Industrial Market Potential for Oilseeds including Canola

From a CLIMA project funded by RIRDC
&
a DAWA project

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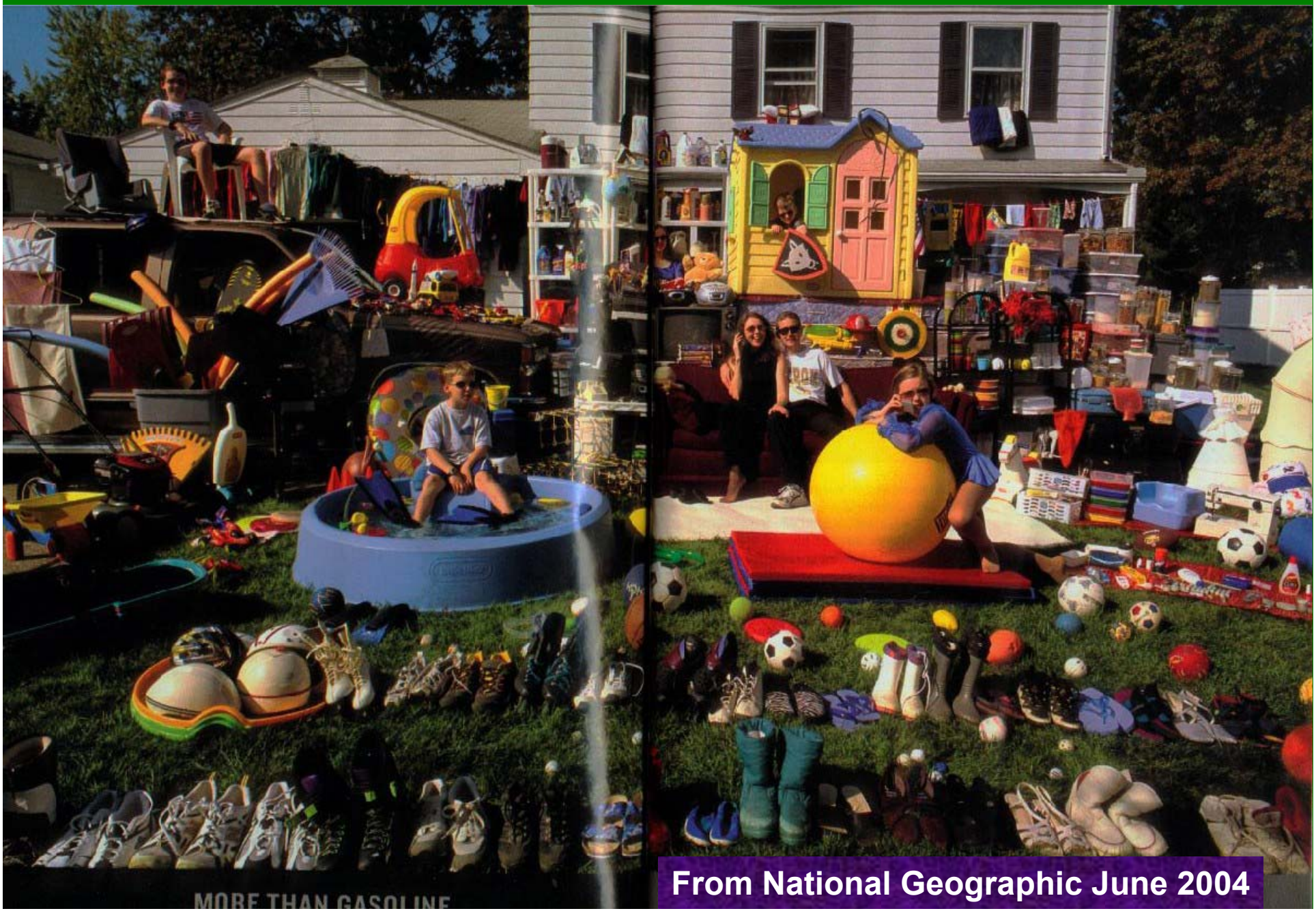
- Australia is seriously dependent on petroleum oil (fossil fuels).
- We are dependent on a resource that is non renewable and depleting.
- And not just for fuel or energy.

Household items made mostly from petroleum based polymers



From National Geographic June 2004

- Oilseeds are renewable, sustainable sources of oil.
- Oilseeds could be part of the solution.
- They could provide alternatives to mineral oil in many ways.

Potential uses or markets

- Biofuels; for heat and energy.
- Industrial lubricants.
- Source of erucamides
- In paints, varnishes and cleaning products.
- Meal for stock feed, fertilizers, bioplastics etc..

The Ideal Oilseed Crop for Fuel

- consistently has a high seed yield.
- has high oil content in the seed (> 40%).
- would have low inputs.
- the seed meal has value.
- Other by-products have value.

Mean Oilseed yields from trials in WA (2000 – 2004)

Year	Location	*B. napus*	*B. carinata*	*B. juncea*	*B. rapa*	Camelina	Crambe
2000	Miling	1.88	2.5	2.75		1.94	2.54*
2000	Wagin	0.75	1.65	1.9		1.13	1.30*
2001	Miling	2.4	1.9	1.9		1	1.90*
2001	Wagin	Shattered	1.27	2.53	0.78	1.23	1.11*
2001	Muresk	0.83	0.87	1.11		0.82	0.82*
2001	Merredin	1.54	1.21	1.34		1.91	1.83*
2002	Wongan Hills	0.78	0.54	0.79	0.48	0.18	0.75*
2002	Mingenew	0.8	0.71	0.55	0.86	0.59	0.42*
2003	New Norcia	2.13	2.19	2.02	0.35	0.42	1.63*
2004	Albany	1.8	1.15	1.58			1.70*
2004	Avondale		0.73	0.74			0.96*
2004	Meckering	1.04	1.22	1.23	0.71	0.2	0.98*
2004	Merredin	0.56	0.16	0.39			0.27*
2004	Mullewa	0.14	0.16	0.39			0.27*
5 yr	Mean	1.22	1.16	1.37	0.64	0.96	1.17*

*seed with hull

Potential oil yields from various crops in the USA

Crop	Kg oil/ha	Litres oil/ha
Cotton	273	325
Hemp	305	363
Soybean	375	446
Linseed	402	478
Pumpkin seed	449	534
Mustard seed	481	572
Camelina	490	583
Safflower	655	779
Sunflowers	800	952
Peanuts	890	1059
Rapeseed	1000	1190
Olives	1019	1212
Castor beans	1188	1413
Jojoba	1528	1818
Macadamia nuts	1887	2246
Avocado	2217	2638
Coconut	2260	2689
Oil Palm	5000	5950

Mean oil content of various oilseeds grown in WA trials in 2004

Species	% Oil	Kg Oil/ha
Brassica napus	42	504
Brassica juncea	42	575
Brassica carinata	40	464
Brassica rapa	42	270
Camelina sativa	38	365
Crambe abyssinica	52	350
Linum usitatissimum	40	400

Estimated costs

(approximates at the end of 2003)

Species	Variable costs/ha
Brassica napus	$278
Brassica carinata	$188
Brassica juncea	$204
Brassica rapa	$204
Camelina	$195
Crambe	$214
Linseed	$204

Some bio-fuel production costs

- Seed cost: $350/tonne x 50 tonnes = $17,500
- Crushing $70/tonne x 50 tonnes = $3,500
- Less Meal : $350/tonne x 25.5 tonnes= $8,925

- (Canola containing approx. 44.6% oil, 1 tonne gives 510 kg meal & 386 kg oil, 54 kg oil left in the meal, 50 kg lost)

- Cost of 50 x 422 = 21,100 litres of oil = $12,075
- Cost per litre of oil is $0.57

- If seed = $400/tonne oil = $0.69/litre
- If seed = $300/tonne oil = $0.45/litre

The value of the meal

- Depends on its composition.
- Depends on its potential use.
- Will be affected by market demand.
- But as a minimum, would have value as fertilizer.

Approx. glucosinolate, erucic acid and protein contents of some of the alternative oilseeds.

Species	Protein	Glucosinolate	Erucic acid
Brassica napus	22	46	0.4
Brassica juncea	23	96 - 152	0.9 – 47
Brassica carinata	22	105	45
Brassica rapa	22	105	42
Camelina	24	105	3.5
Crambe	23	150	60
Linseed	22		0

Meal for stock feed

- Canola meal is a good source of protein for stock. Can be used for up to 10% of rations.
- Currently worth about $350/tonne
- Oilseeds with a higher content of glucosinolates in the meal eg Mustards and Crambe, are not as palatable and less can be used in the feed, up to 5% of rations.

Additional uses for meal

- Potentially the meal could be used to make plastics and adhesives, for lawn care and in fertilizer products.
- Meal containing glucosinolates would have added value as an organic fertilizer with fumigant characteristics.

Other By-products

- Glucosinolates which make meal less palatable, can be removed with water. They can be used as a natural snail repellant or biofumigant in the soil.

- Lecithin, another by-product, is used as an emulsifier in margarine , chocolate, confectionery, cosmetics and industry. Australia imported 2500 tonnes of lecithin in 1998. (cost of $1 - $3/kg)

Oilseeds for other uses

- The oil of some oilseeds have a greater industrial value than that of energy.
- Oils with high erucic acid content are highly valued as engine lubricants and as a source of erucamides; used as slip agents in plastic, as lubricants in the production of plastics, nylon and in heat sensitive dyes.
- Drying oils have been used in paints, varnishes, cleaning products, linoleum and brake linings.

?

- Which oilseed?
- Which end use?
- Where can it be grown?


Brassica napus
Canola
August 22nd 2001
Miling

Brassica napus
(Canola)

Fatty acid	% in oil
Palmitic	4.0
Stearic	2.0
Oleic	**60.0**
Linoleic	20.5
A Linolenic	10.0
Eicosenoic	2.0
Erucic	1.0
% oil in seed	42

Characteristics

Erucic acid levels limited to less than 2% of oil in most varieties.

Herbicide tolerant lines developed making weed control easy.

Potential Uses

Food oil

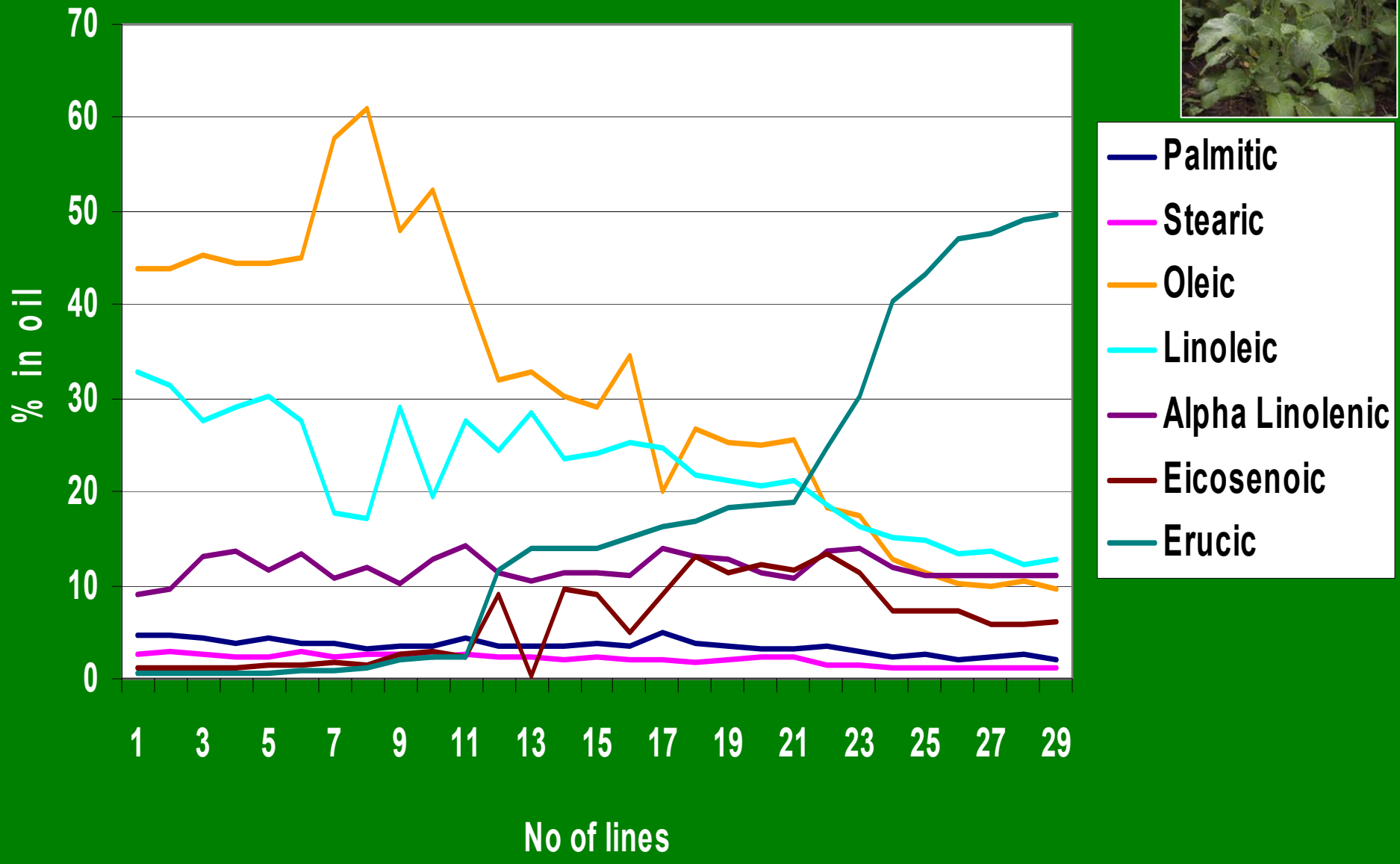
Meal used for stock feed.

Organic fertilizer

HEAR developed as a source of Erucic acid for industry


Brassica juncea
Northam
August 11th 2004

Fatty acids in *Brassica juncea*



Brassica juncea

(Indian & Oriental mustard)

Fatty acid	% in oil
Palmitic	4
Stearic	2
Oleic	31
Linoleic	25
A Linolenic	11
Eicosenoic	7
Erucic	13
% Oil	36

Characteristics

Erucic acid levels vary from 0 to 50% of oil

Often had the best yields in trials.

Potential Uses

As a feed stock for biofuels

Organic fertilizer

Food: oil and condiment.

Source of Erucic acid for industry


Brassica carinata
near Albany
November 12th 2004
(1.15 tonnes/ha)

Brassica carinata

(Ethiopian Mustard)

Fatty acid	% in oil
Palmitic	3
Stearic	1
Oleic	8-10
Linoleic	16
A Linolenic	12
Erucic	44
% Oil	31 - 38

Characteristics

Needs a longer cooler season than Brassica juncea.

Tolerant of Black leg .

Erucic acid content of the oil can vary between 35 and 53%.

Potential uses

Feed stock for biodiesel

Source of erucic acid


Brassica rapa ssp. campestris
Turnip Rape


Brassica rapa ssp. campestris
Fruit maturing

Brassica rapa ssp. campestris

Turnip Rape

Fatty acid	% in oil
Palmitic	2
Stearic	1
Oleic	10
Linoleic	12
A Linolenic	9
Eicosenoic	10
Erucic	**55**
% Oil	36

Characteristics

Very short season, it is the earliest of the Brassica species to flower and set seed. However, it is very susceptible to black leg infection.

Seed is similar in size to canola, can be yellow or brown.

The seed meal contains Glucosynolates.

Potential uses

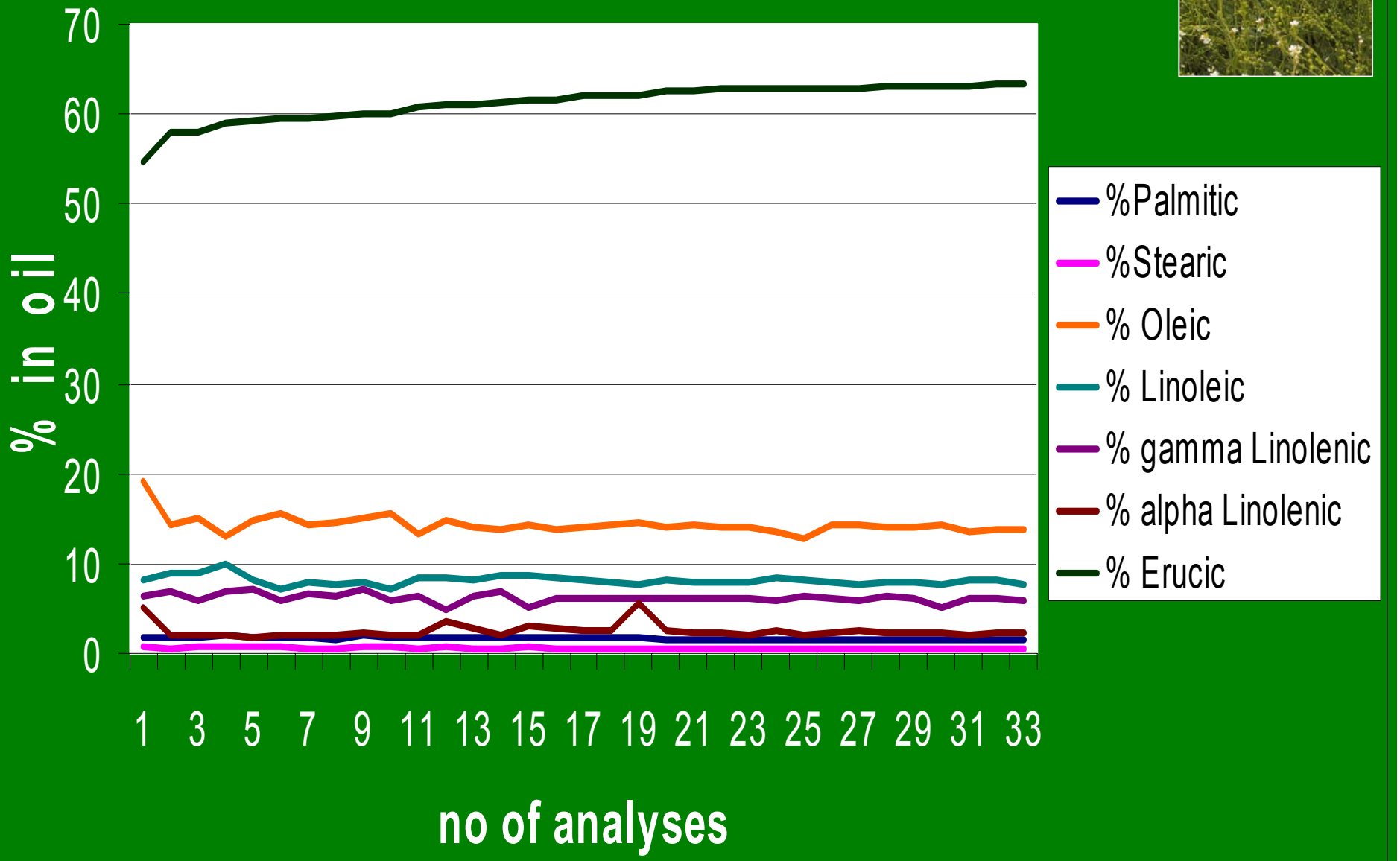
Source of erucic acid

For biodiesel


Crambe abyssinica
Near Albany
November 12th 2004
(1.6 tonnes/ha)


Crambe abyssinica
New Norcia

Fatty acids in lines of *Crambe abyssinica*



Crambe abyssinica

Fatty acid	% in oil
Palmitic	1.6 – 1.9
Stearic	0.5 – 0.9
Oleic	13.5 – 19.0
Linoleic	7.6 – 8.8
A Linolenic	5.0 – 7.0
Eicosenoic	2.0 – 3.0
Erucic	**54.6 - 63.4**
% Oil in fruit	28 - 36

Characteristics

Very robust, it does not seem to be attractive to insect pests and appears to be immune to black leg infection.

Usually one seeded, the whole fruit is harvested intact. This makes the harvest light and bulky.

The oil is rich in erucic acid.

Potential uses

Industrial lubricant

The best source of Erucic acid

High erucic acid oils

- Crambe oil contains 55 – 60% erucic acid.
- It has better friction reduction properties than canola or soy.
- It does not contain any carcinogens.
- The smoke point is 251 degrees C.
- Environmentally friendly: it is biodegradable.
- Good heat removal characteristics

Source: E. T. Libuit 2003


Camelina sativa


Camelina sativa
Popanyining
7th October 2003

Camelina sativa
(False flax)

Fatty Acid	% of Oil
Palmitic	5 – 6.5
Stearic	2 – 3
Oleic	12 – 19
Linoleic	16 – 23
Linolenic	31 – 37
Eicosenoic	14 – 17
Erucic	2.5 – 4.5
% oil content	32 - 39

Characteristics

Ancient oilseed crop used for heating and light.

Low input crop

Appears tolerant of aphids.

Fruit generally non-shattering

Potential uses

Healthy food oil

Good emollient oil for cosmetic industry


Linum usitatissimum
Linseed or Flax


Linum usitatissimum

Linum usitatissimum

Linseed

Fatty Acid	% in oil
Palmitic	7
Stearic	3
Oleic	16
Linoleic	18
A Linolenic	56
% oil in seed	40

Characteristics

Oil high in Alpha linolenic acid (an Omega 3 fatty acid)

Long season

Tolerant of a range of herbicides

Produces a drying oil suitable for a range of industrial applications.

Linseed or flax

- A very old industrial oil. Was cultivated as an industrial oil by the Romans
- Used in paints, varnishes and linoleum
- Also soaps, cosmetics and inks.
- It waterproofs and preserves timber
- Currently has high value when organically grown and cold pressed as a food supplement for health
- The stems have an added value in the market for fibre.

Oilseeds for Phytoremediation

- Phytoextraction of heavy metals from contaminated soils eg tailings of mine sites, toxic waste sites or where fertilizers containing cadmium have been used.
- Several of the oilseeds (the mustards) have been shown to accumulate the metals in the vegetative parts.
- The metals can be recovered by burning the leaves etc in a furnace.
- Useful way to rehabilitate the land.

In conclusion

- We are dependent on a non renewable, depleting resource for energy and chemicals that affects various facets of our lives. Alternatives are needed.
- Oilseeds could provide alterative resources that would help reduce the Australian dependence on petroleum oil.
- Amongst the alternative oilseeds there are species with the potential to be grown for fuel in Australia.
- Oilseed that would be grown for energy must consistently produce a nett profit of energy. Crops that are high yielding, have seed with high oil content but have reduced inputs are needed. (Mustards?) The by-products should also have value.
- Other species have greater value in specialised industrial applications, eg crambe and linseed.