

# A to Z of *Jatropha curcas* L.

## 2. Claims and Facts on *Jatropha curcas* L.

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# Introduction

- Jatropha curcas Evaluation Program
- Claims and Facts



# People: Positive social effects

## *Jatropha curcas*

- enables local / rural development
- creates jobs / labour needed
- generates income
- does not compete with food production

Claims

# Planet: Positive environmental effects

## *Jatropha curcas*

- reclaims marginal soils
- conserves, protects and improves soils
- protects against erosion
- production of CO<sub>2</sub> neutral bio-fuel

Claims

# Planet: Crop requirements are low

## *Jatropha curcas*

- has low nutrient requirements
- grows well under saline conditions
- is drought tolerant
- has low water use (high water use efficiency)
- is tolerant or resistant to pests and diseases

Claims

# Profit: Crop outputs are high

## *Jatropha curcas*

- is an energy crop
- grows seeds with high oil contents
- provides oil of high quality
- ...provides high oil yields
  
- → Unfounded extrapolation...

Claims

# Extrapolation, assumption & misunderstanding

- Yield claims

# Mother trees

- Solitary trees
- Old and Mature
- No competition effects
  - Radiation
  - Water
  - Soil fertility
- No pressure
  - Pests
  - Diseases
- Abundance of seeds



# Seeds



- Seed weight  
0.1-1.0 g seed<sup>-1</sup>
- Seed oil content  
15 - 45%

# Extrapolation, assumption & misunderstanding

Seed Yield (8 kg tree-1)?

X

Seed oil content (45%)?

X

3.6 kg oil tree-1

2500 trees ha-1 (?)

X

9000 kg oil ha-1

45 MJ kg.oil-1

X

400 GJ ha-1

$2 * 10^9$  ha marginal land (?)

=

800 EJ

1. Solution of energy crises

2. Big Business

Old and Mature tree?

Genetic? Pressing efficiency?

Optimum? Competition? Inputs?

Pests and diseases?

What is marginal land?

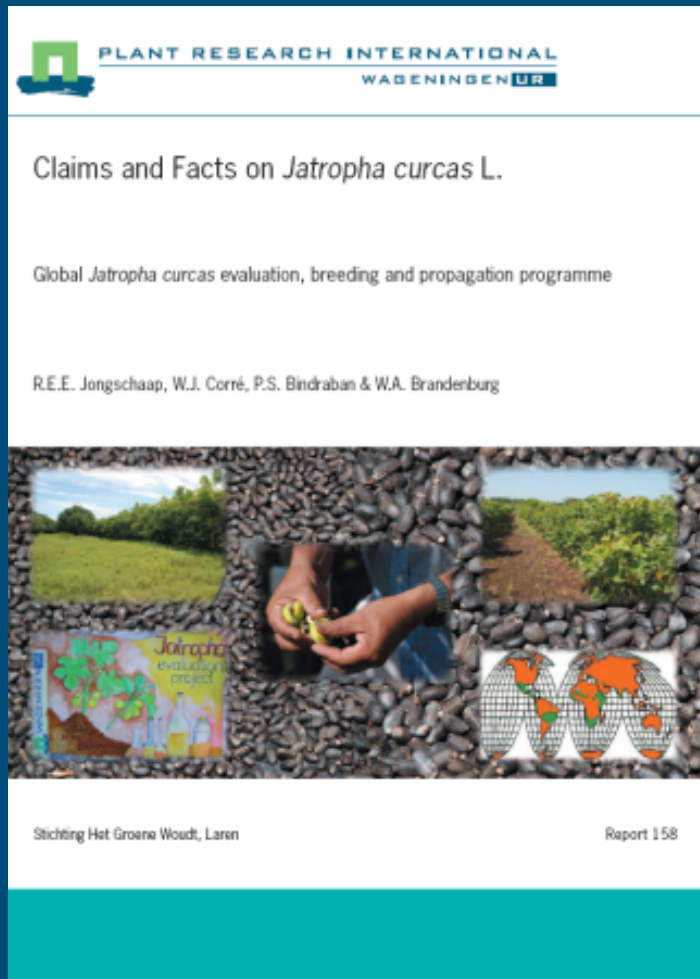
Water, Fertility, Labour needs, Logistics

For whom are we producing?

# Conclusions 'Claims and Facts on *J. curcas* L.'

- Claims are **correct** for **traditional use**
  - Inputs and requirements
  - Environmental effects
- Claims are **incorrect** for **high oil production**
  - Inputs and requirements (water, fertility, labor)
  - Pest and diseases (mono-crop, plantations)
  - Yield components

# Claims and facts on *Jatropha curcas* L.



- Position Paper  
Expert seminar March 2007  
(Daey Ouwens *et al.*, 2007)
- Plant Research International  
Report 158, October 2007  
(Jongschaap *et al.*, 2007)
- People Planet Profit

# Marginal lands

- What are marginal lands, why are they marginal?
- How do they look like?
- Where are they?

# Marginal lands

- Since 1945 extent of soil degradation by human activity:  
2 Billion ha (=  $2 \cdot 10^9$  ha = 2,000,000,000 ha)  $\approx$  17% Earth surface
- $\approx$  750 M ha (38%)
  - **lightly degraded** (small decline in agricultural production, potential to recover)
- $\approx$  910 M ha (46%)
  - **moderately degraded** (great reduction in agricultural productivity; restoration only through considerable financial and technical investment);
- $\approx$  300 M ha (15%)
  - **severely degraded** (no agricultural utility under local management systems; reclaimable only with major international assistance)
- $\approx$  9 M ha (0.5%)
  - **extremely degraded** (incapable of supporting agriculture and unreclaimable).

# *Jatropha curcas* marginal land reclamation

- Perennial
  - Use as re-forestation species in remote areas
  - Cropping system design
- Drought tolerant
  - Survives dry years
- Deep roots
  - Soil exploration for water and nutrients (recycling)
  - Senescent root material as Organic Matter in soil profile
- Canopy covers soil
  - Anti-erosion

# Facts of soil improvement by *Jatropha curcas*

- Increase of soil aggregate size
- Increase in soil organic matter content
- Decrease of soil bulk density

# System approach

- Understand processes on lower levels to explain or evaluate results at higher integration levels

→ **Gives handles to interfere**

**Comes back in Agronomy section**

# Crop growth limitations



- water    + water    - water    + water  
- nutrients    - nutrients    + nutrients    + nutrients

- No such thing as plants growing without water, nutrients, CO<sub>2</sub>, land, ...
- Low input – low yield
- Competing Claims on natural resources  
**HUGE!**



# Basics of crop production

## Growth & yield defining factors

- Weather
- Crop genetic potential



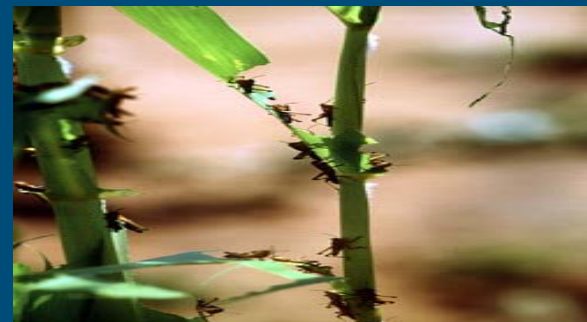
## Growth & yield limiting factors

- Water
- Nutrients



## Growth & yield reducing factors

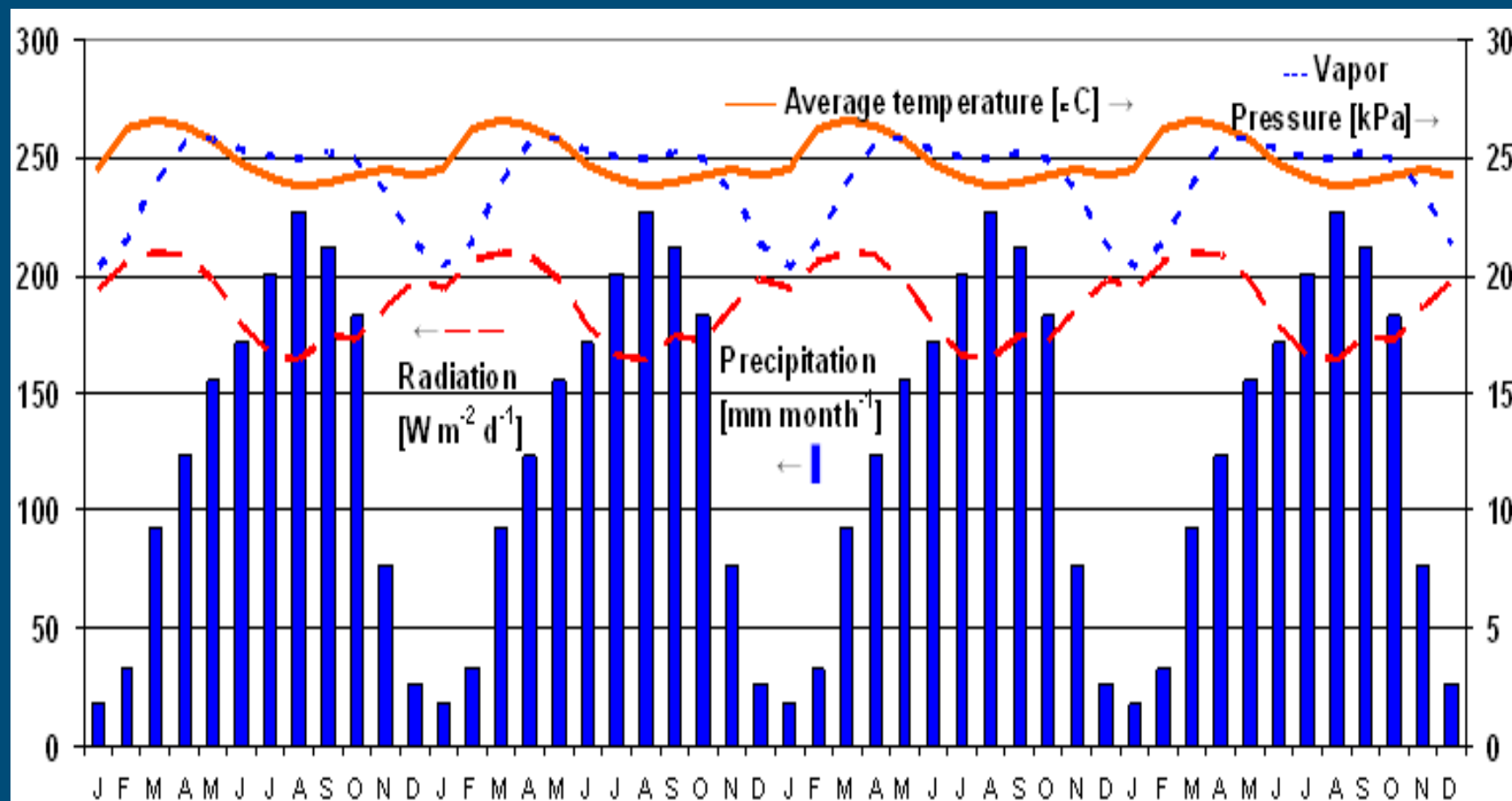
- Weeds
- Pests
- Diseases



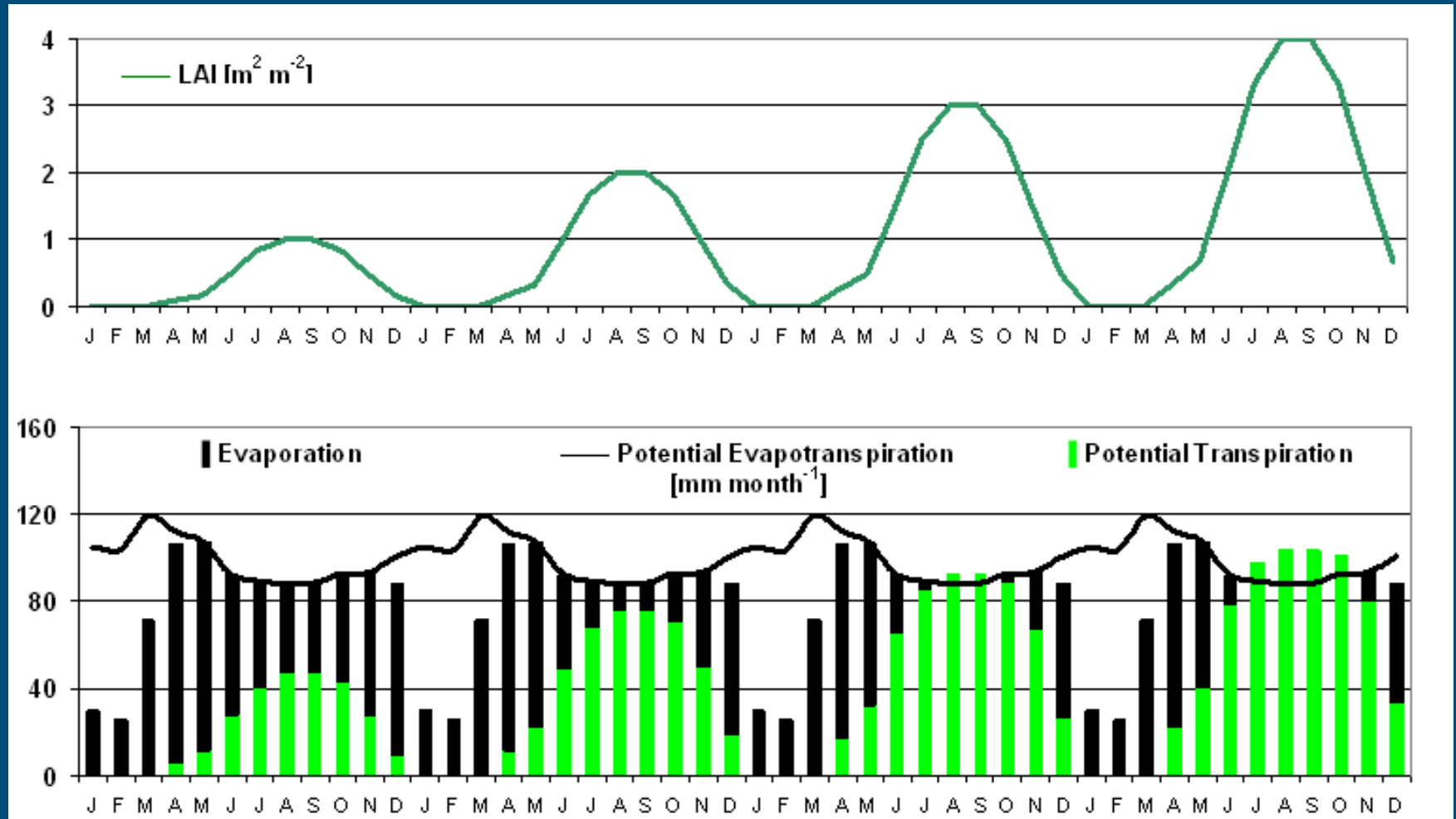
# Example of system approach

- 'Yield per hectare' (higher level) depending on sub-processes (lower integration levels)
  - **Radiation interception and radiation use efficiency**
    - Growing season
    - Interception capacity (Leaf Area Index, Plant density, Chlorophyll content)
    - Photosynthesis capacity
    - Carbohydrate assignment to organs (roots, stems, leaves, fruits, seed)
  - **Water availability and water use**
    - Precipitation
    - Soil characteristics, soil management
    - Root system penetration
    - Transpiration characteristics
    - Competition

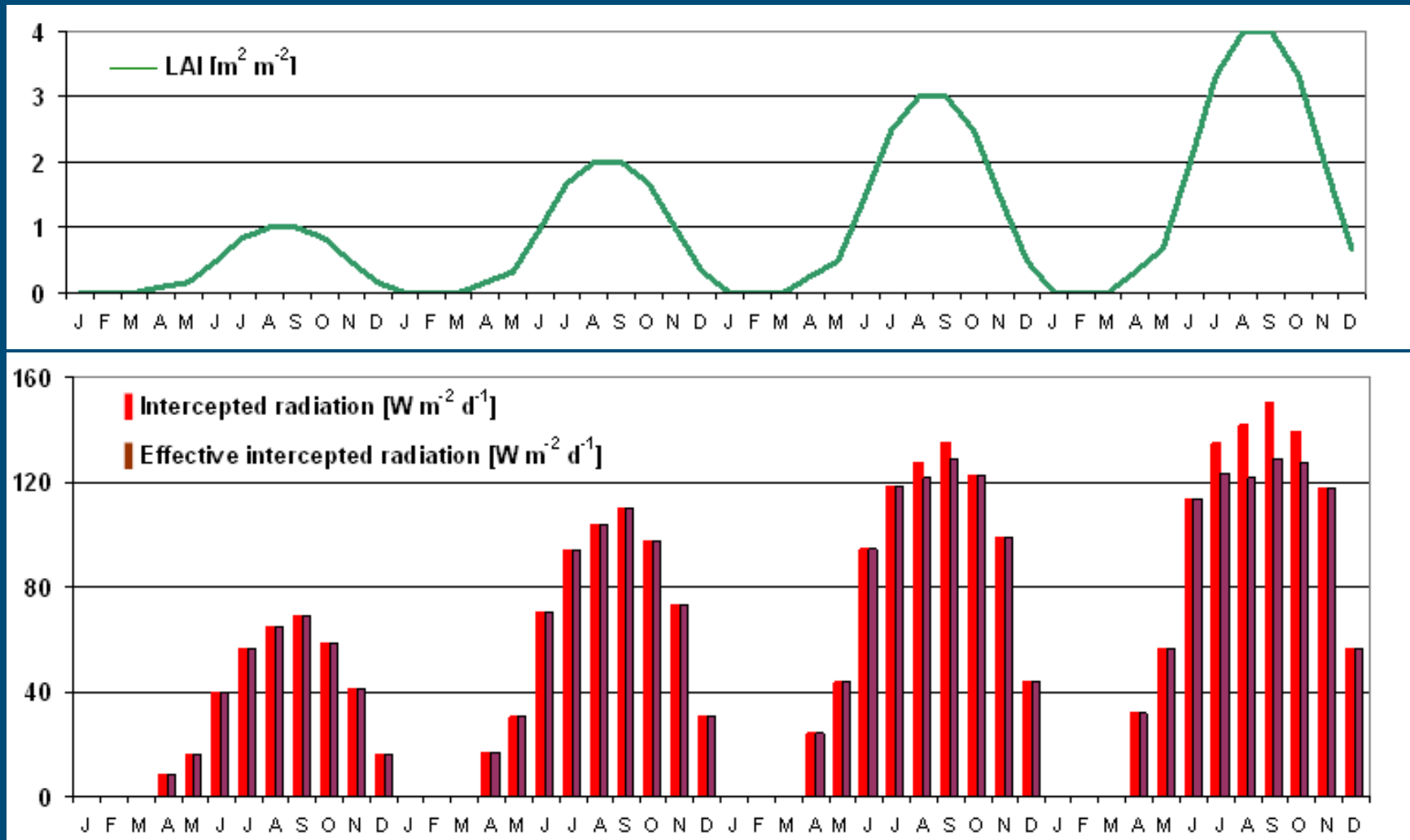
# Weather conditions



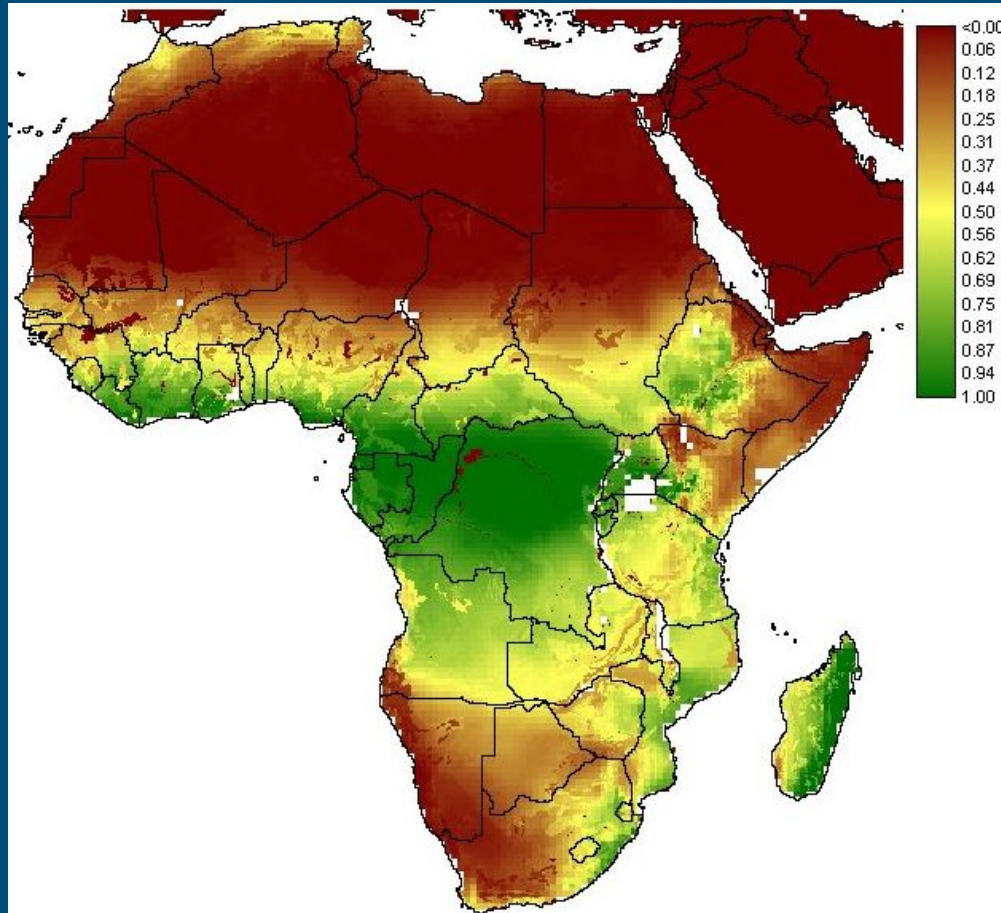
# Crop development and water use



# Canopy development and radiation use



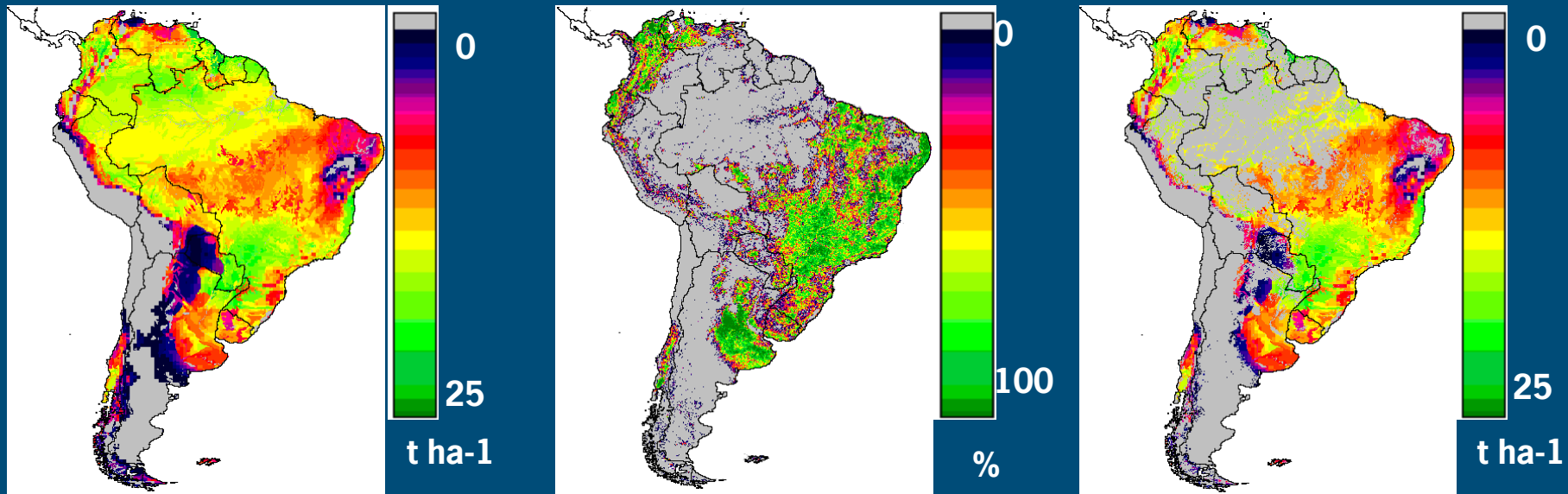
# Water Use: Africa AET/PET ratio



Based on (1960-1990):

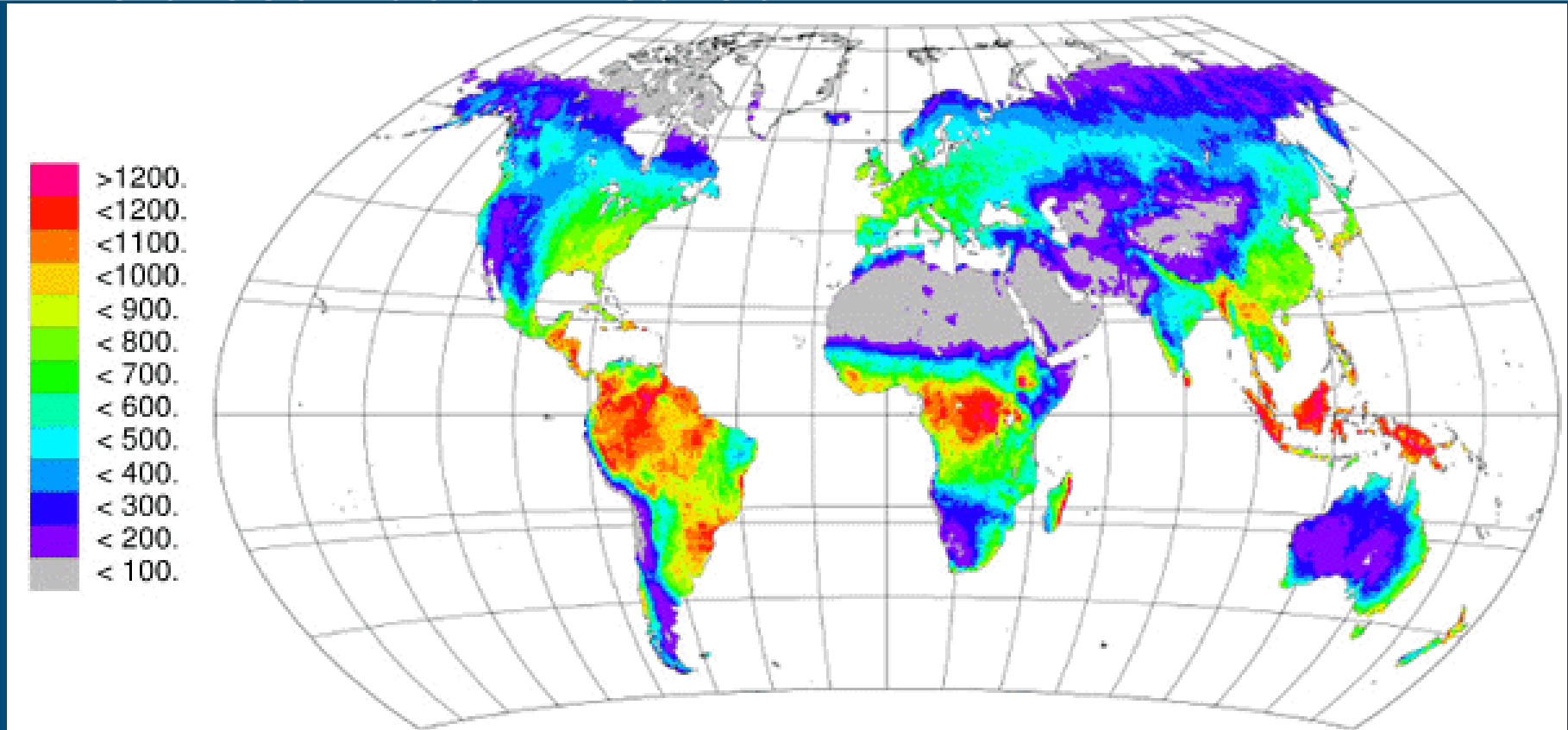
- Radiation
- Temperature
- Wind speed
- Soil water availability
  
- Annual
- Growing season

# Rain-fed cereal production



Sophisticated integration of most recent spatial data on climate, soils and current land use combined with dynamic crop growth simulation modeling results in a realistic prospective on biomass production.

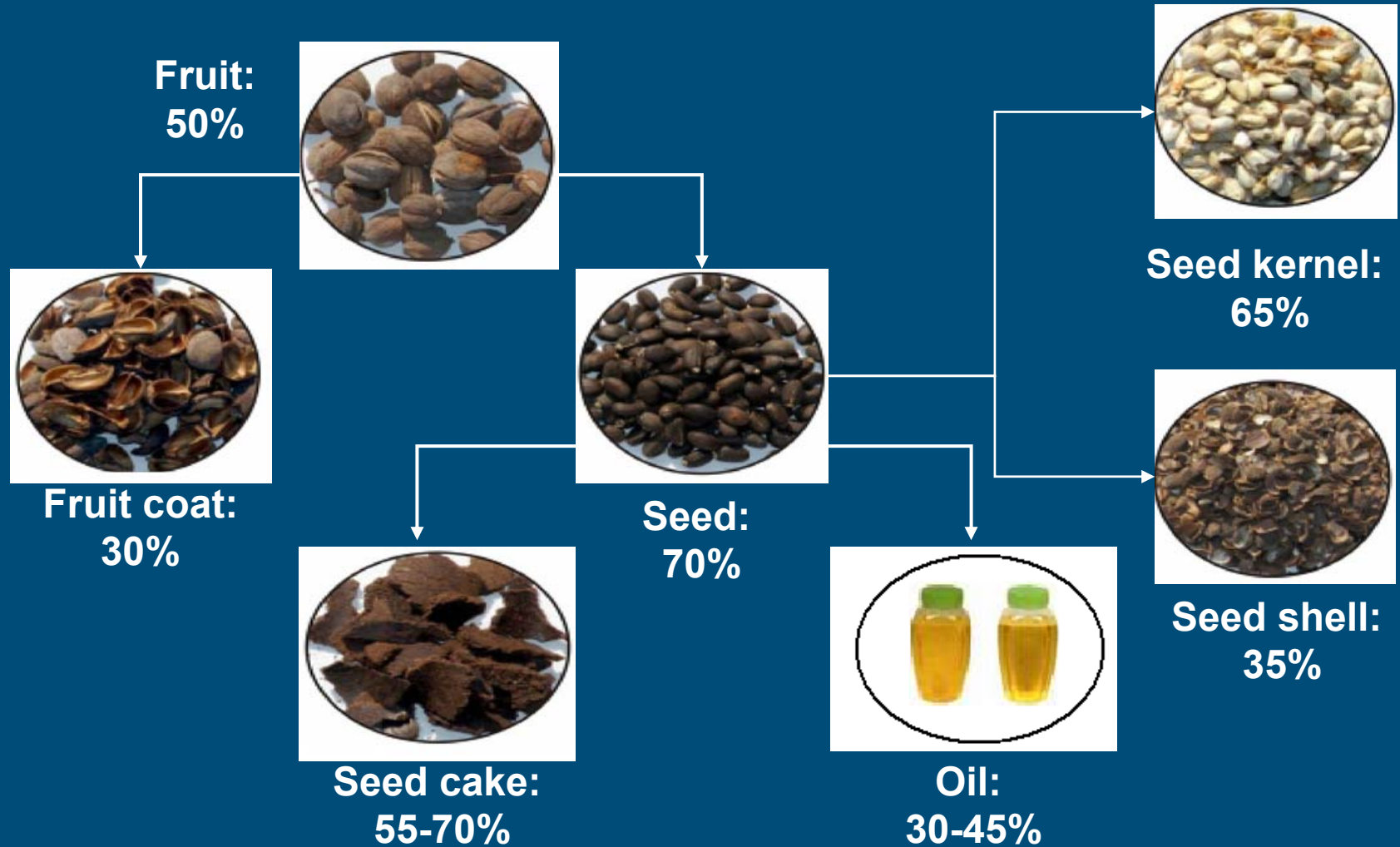
# Yield estimation method



*Annual net primary production (NPP, g C m<sup>-2</sup> y<sup>-1</sup>) estimated by different simulation models (Sahagian & Hibbard, 1997).*

('Claims and Facts on *Jatropha curcas* L.' available at [www.jatropha.wur.nl](http://www.jatropha.wur.nl))

# Dry matter distribution



# Yield estimation method (cont'd)

- **MAX** 1000 g C m<sup>-2</sup> y<sup>-1</sup> equals 10 ton C ha y<sup>-1</sup>
- 47.5% C in dry matter: 22.2 t dry matter ha y<sup>-1</sup>
- 25% leaves, 25% stems: 50% fruits: 11.1 t ha y<sup>-1</sup>
- 70% seed in fruit: 7.77 t seed ha<sup>-1</sup> y<sup>-1</sup>
- 35% seed oil content: 2720 kg oil ha<sup>-1</sup> y<sup>-1</sup>
- 75% pressing efficiency : 2040 kg oil ha<sup>-1</sup> y<sup>-1</sup>
- 0.92 kg oil liter<sup>-1</sup> → 2220 liter oil ha<sup>-1</sup> y<sup>-1</sup>

# Tolerance to pests and diseases

- The claim that *Jatropha curcas* is tolerant to pests and diseases is **not** sustained by reality
  - **Not** in plantation/monoculture
  - **Not** under humid conditions



# Conclusions

- Base your expectations on solid knowledge
- Science is needed
- Science is costly, but a good investment

# References

- Conijn, J.S., R.E.E. Jongschaap, P.S. Bindraban & P.W.J. Uithol, 2008. South America rain-fed cereal production potential. Plant Research International, Wageningen, the Netherlands.
- Chaudhary, D.R., J.S. Patolia, A. Ghosh, J. Chikara, G.N. Boricha & A. Zala, 2007. Changes in soil characteristics and foliage nutrient content in *Jatropha curcas* plantations in relation to stand density in Indian wasteland. Expert seminar on *Jatropha curcas* L. Agronomy and genetics. 26-28 March 2007, Wageningen, the Netherlands, Published by FACT Foundation.
- Daey Ouwens, K., G. Francis, G., Y.J. Franken, W. Rijssenbeek, A. Riedacker N. Foidl, R.E.E. Jongschaap & P.S. Bindraban, 2007. State of the art, small and large Scale Project Development. Position paper on *Jatropha curcas*.. Expert seminar on *Jatropha curcas* L. Agronomy and genetics. 26-28 March 2007, Wageningen, the Netherlands. Published by FACT Foundation.  
[http://www.fact-fuels.org/media\\_en/Position\\_Paper\\_on\\_Jatropha\\_Curcas](http://www.fact-fuels.org/media_en/Position_Paper_on_Jatropha_Curcas).
- Dagar, J.C., O.S. Tomar, Y. Kumar, H. Bhagwan, R.K. Yadav & K. Tyagi, 2006. Performance of some under-explored crops under saline irrigation in a semiarid climate in northwest India. Land Degrad. Develop. 17, 285-299.



# References

- Jongschaap, R.E.E., W.J. Corré, P.S. Bindraban & W.A. Brandenburg, 2007. Claims and Facts on *Jatropha curcas* L. Global *Jatropha curcas* evaluation, breeding and propagation programme. Plant Research International B.V., Wageningen, the Netherlands, Report 158, 42 pp + annexes.  
[http://www.fact-fuels.org/media\\_en/Claims\\_and\\_Facts\\_on\\_Jatropha\\_WUR](http://www.fact-fuels.org/media_en/Claims_and_Facts_on_Jatropha_WUR)
- Ogunwole, J.O., J.S. Patolia, D.R. Chaudhary, A. Ghosh & J. Chikara, 2007. Improvement of the quality of a degraded entisol with *Jatropha curcas* L. under Indian semi-arid conditions. Expert seminar on *Jatropha curcas* L. Agronomy and genetics. 26-28 March 2007, Wageningen, the Netherlands, Published by FACT Foundation.
- Oldeman, L. R., R. T. A. Hakkeling, & W. G. Sombroek, 1990. World Map of the Status of Human Induced Soil Degradation: An Explanatory Note, rev. (International Soil Reference and Information Center (ISRIC), Wageningen, Netherlands, rev. ed. 2, 1990);
- Pant, K.S., V. Khosla, D. Kumar & S. Gairola, 2006. Seed oil content variation in *Jatropha curcas* Linn. in different altitudinal ranges and site conditions in H.P. India. *Lyonia* 11, 31-34.



# End module 2

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