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Myths and facts of Jatropha

Graham von Maltitz

CSIR

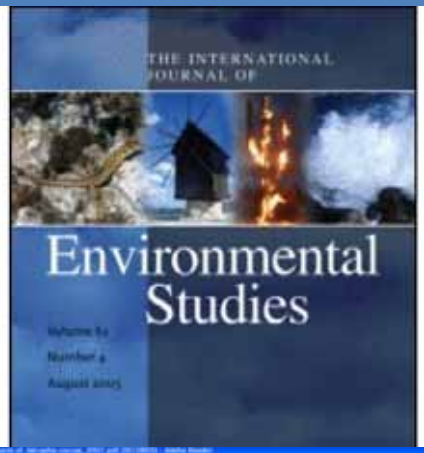
Southern African round table

Maputo 12 September 2008

Review

Jatropha bio-diesel production and use

W.M.J. Achten[a], L. Verchot[b], Y.J. Franken[c], E. Mathijs[d], V.P. Singh[e], R. Aerts[a], B. Muys[a,*]



International Journal of Environmental Studies

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Prospects for jatropha methyl ester (biodiesel) in India

A. Ghosh [a]; D. R. Chaudhary [a]; M. P. Reddy [a]; S. N. Rao [a]; J. Chikara [a]; J. B. Pandya [a]; J. S. Patolia [a]; M. R. Gandhi [a]; S. Adimurthy [a]; N. Vaghela [a]; S. Mishra [a]; M. R. Rathod [a]; A. R. Prakash [a]; B. D. Shethia [a]; S. C. Upadhyay [a]; V. Balakrishna [a]; R. Prakash [a]; P. K. Ghosh [a]
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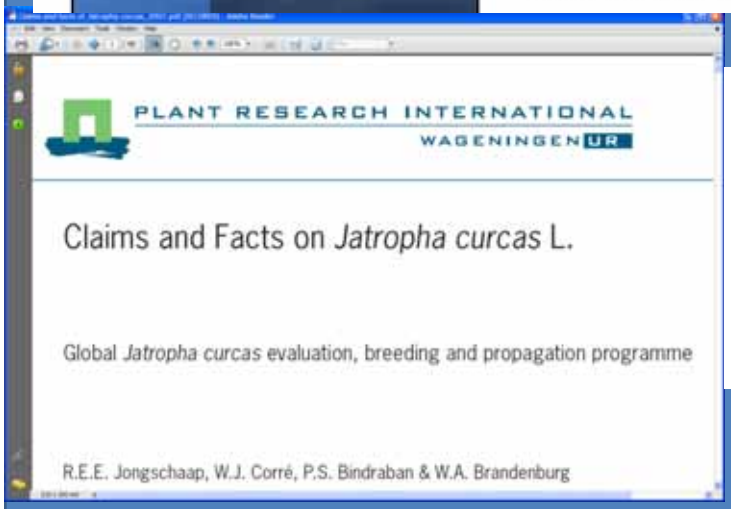

Review

An evaluation of multipurpose oil seed crop for industrial uses (*Jatropha curcas* L.): A review

*Ashwani Kumar, Satyawati Sharma**

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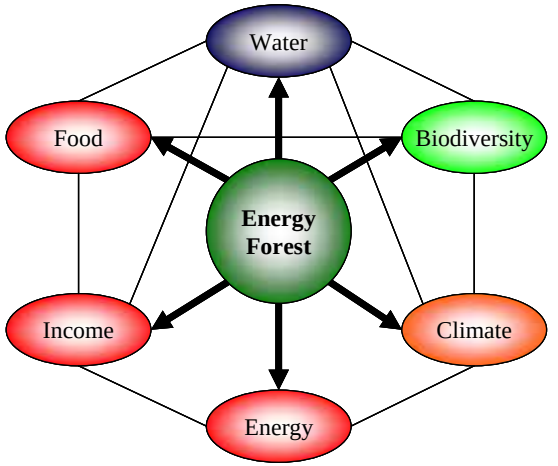
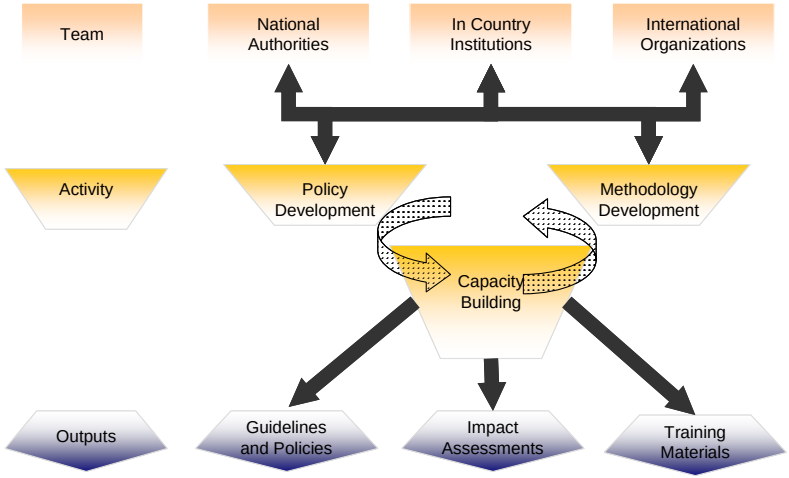
- **Evaluate trends- CDM opportunities**
- **Impact assessment framework- water, biodiversity, societal**
- **Learning- bioenergy curriculum, MSc**
- **Capacity building- industry standards**
- **Policy and dissemination- stakeholder groups /IUFRO**





Human Dimensions

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The SEA Framework

	Water	Bio - diversity	Climate change	Socio-economic
Global				
National				
Local				

Overview

- Grows on wasteland
- Yield
- Water impacts
- Biodiversity impacts
- Energy and carbon impacts
- Labour requirements
- Poisonous
- As a fertilizer
- Use as fuel
- Tolerance to pests and diseases

What do we mean by "grows on low potential/waste land"

- Is reported to grow on 200 – 300 mm of rain
- Is drought tolerant – looses leaves but does not die
- Good yields may need 800 mm or more
- Will grow on low nutrient, but responds to good nutrients
- Suggested will need *** kg fertilizer per ton of seed harvested
- Land reclamation role vs seed yield role

Yield

- No reliable yield model
- Yield likely to be up to an order of magnitude less than some predictions
- Yield dependent on water and nutrients
  - Reports of doubling yield with fertiliser
  - Seed cake increases yield
- Management important in yield
- Sensitive to grass / weed competition

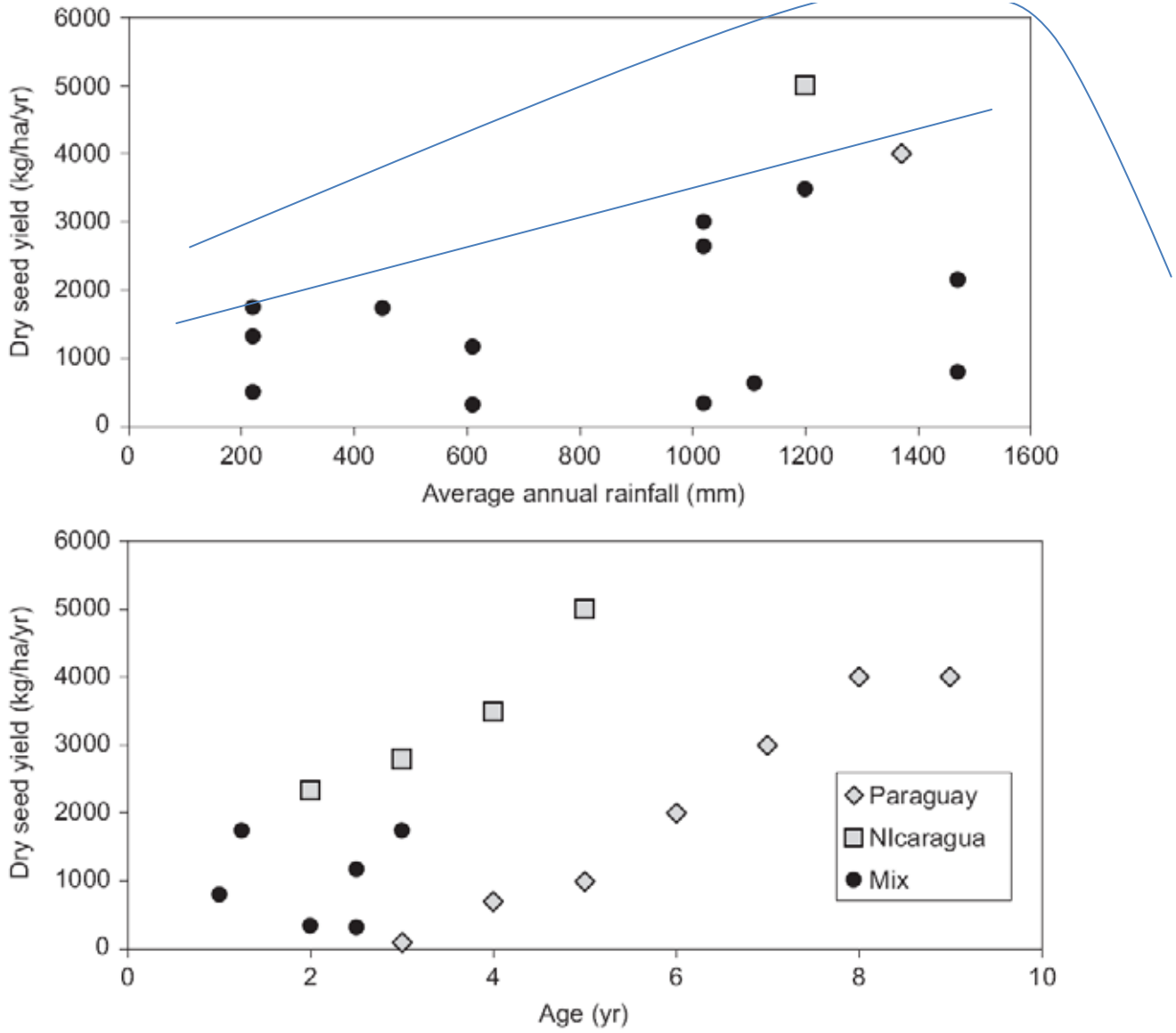


Fig. 2 – Dry seed yield in relation to average annual rainfall (mm) and age of the JCL crop. The plotted points represent a mix of provenances, site conditions and plant age or average annual rainfall. *Sources*: [9,11,13,52,53,56] and personal communication: Kumar, 2005 and Buisman, 2005.

Achten et al 2008 in pres

Table A1 Achten et al 2008 in pres

Reference	Location	AAR[a]	Age	kg tree^{-1} yr^{-1}	kg ha^{-1} yr^{-1}
[13]	Nicaragua, Managua	1200	2		2327
	Nicaragua, Managua	1200	3		2786
	Nicaragua	1200	4		3484
[9]	Cape Verde	600	–	0.80	
	India		3		1733
	Nicaragua, Managua	1200	–		5000
	Mali	1020	–		2640
	Thailiand	1470	–		2146
	Mali	1020	–		8000
	Madagascar	1370	–	3.25	
	Paraguay	1370	3		100
	Paraguay	1370	4		700
	Paraguay	1370	5		1000
	Paraguay	1370	6		2000
	Paraguay	1370	7		3000
	Paraguay	1370	8		4000
	Paraguay	1370	9		4000
	Cape Verde	220	–		1750
	Cape Verde	220	–		500
	Thailand	1470	1	0.32	794
	Thailand	1470	1	0.06	
	Burkina faso	815	–	0.96	
	Semi-arid areas	–	–		2500
[52]	Nicaragua	1200	5	4.50	5000
[65]	Mali	1020	–		3000
[10]	–	–	–		400–12,000
	Mali	1020	–		2500–3500
[8]					5000
[1]	Indian wasteland		–		2500
[60]	–		–		700–1000
[64]	Nicaragua	1200	–	4.50	5000
	India		–	3.05	6700
[28]	India	–	–		5000
[56]	India	450	1.25	1.73	1733
Pers. comm., Kumar (2005)	India, Rajasthan	610	2.5	0.47	1172
	India, Rajasthan	610	2.5	0.13	313
Pers. comm., Buismans (2005)	Mali, Digini	1020	2	0.30	337
[46]	Zimbabwe	725	–	0.4	

[a] AAR: average annual rainfall (if not reported in publication, obtained from http://www.worldclimate.com)

Oil yield

- 30 to 40 % oil (down to 26% in some studies)
- 60 to 99 % recovery
  - Ram 60-65
  - Screw press 70-80 % (or 91%using 2 or more passes with cooking)
  - Chemical up to 99%
- Density of 0.91
- 0.20 to 0.43 l per kg
- 2.3 to 5.0 t to get 1000 l

Achten et al 2008 in pres

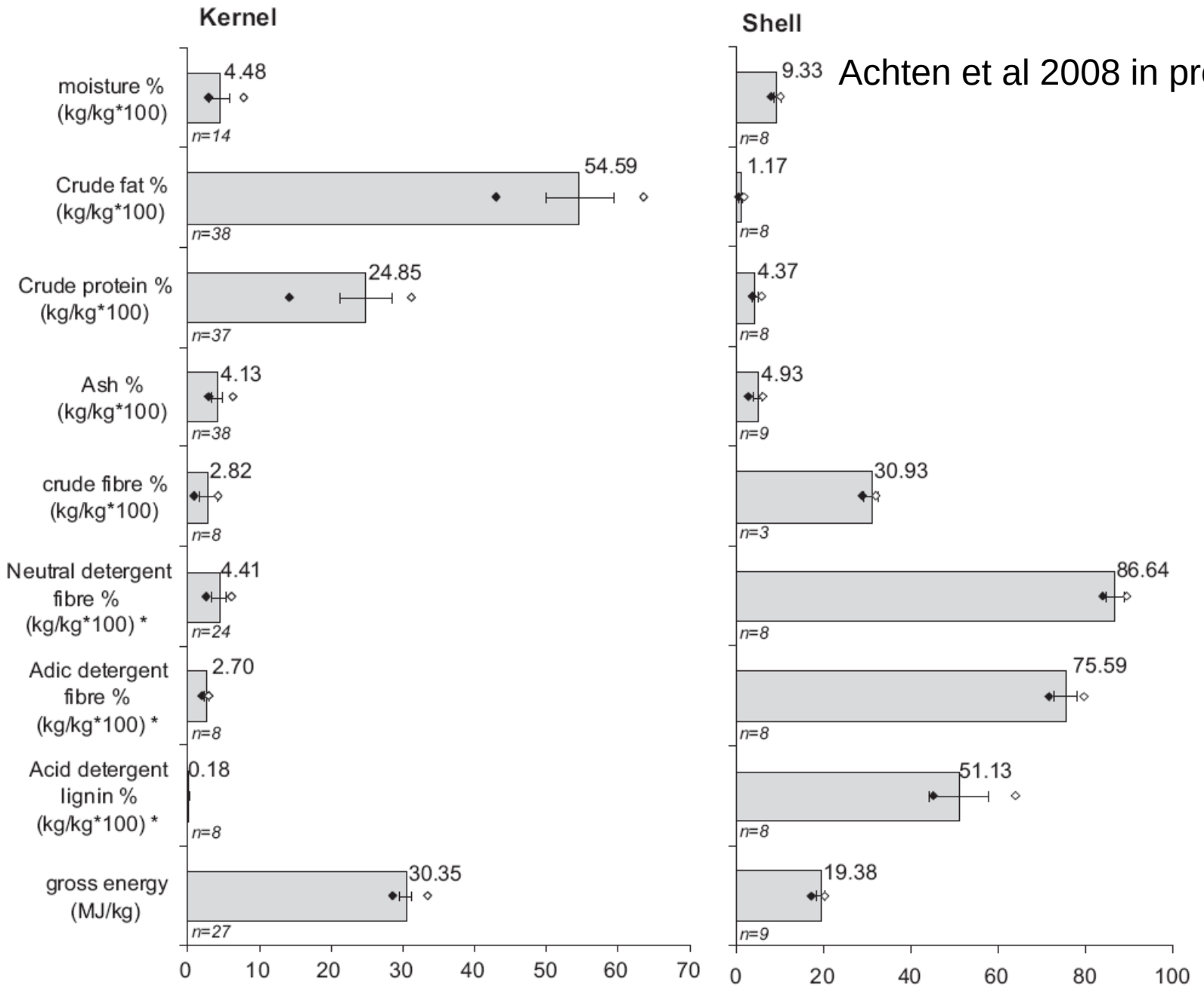


Fig. 4 – Average kernel and shell composition and standard deviation based on *n* reported data sets. ◆—minimum; ◇—maximum. *Calculated from values obtained for fat-free samples since high fat content interferes with the analyses.

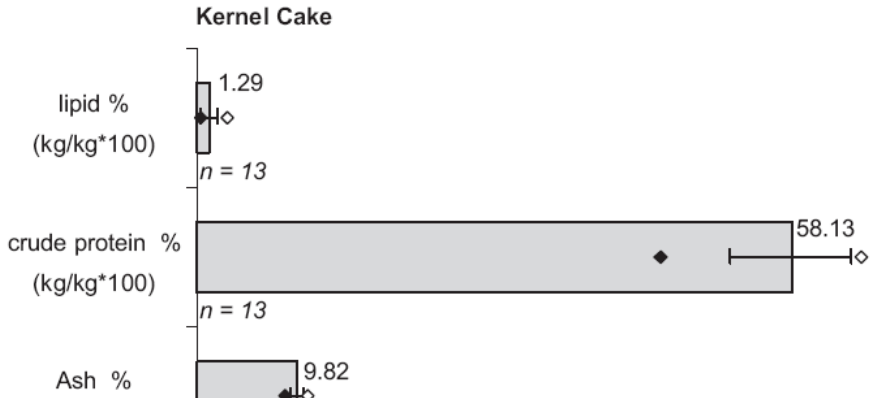


Table 2 – Nutritional analysis of oil seed cakes, and manure (%) (Delgado and Parado, 1989)

Property	*J. curcas* oil cake	Neem oilcake	Cow manure
Nitrogen	3.2–4.44	5.0	0.97
Phosphorus	1.4–2.09	1.0	0.69
Potassium	1.2–1.68	1.5	1.66

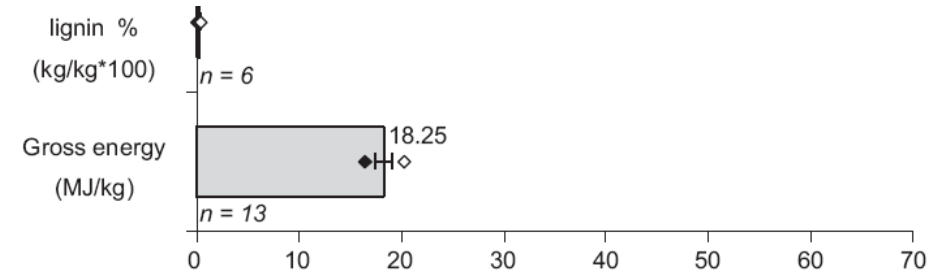


Fig. 7 – Average kernel cake composition and standard deviation based on *n* reported data sets of solvent extracted JCL kernels. ◆—minimum; ◇—maximum. Inset table: ranges of reported chemical composition indicating the percentages of N, P, K, Ca and Mg (based on $n = 5$ data sets). *Sources*: [5,6,8,10,26,28,31,59,71,90].

Table 4 – Summary of case studies using JCL seed cake as fertilizer

Reference	Country	Crop	Dosage[a]	Comments
[92]	Mali	Pearl millet	5 t ha^{-1}	46% yield increase in comparison to zero-input
[93]	Zimbabwe	Cabbage	2.5–10 t ha^{-1}	• 40–113% yield increase in comparison to zero-input • Free from pest and disease, while cutworm infestation occurred with cow manure application
[9]	Nepal	Rice	10 t ha^{-1}	11% yield increase in comparison to zero-input
[94]	India	JCL	0.75–3 t ha^{-1}	13–120% yield increase in comparison to zero-input

[a] 1 t seed cake is produced on 0.27–0.54 ha JCL plantation. (own calculation based on an expected seed yield of 2.5–5–t dry seed ha^{-1} yr^{-1} with an oil content of 34.4 wt% and a mechanical extraction efficiency of 75%).

Achten et al 2008 in pres

Energy efficiency

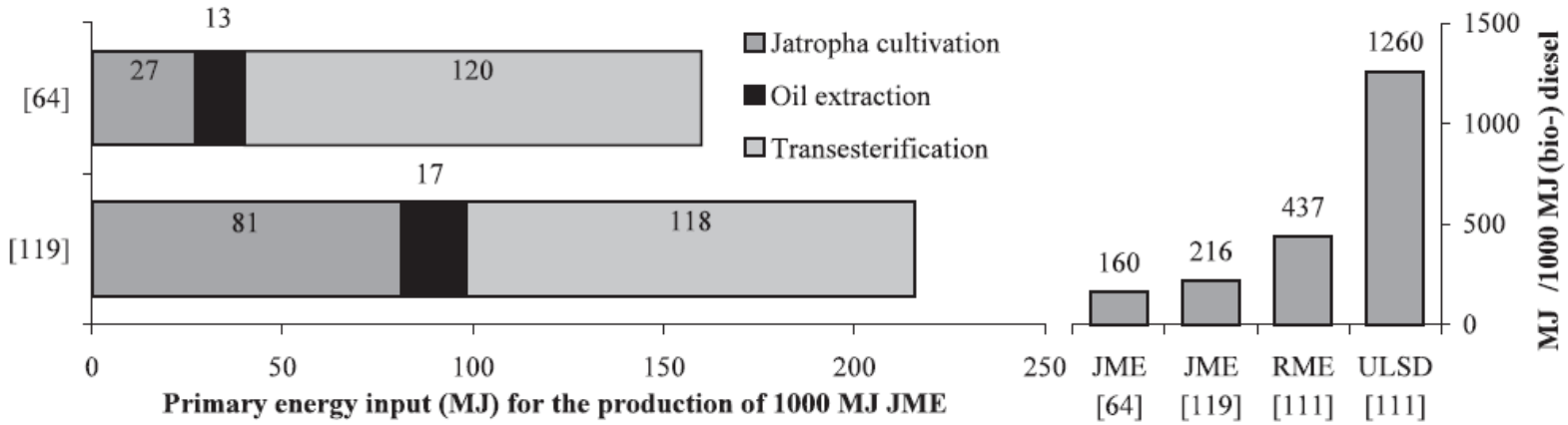


Fig. 9 – Primary energy input for the production of 1000 MJ JME after pro-rata allocation of the total energy requirement of the whole production process over the JME product and the by-products based on the energy content of the JME product and the by-products. *Sources*: [64] with low cultivation intensity and [119] with high cultivation intensity. Comparison with reference systems rapeseed methyl ester (RME) and ultra-low sulfur diesel (ULSD) from crude oil [111].

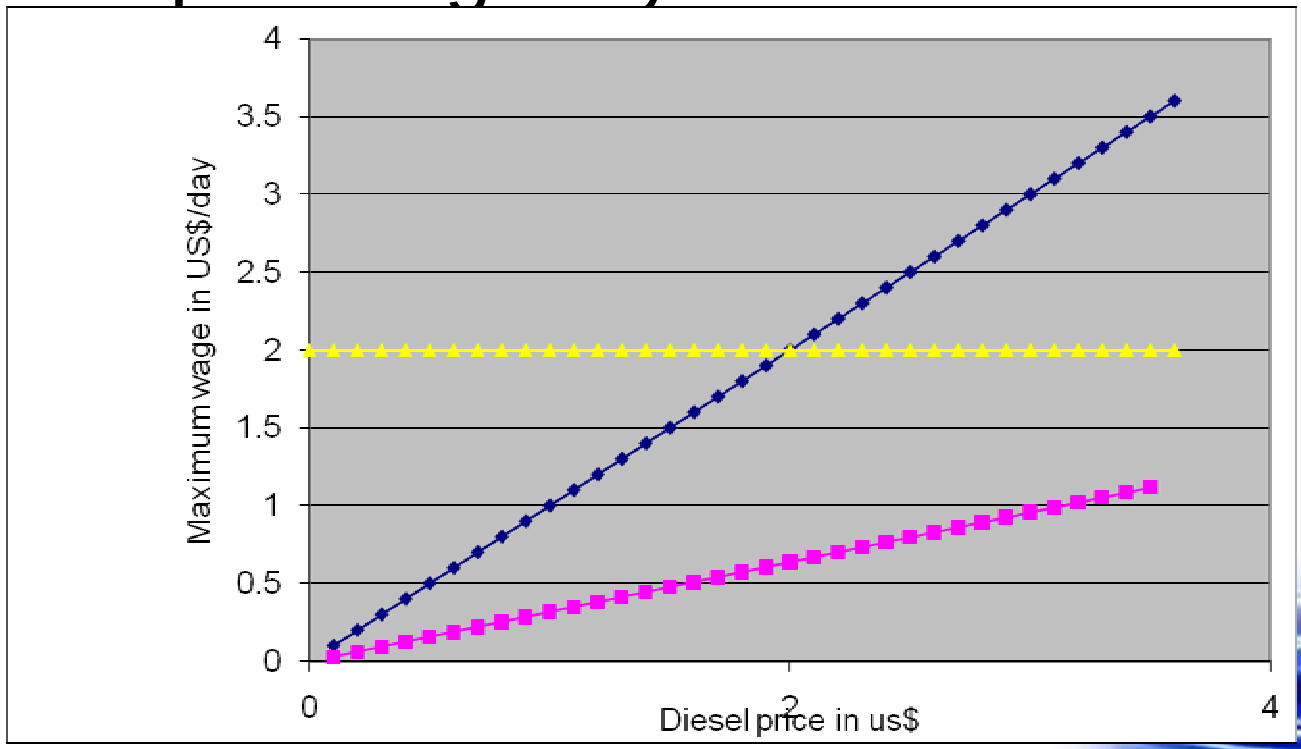
Achten et al 2008 in pres

Carbon Efficiency

Two studies, both rudimentary
Suggest positive balance
Dependent on land transformation, management, fertilisation, albedo, transport, source of energy

Does not need lots of management ??

- Needs weeding
- Harvesting very labour intensive
- Hand pressing very labour intensive



Biodiversity impacts

- Is it invasive??
- Land transformation a real issue
- Wasteland might = high biodiversity
- Lots of opportunity for mitigation
- Need for strategic planning

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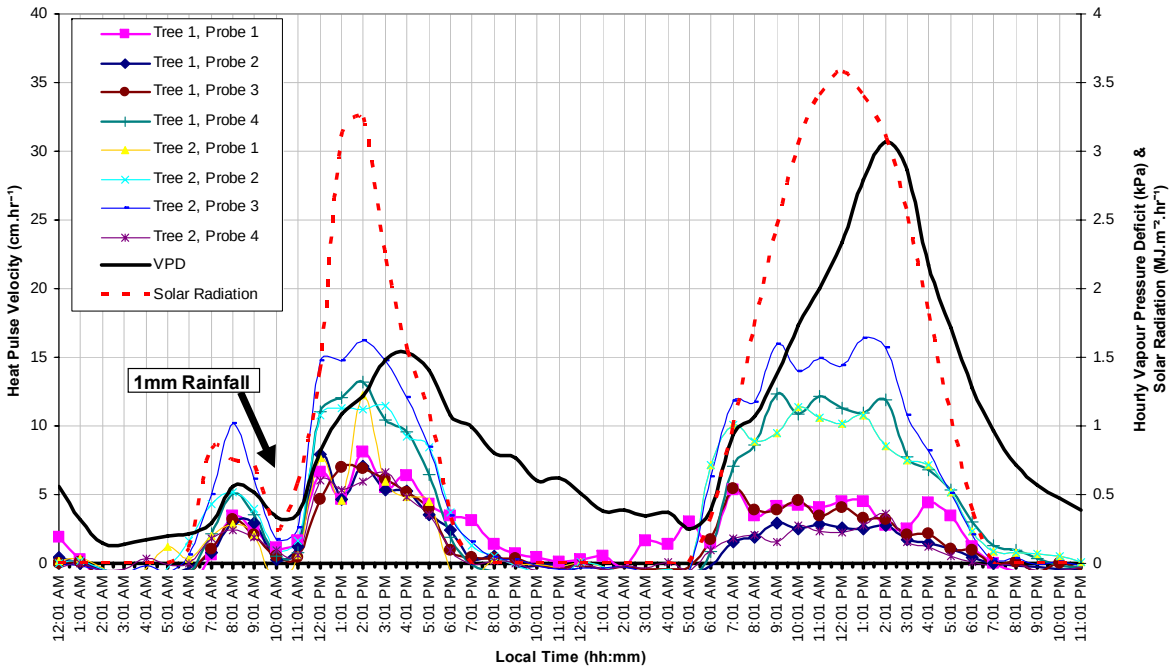
Hydrological impacts



Hourly corrected heat pulse velocity (cm.hr-1), solar radiation (MJ.m-2.hr-1) and vapour pressure deficit (kPa) data from the Makhathini site on the 14th and 15th November 2005. (Gush et al. 2007)

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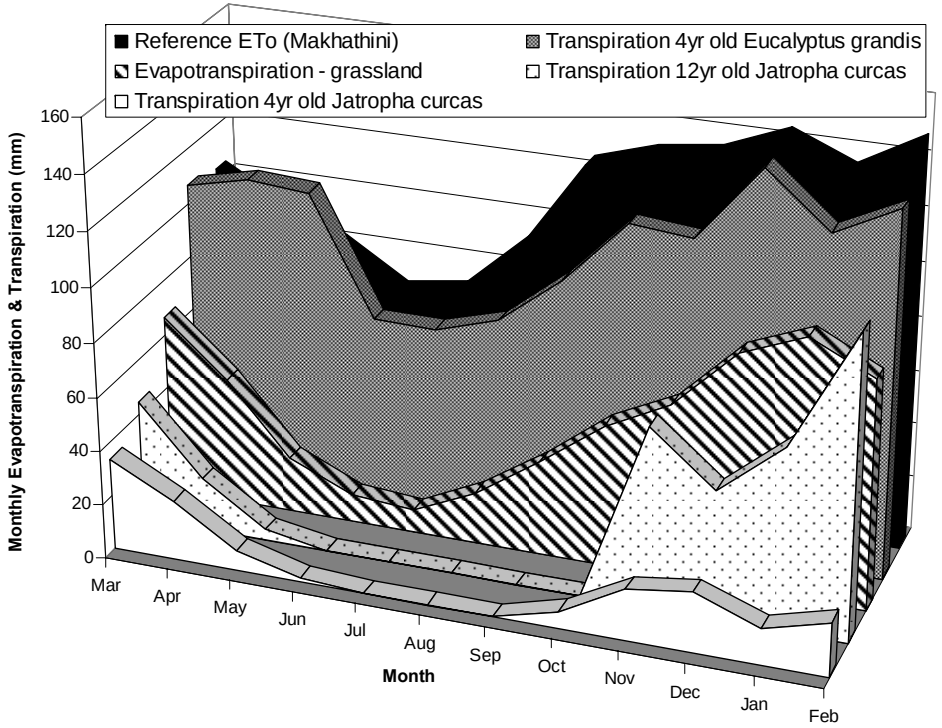
Hydrological impacts



Comparison of transpiration from two ages of *Jatropha curcas* tree against measured transpiration and evapotranspiration results from a range of vegetation water use studies in South Africa (Gush et al. 2007)

As a fuel

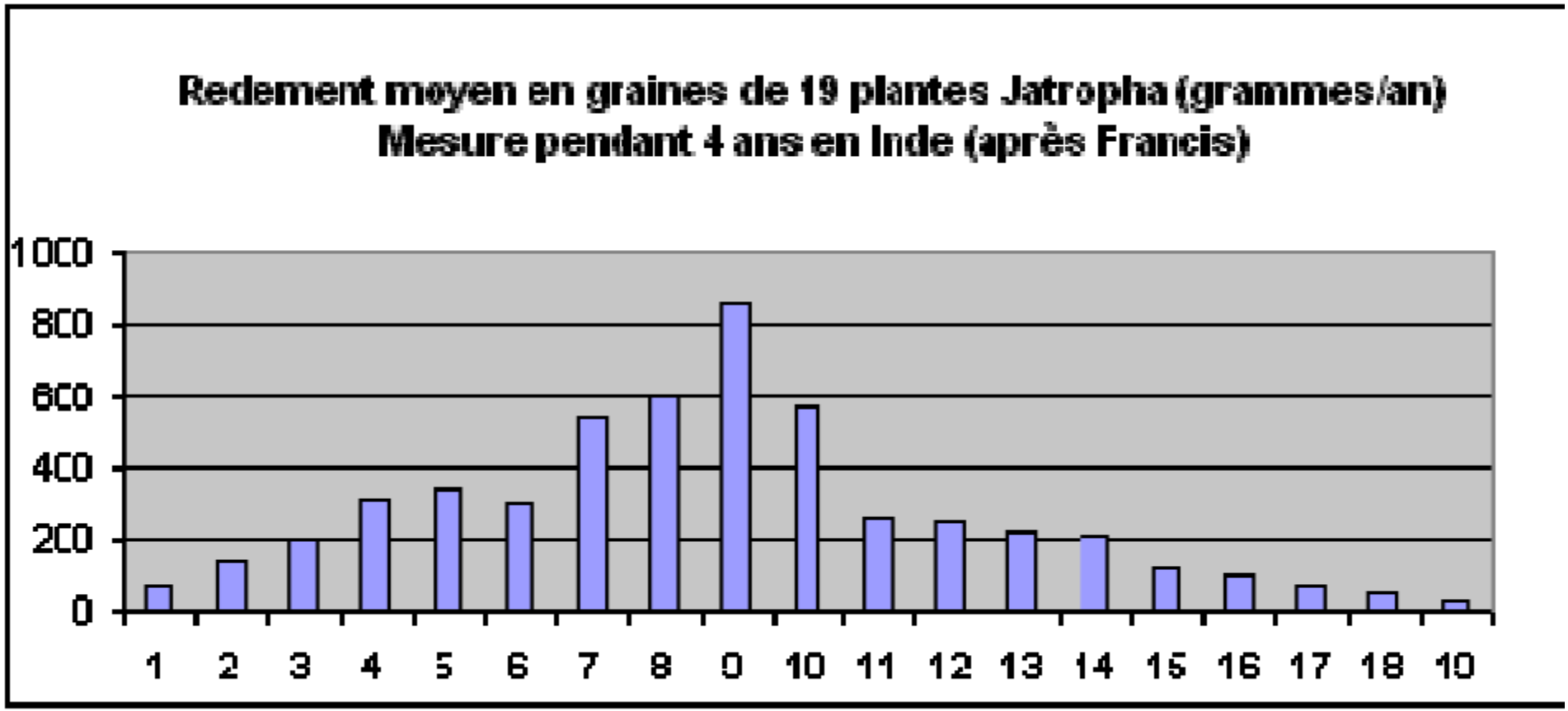
Excellent as feedstock for biofuel

Waste as fuel
Husks as good as coal – no
But can be a fuel

Pests and diseases

A number of pathogens identified
Risk of disease increases as area under monoculture increases

Jatropha is a wild plant – not yet domesticated



Reinhard Henning

Conclusions

Will grow on wasteland – but do not expect an economic yield
Is drought tolerant – but needs high rain for useful yield
No convincing yield data for region
Seedcake good fertilizer but no good for food
Invasiveness still not proven
Land transformation = big biodiversity impact
Energy and carbon balance seems OK, but check for land transformation
Water impact looks low (at least in comparison to euc)
Needs lots of management – weeding, fertilizer, pruning
Economics not proven
Good oil properties

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Thank you for your attention

CLUWRR

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WINROCK INTERNATIONAL INDIA

UNIQUE forestry consultants

CMES Centre for Mountain Ecosystem Studies
山地生态系统研究中心

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