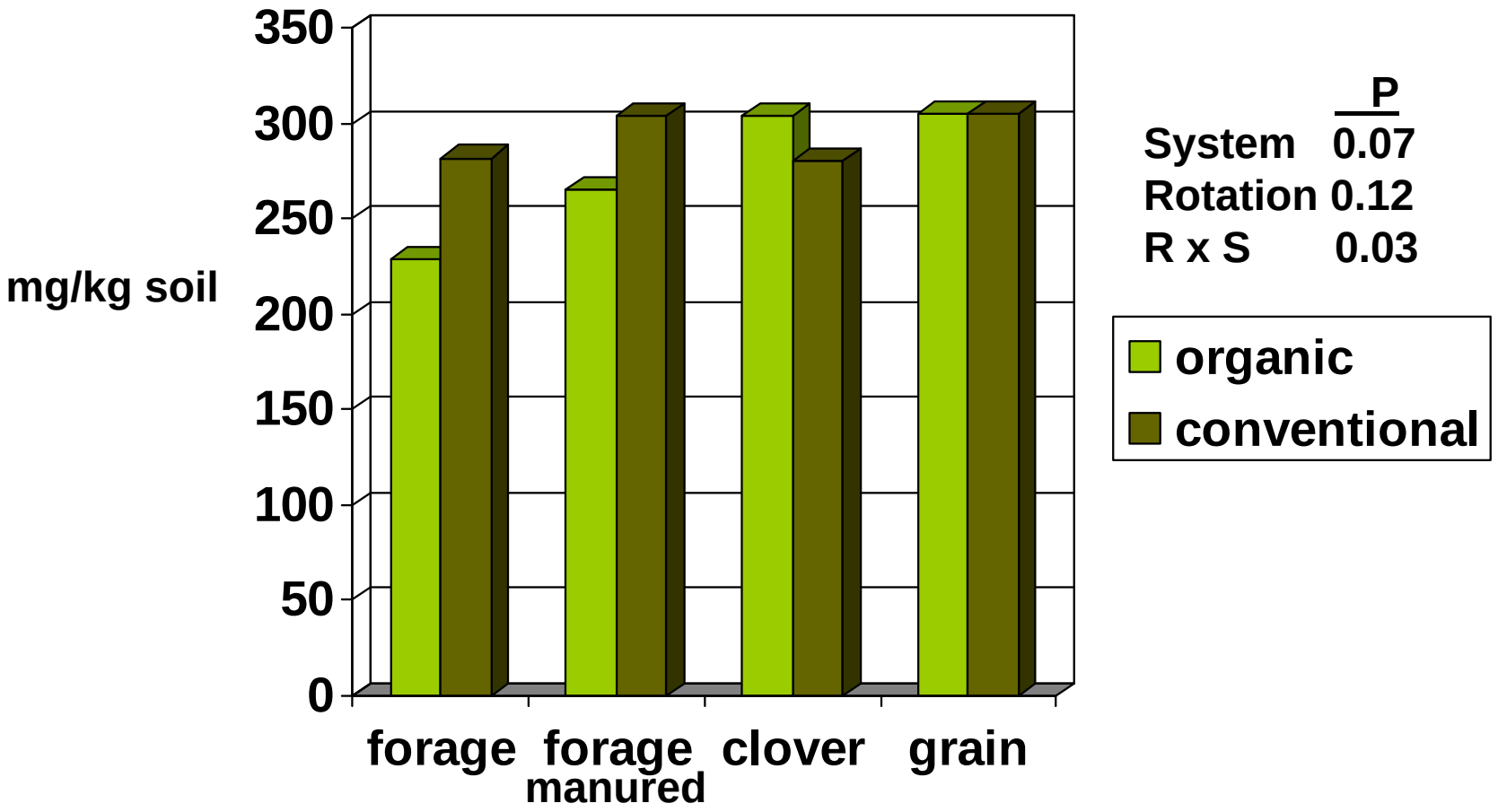
Adapted from Welsh (2007)



Total Soil P: Glenlea 2005

Available P plus HCl extractable P, Glenlea 2005

Adapted from Welsh (2007)



Mycorrhiza

Annual rotation

Conventional **Organic**

Mycorrhiza

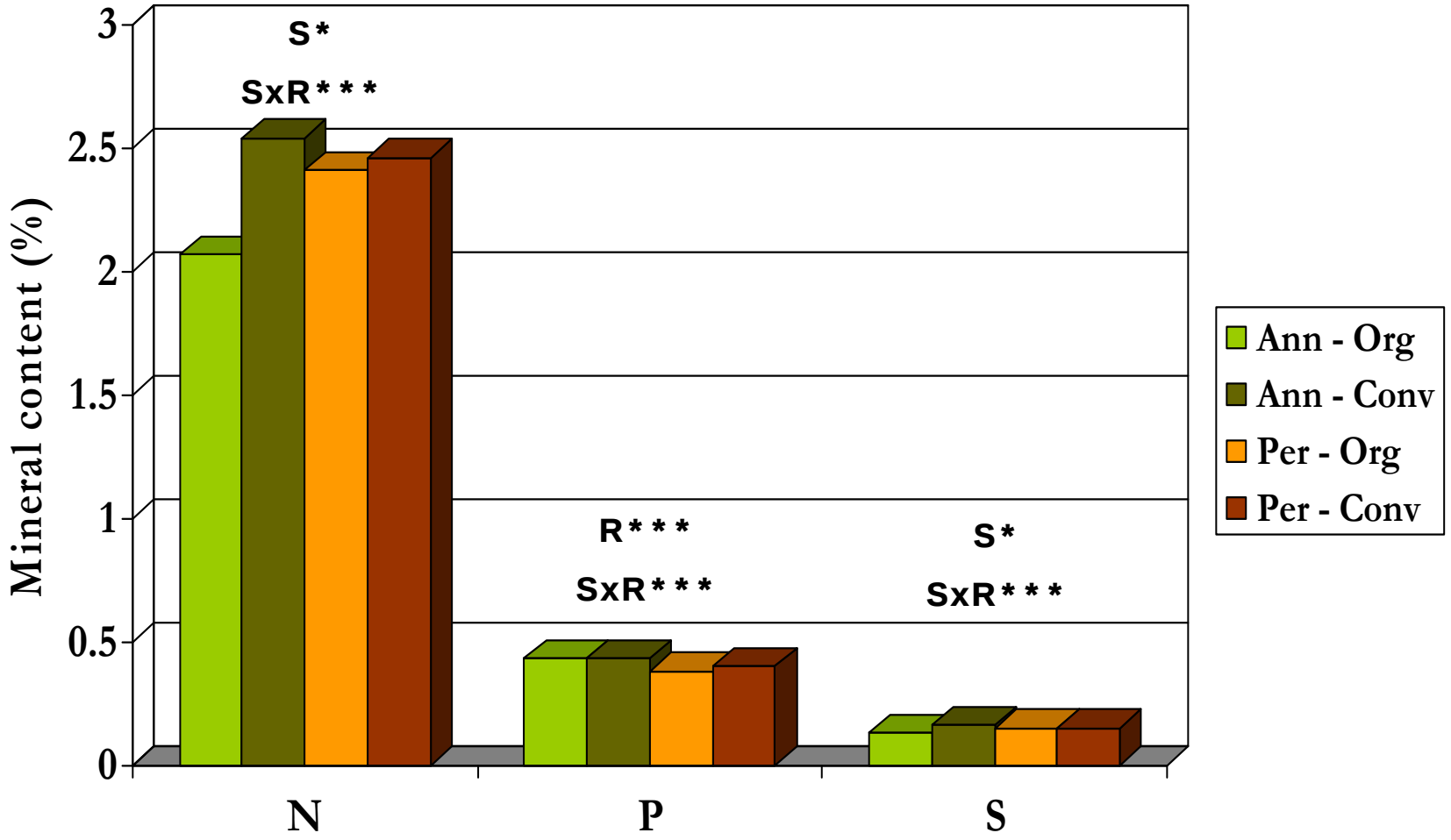
Forage-grain with manure

Conventional **Organic**

Grain Mineral Content

- Mineral content of wheat
- N, P, K, S, Ca, Mg, Fe, Mn, Zn, Cu

Grain Mineral Content



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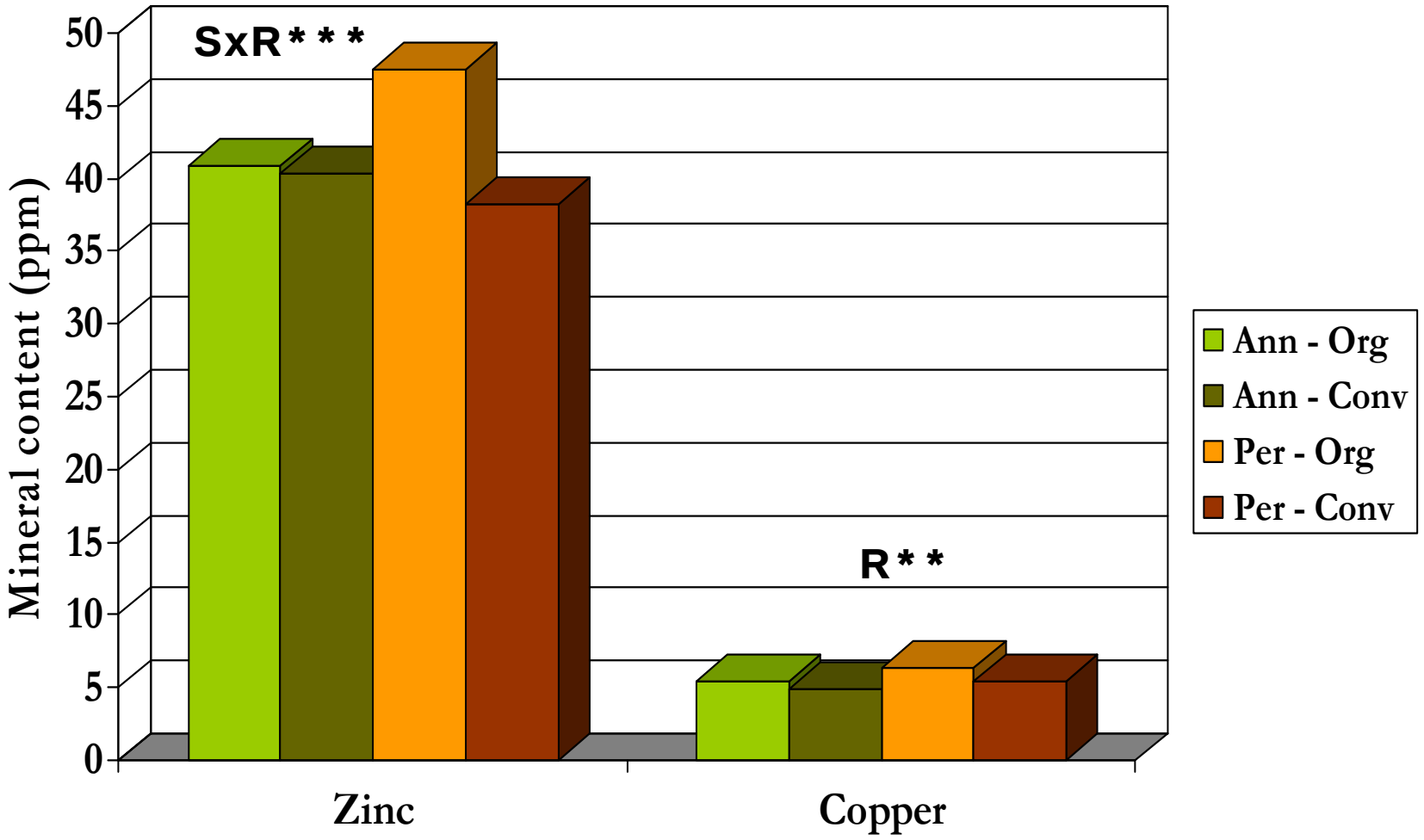


Recent Lessons

- Crop yields and soil fertility seem to be sustainable in the organic grain-forage rotation with added manure.
- Canada thistle control is a challenge in the organic grain-forage system.
- More mycorrhizal association in organic systems.
- Crop rotation and inputs affect grain mineral content through:
  - soil nutrient status
  - mycorrhizal association

Acknowledgements

Thanks to…

- all the researchers and graduate students who have contributed to the Glenlea study
- Keith Bamford, technician extraordinaire
- Funding organizations:
  - Manitoba Agriculture, Food and Rural Initiatives
  - NSERC
  - Many others

For more information…

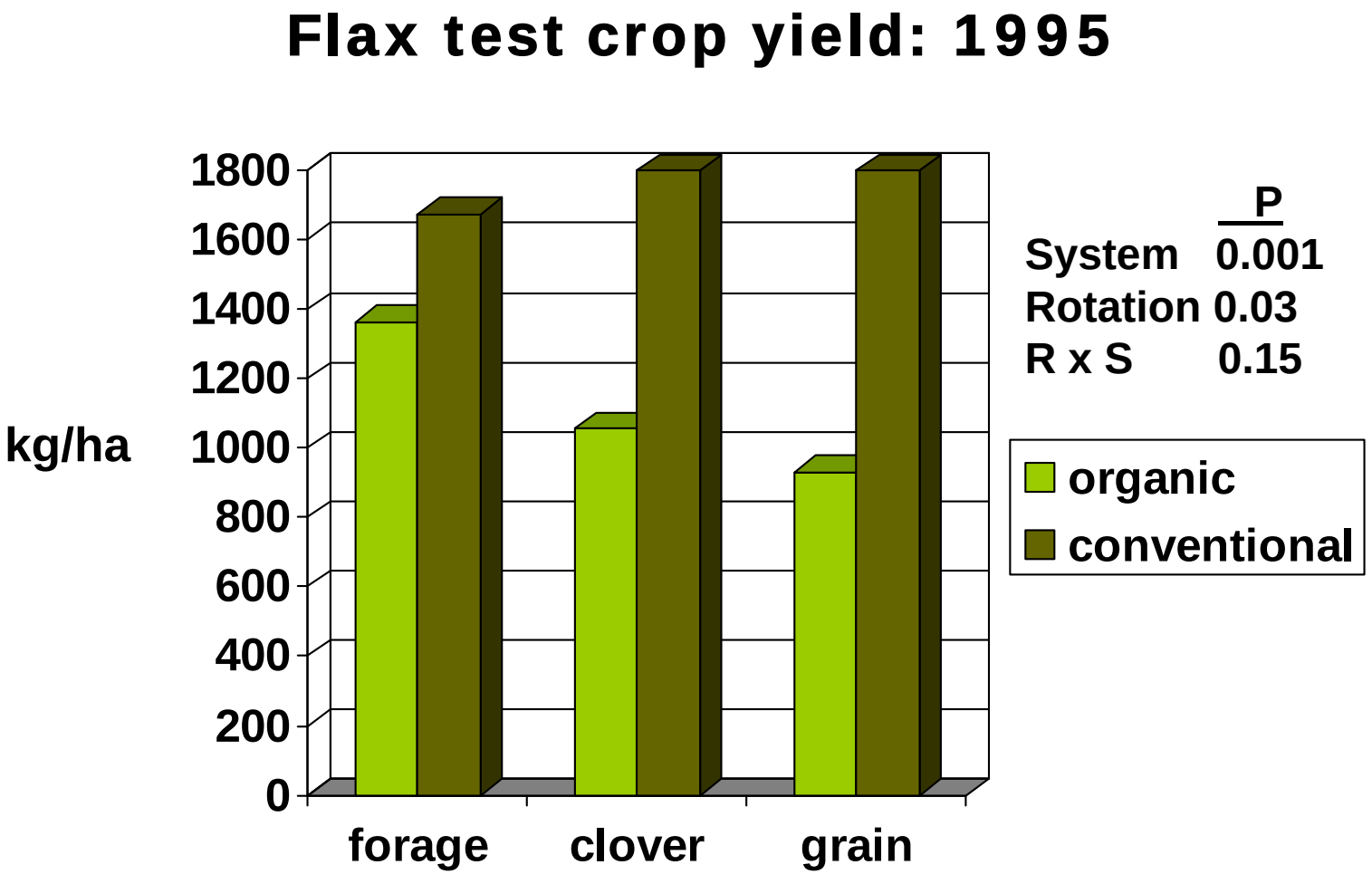
Natural Systems Agriculture

www.umanitoba.ca/outreach/naturalagriculture/organic.html

Glenlea Long-Term Rotation Study

www.umanitoba.ca/afs/plant_science/glenlea/glenlea.html

Crop Yields: 1992-2003



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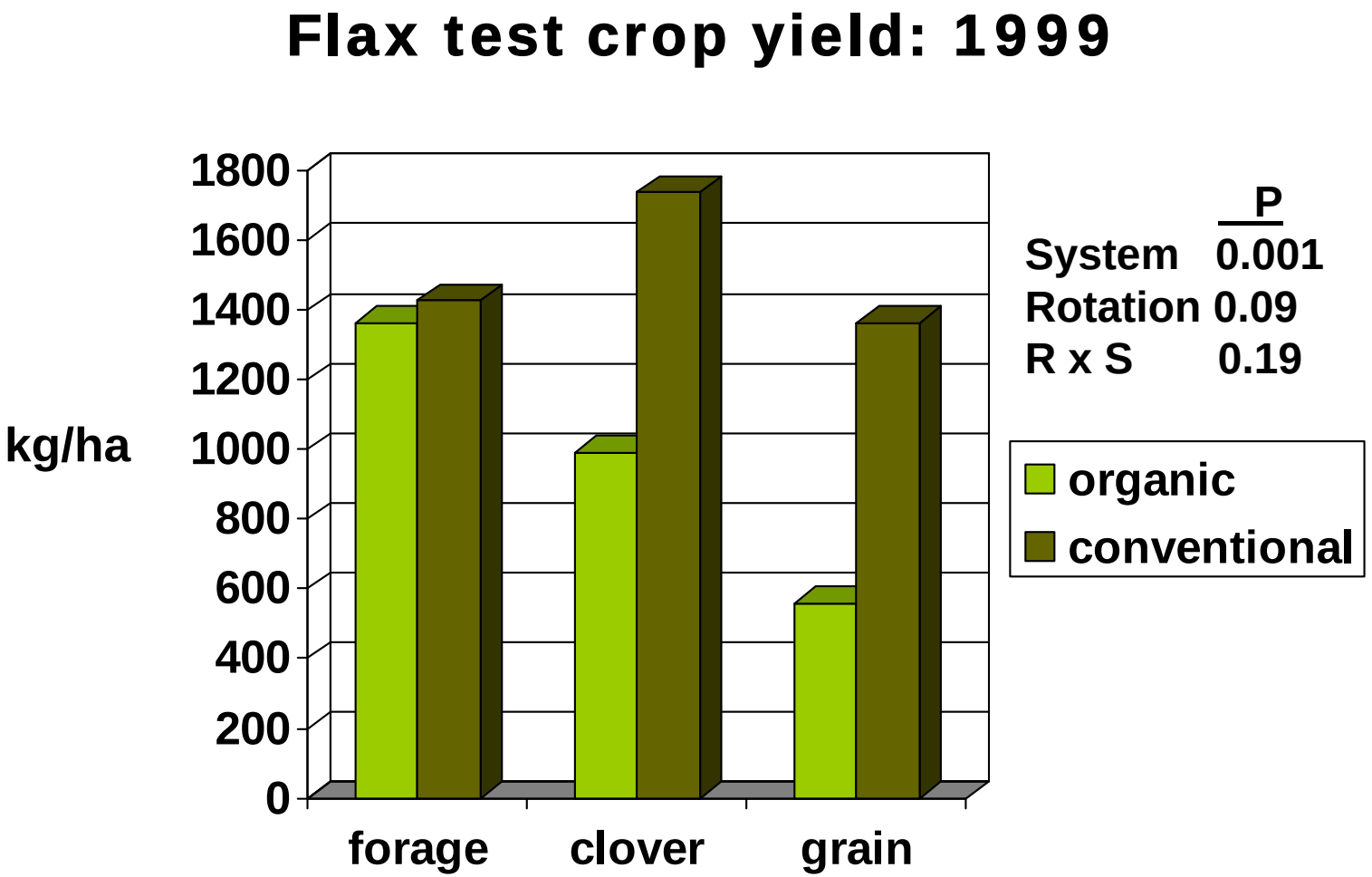

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Annual rotation conventional

Conventional oat and flax in 2007

HCl extractable P: Glenlea 2005

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