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Myths and facts of Jatropha



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Graham von Maltitz
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Southern African round table

Maputo 12 September 2008

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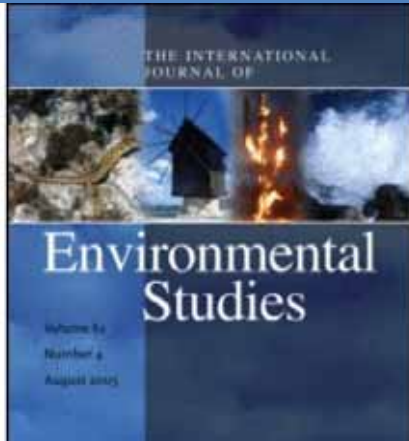
RE-Impact: Forestry based Bioenergy for Sustainable Development



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

Publication details, including instructions for authors and subscription information:
<http://www.informaworld.com/smpp/title~content=t713642046>

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

^a Central Salt and Marine Chemicals Research Institute, Gujarat, India



Review

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

Ashwani Kumar, Satyawati Sharma*



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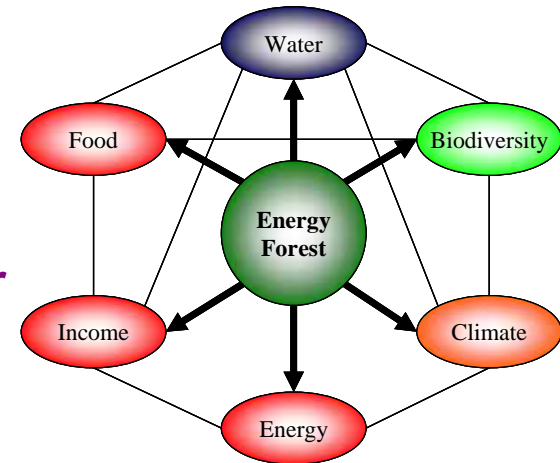
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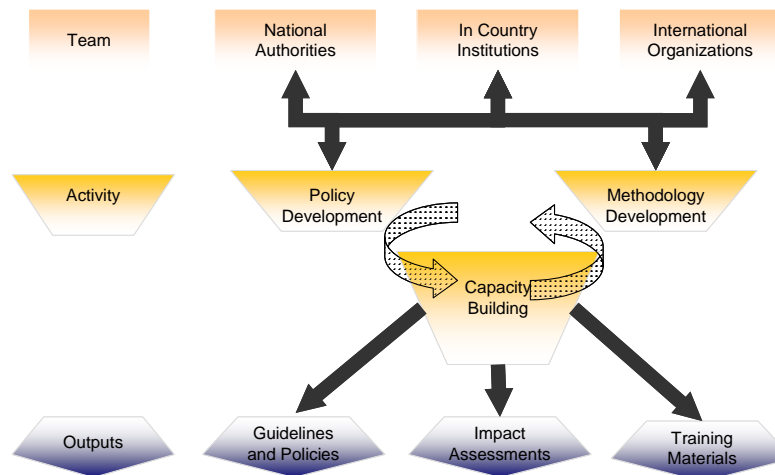


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- Evaluate trends- CDM opportunities
- Impact assessment framework- water, biodiversity, societal
- Learning- bioenergy curriculum, MSc
- Capacity building- industry standards
- Policy and dissemination- stakeholder groups /IUFRO



 Human Dimensions





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The SEA Framework

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

RE-Impact: Forestry based Bioenergy for Sustainable Development





Overview

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- 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”

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- Is reported to grow on 200 – 300 mm of rain
- Is drought tolerant – loses 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

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- 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



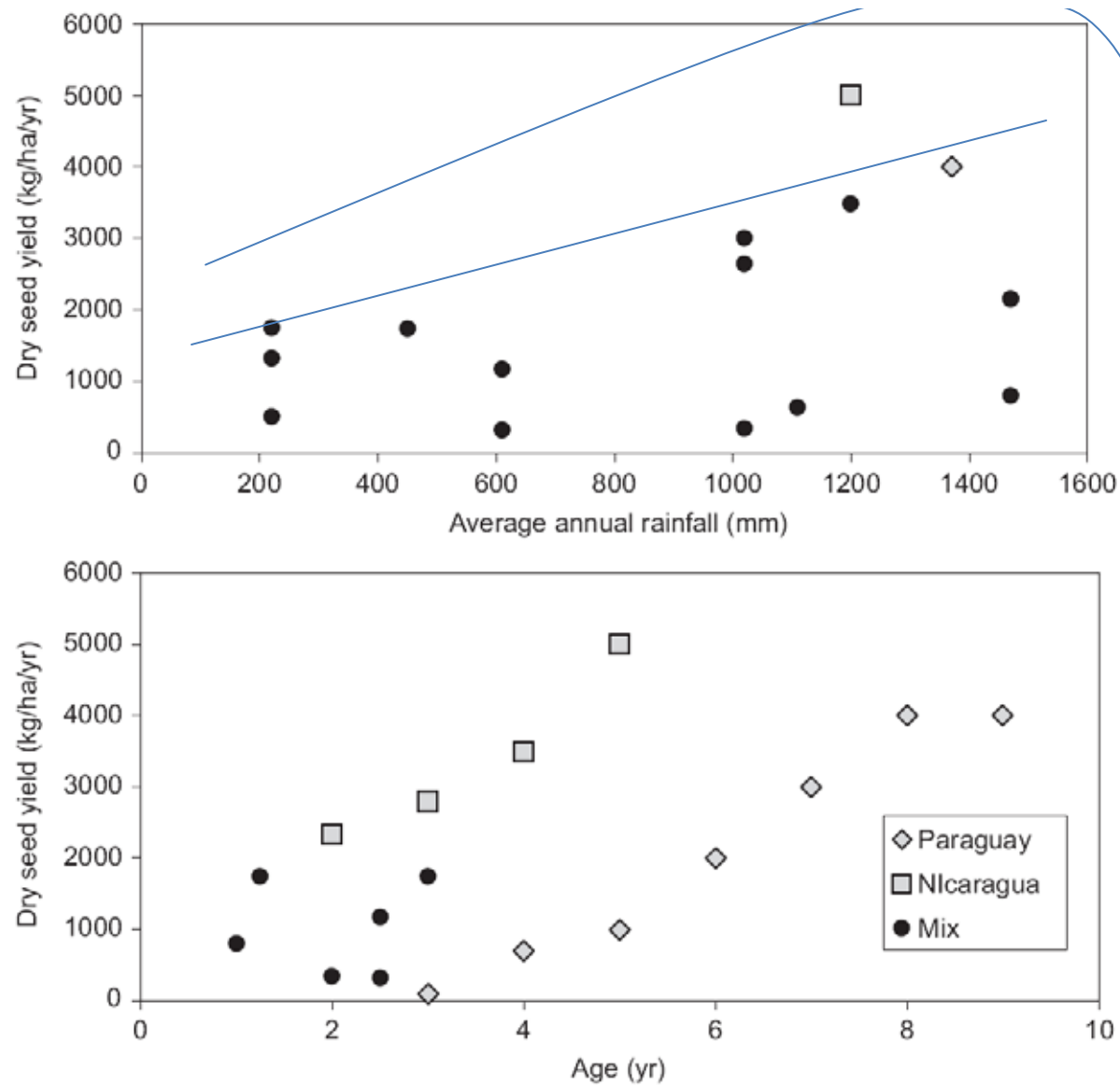


Fig. 2 – Dry seed yield in relation to average annual rainfall (mm) and age of the JCL crop. The plotted points represent a mix of provenances, site conditions and plant age or average annual rainfall. Sources: [9,11,13,52,53,56] and personal communication: Kumar, 2005 and Buisman, 2005.

Achten et al 2008 in pres





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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
	Thailand	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

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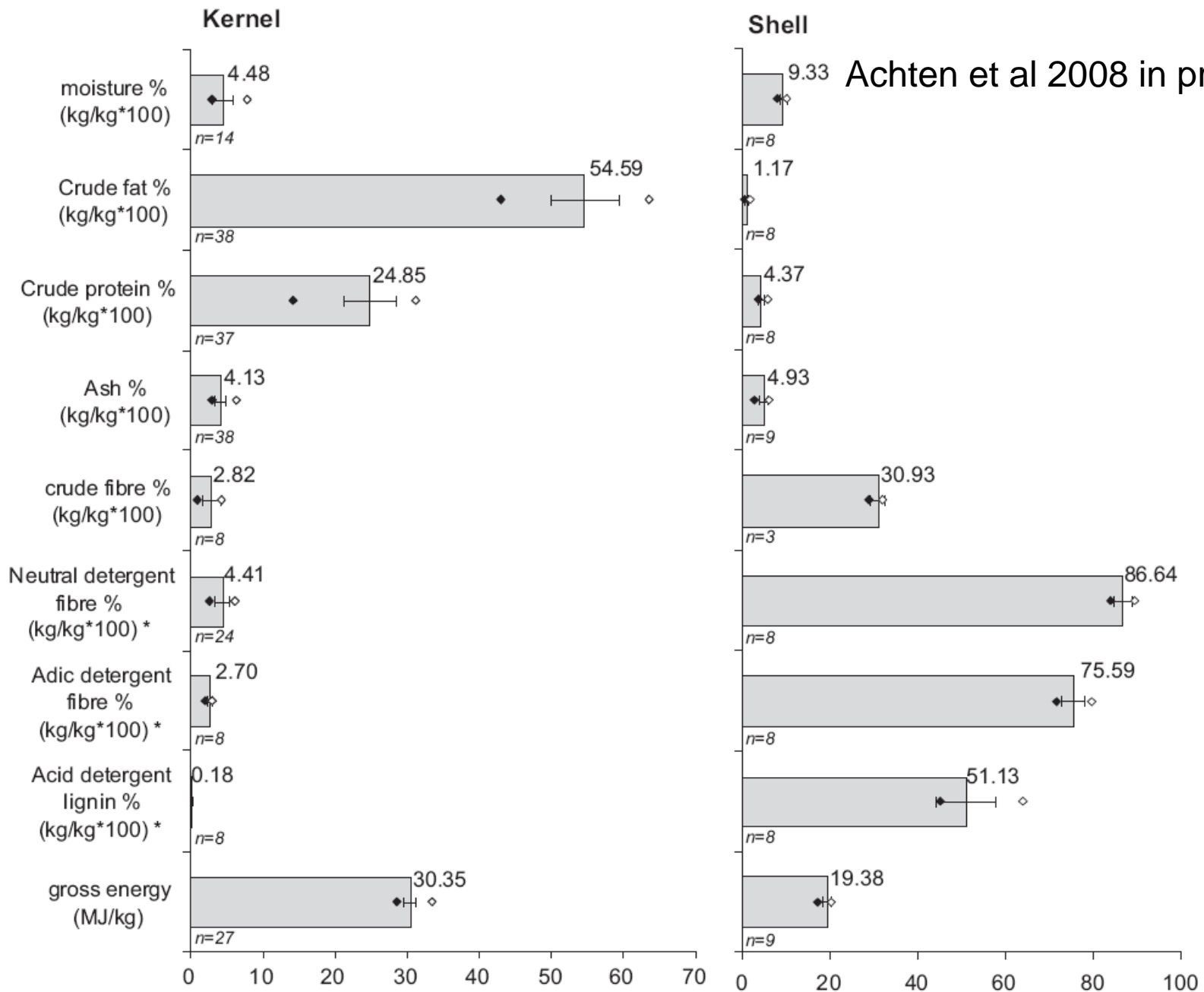
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- 30 to 40 % oil (down to 26% in some studies)
- 60 to 99 % recovery
 - Ram 60-65
 - Screw press 70-80 % (or 91% using 2 or more passes with cooking)
 - Chemical up to 99%
- Density of 0.91
- 0.20 to 0.43 l per kg
- 2.3 to 5.0 t to get 1000 l





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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.

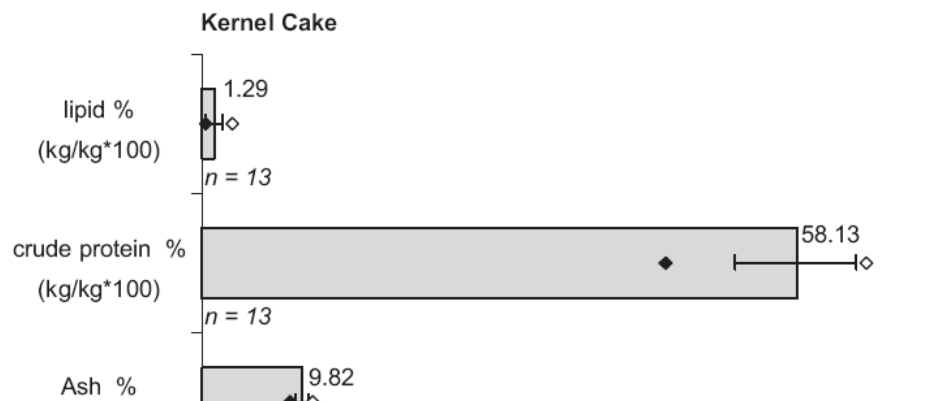


Table 2 – Nutritional analysis of oil seed cakes, and manure (%) (Delgado and Parado, 1989)

Property	<i>J. curcas</i> 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

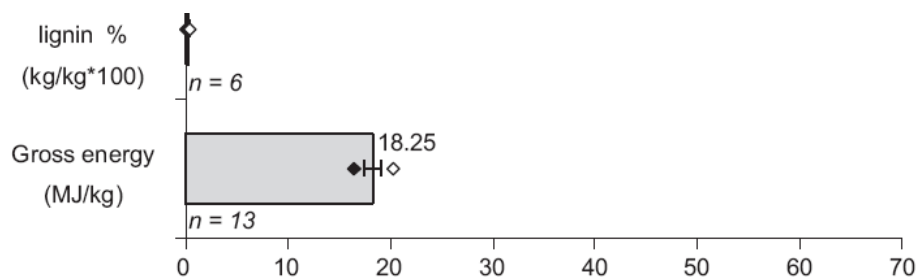


Fig. 7 – Average kernel cake composition and standard deviation based on n reported data sets of solvent extracted JCL kernels. ♦—minimum; ◇—maximum. Inset table: ranges of reported chemical composition indicating the percentages of N, P, K, Ca and Mg (based on n = 5 data sets). Sources: [5,6,8,10,26,28,31,59,71,90].

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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	<ul style="list-style-type: none"> ● 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%).



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Energy efficiency

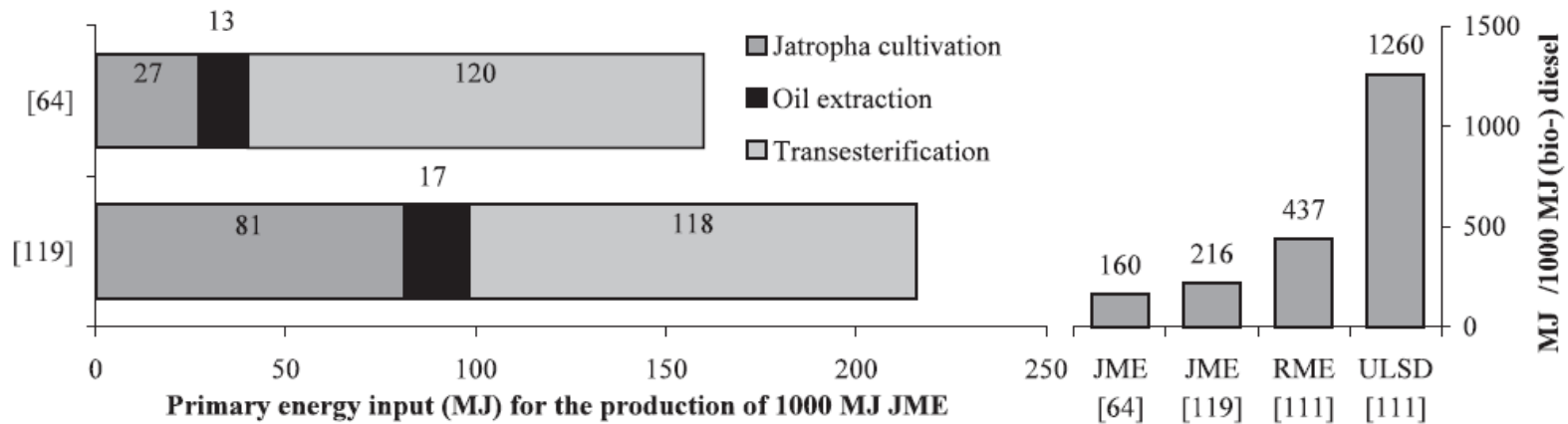


Fig. 9 – Primary energy input for the production of 1000 MJ JME after pro-rata allocation of the total energy requirement of the whole production process over the JME product and the by-products based on the energy content of the JME product and the by-products. Sources: [64] with low cultivation intensity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



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Carbon Efficiency

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





Does not need lots of management ??

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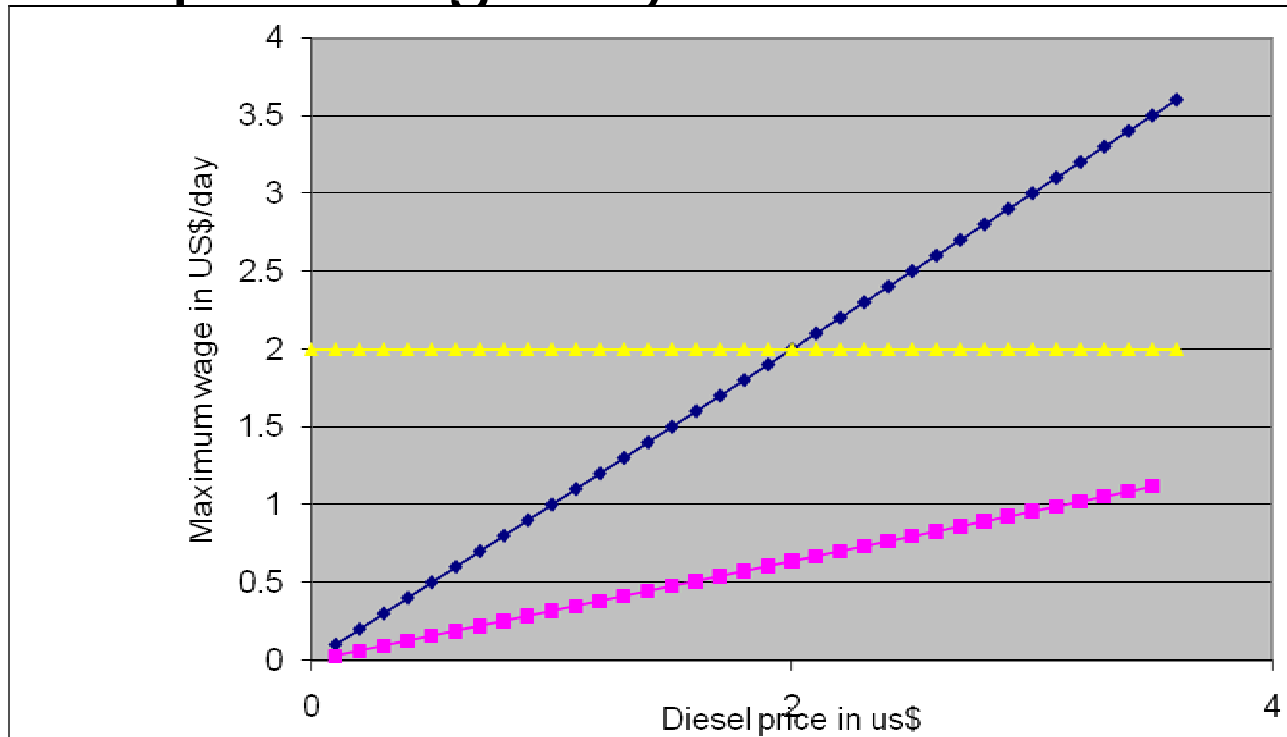
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- Needs weeding
- Harvesting very labour intensive
- Hand pressing very labour intensive





Biodiversity impacts

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





Hydrological impacts

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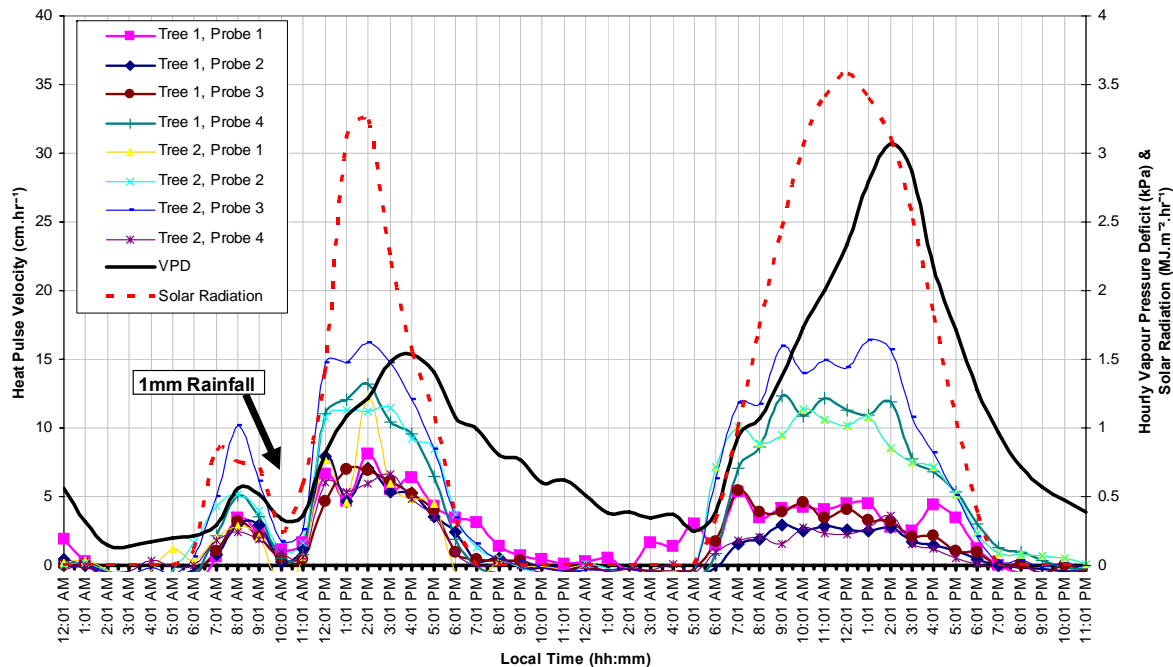
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Hourly corrected heat pulse velocity (cm.hr⁻¹), solar radiation (MJ.m⁻².hr⁻¹) and vapour pressure deficit (kPa) data from the Makhathini site on the 14th and 15th November 2005. (Gush et al. 2007)





Hydrological impacts

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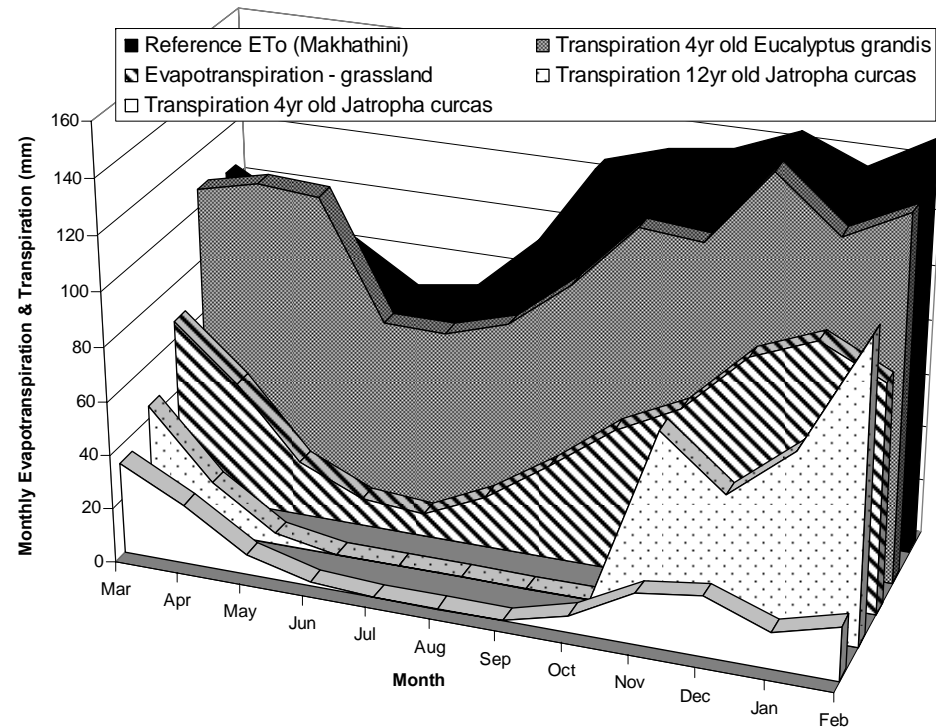


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Comparison of transpiration from two ages of *Jatropha curcas* tree against measured transpiration and evapotranspiration results from a range of vegetation water use studies in South Africa (Gush et al. 2007)





As a fuel

Excellent as feedstock for biofuel

Waste as fuel

Husks as good as coal – no

But can be a fuel

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Pests and diseases

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

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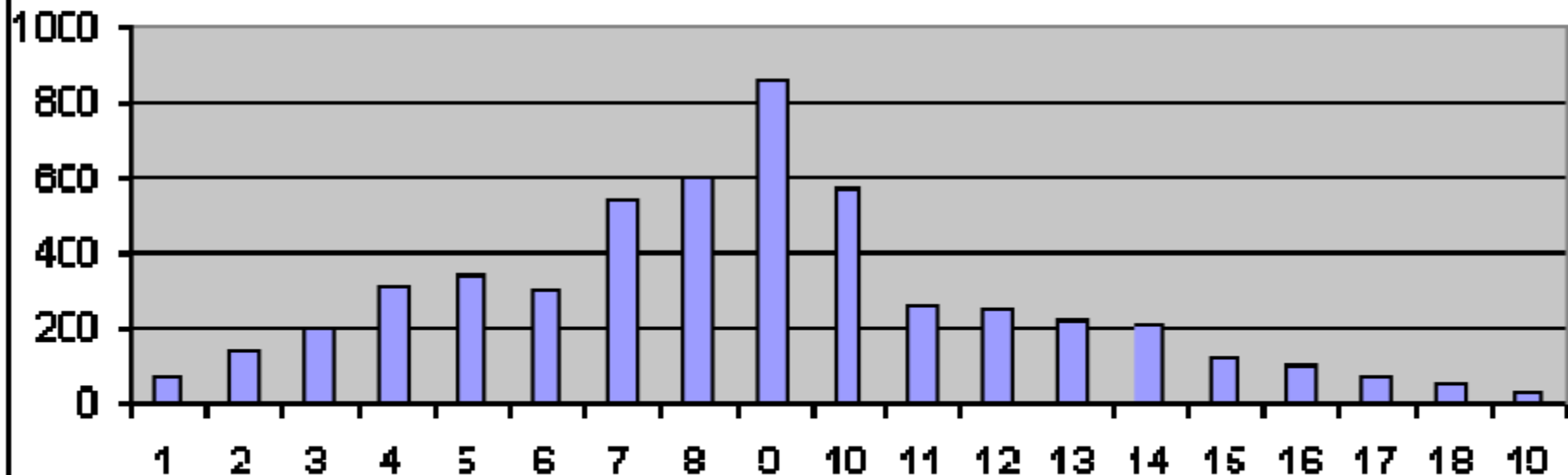




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Jatropha is a wild plant – not yet domesticated

Redement moyen en graines de 19 plantes Jatropha (grammes/an) Mesure pendant 4 ans en Inde (après Francis)



Reinhard Henning





Conclusions

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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

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