Jatropha, retrospective and future development

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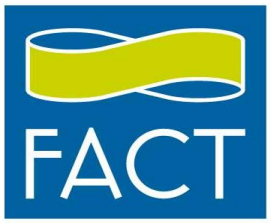
NB:
All Jatropha yields in this presentation are in kg. dry seeds!

statement



"if one doesn't know how to quantify, one may never expect to effectively accomplish the task"

1. Retrospective

- 1992-1997: Proyecto Tempate - Nicaragua
- 2005: Strong interest in renewable energy & biofuels
- 2005: Many claims were made
  - Some are individually right, but they were wrongfully assumed to be true in combination!

High yields	**Living fence**
Drought resistent	**Low input/ low maintenance**
Grows on marginal soils	**Erosion control**
No competition with food	**Resistance to pests diseases**

- 2007: FACT scientific Jatropha seminar
- 2005-2009: Start of many Jatropha projects

2. Findings

FACT finished Jatropha projects:

- Mali, Mozambique and Honduras (2006-2010)
  - New cash crop
  - Processing
  - Pure Plant Oil –fuels
  - Biodiesel
  - Rural electrification

Ongoing FACT Jatropha projects:

- Laos: Jatropha biodiesel
- Kenya: Jatropha presscake biogas

FACT Jatropha Research

- Yields
- Oil pressing
- Economics
- Intercropping
- Biogas

2. Findings/ production costs

Materials - Equipment
Seeds or seedlings
Land Prep/Plant Equip
Weeding/Pruning Equip
Fertilizer
Irrigation system
Irrigation water
Pest/Disease Control
Harvesting Equipment
Seed Processing/Storage

Labor
Land Preparation
Planting
Fertilization
Irrigation
Pest Disease Mgmt.
Pruning
Weeding
Harvesting

2. Findings/ production costs

- Example IRRIGATION
- System costs: $ 1000,- /ha → or $ 100,- /yr with 10 yr depreciation
- Water: $ 250,-/ year (500mm at 0,05 USD/m3)
- At $ 0,15/ kg seeds you already need 2’333 kg/seeds/ year to compensate these costs

- Example IMPROVED PLANT MATERIAL
- $ 0,50/ seedling*
- 1111 seedlings/ha = $ 556,-
- 3’703 kg of seeds need to recover these costs

- Example fertilization
- $ 100,-/ha
- 667 kg/ dry seeds to recover costs
- Removal of seeds/fruits results in nutrient losses (even when presscake is returned!)

- Pest and disease control
- $ 25,-/ha
- 167 kg/seeds to recover costs

- **Labour not yet included!**

*could come down to $ 0,15 with mass production

2. Findings/ Mali

- Rural electrification succesful

- Jatropha yield data:
  - 2 yrs old, 330 kg/ha/year (data Koen Buisman, 2005)
  - 3-4 years old plantations, 80 to 200 kg/ha/yr (FACT observation, 2010)
  - Expectation Mali Folke Center from 3000kg/ha/yr (2006) → 750 kg/ha/yr (2010)
- Field observation:
  - Jatropha not harvested, not profitable
  - Project so far runs succesfully on diesel

2. Findings/ Mozambique

- Jatropha yields lower than expected
  - Low yields, estimates indicate a maximum of 700 kg/ ha in the 5th or 6th year
  - Current yields are similar to Mali
  - High plant losses due to pests/ diseases
  - Majority now in hedges (living fences)

  - Tanzanian organizations came and bought seeds at $ 1,- /kg. Project is now without seeds!
  - Jatropha seed scarce now resulting in high prices, but future prices will likely be between $0,10 -$ 0,20.

2. Findings/ Honduras

- Jatropha so far no success

  Results in the 3d year:

  - Low yields (up to 398 kg/ha/yr in farmer plots)
  - Up to 535 kg/ha/yr in experimental plots with fertigation (photo)

- Soil humidity too high
  - Due to heavy rains, heavy soils
  - and water stagnation
- Farmers convert fields back into beans and corn
  - More profitable

2. Findings/ Honduras

5.3. Low Jatropha yields

During the design of the project, the Jatropha yields during the first years were expected to be several hundreds of kg of dry seed during per hectare during the first two years and more than 1 MT per ha in year 3. In practice one can observe great differences in yields of plantations with the same age, but even the highest yield (400 kg/ha in year 3) is not near the original expectations.

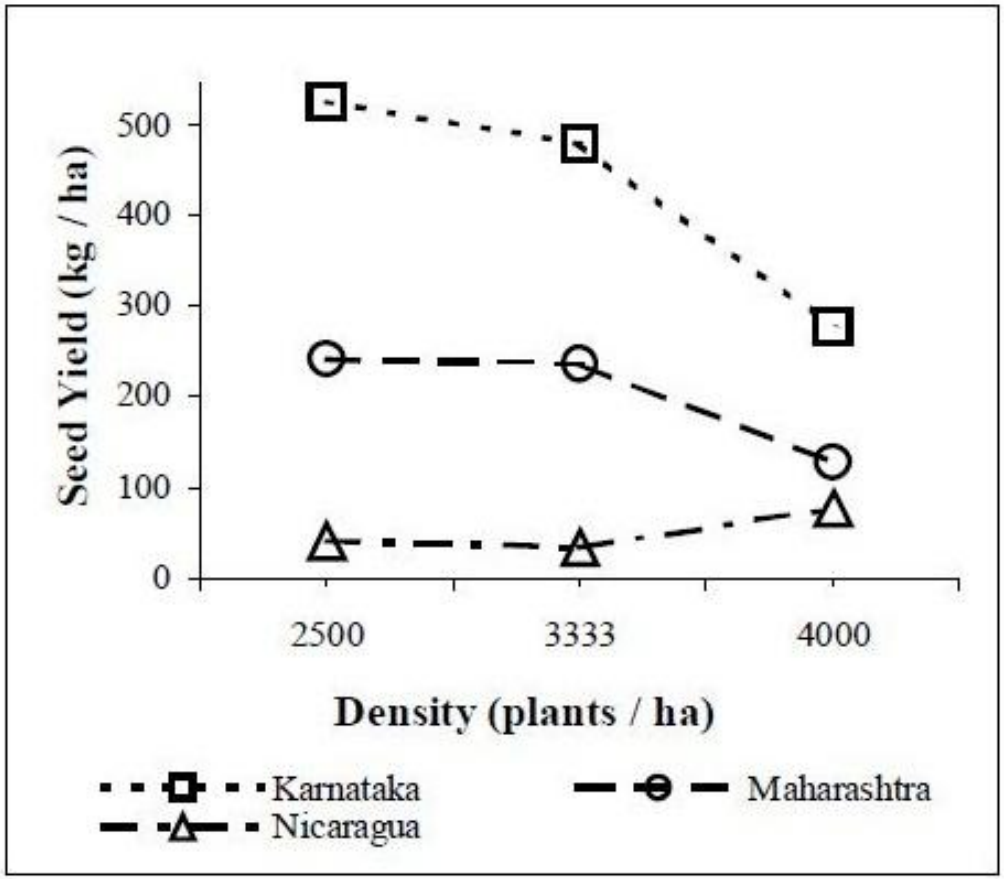
Table . *Jatropha production and yields per ha (in kg of dry seeds) in 2009*

NOMBRE DEL PRODUCTOR	AREA DE FINCA en has	PROCEDENCIA	Año de Siembra	VARIEDAD	PRODUCCION 2009 CANTIDAD KILOS	RENDIMIENTO kilos /ha DEL 2009
FHIA	0.50	Comayagua	2007	Cabo Verde	199.00	398.00
FHIA	1.00	Guaruma	2007	Cabo Verde	98.18	98.18
Miguel Angel Flores	1.20	Finca Flor Azul	2006	India Salvadoreña	217.73	181.44
Jimy Rafael Calix Minero	0.70	Finca Sarahi	2006	India Salvadoreña	172.27	246.10
Dionicio Mejia	0.60	El Rosario Locomapa	2008	India Salvadoreña	16.59	27.65
Grupo Pastoral	0.70	Roque Oloman	2008	India Salvadoreña	99.09	141.56
Isidro Machado	0.70	Victoria	2008	India Salvadoreña	30.91	44.16
Albino Amaya	0.5	Cuyamapa, Yoro	2008	India Salvadoreña	97.73	195.46
Juan Silverio Lopes	0.7	Chancaya, Yoro	2008	India Salvadoreña	32.72	46.74
Ramon Medina Garay	2.62	El Negrito	2008	India Salvadoreña	128.63	49.10
Jose Santos Hernandez	0.5	El Negrito	2008	India Salvadoreña	23.63	47.26

Source: *Own data Gota Verde.*

2. Findings/ India

- Study in Ecological Economics (Ariza Montobbio, Lele - 2010)
  - 450 kg/ ha / year (rainfed 3d year)
  - 750 kg/ha / year (irrigated 3d year)
  - Seed yields - year 5 at BAIF Institute – Karnataka - India (Dr. J.N. Daniel):



2. Findings/ India

Economics of Jatropha cultivation (in 3d year):

(Costs in USD)	Irrigated Electric	Diesel Irrigated	Rainfed
Initial Investment	175*	208*	161*
Annual Maintenance	182	213	71
Harvesting costs	37	37	36
Total Annual Costs	219	250	106
Price / kg	0,22 !	0,22 !	0,22 !
Yield	750	750	450
Gross Return	165	165	99
Net Return (disregarding initital investment)	**- 54**	**-85**	**-7**

- Data converted to USD from: Ariza Montobbio, Lele – Ecological Economics, 2010
- As comparison Irrigated peanut (one single crop cycle) has a net return of + 450 USD

2. Findings/ India

- Study 2010 Ecological Economics (Ariza Montobbio, Lele):
  - 82% of farmers were previously cultivating food crops on current Jatropha plots
  - Half of plots: Jatropha occupied more than 50% of total landholding of the farmer
  - Farmers are dropping out
    - 30 % removed Jatropha
    - 50% is not maintaining fields anymore

2. Findings/ GTZ Kenya

- Study: Jatropha reality check - November 2009
  - Best plots from 289 farmers assessed;
  - 63% reported pests and diseases;
  - Profitability monocrop convert to USD (lower estimate yields);

Table: Revenue Over 10 Years, One Hectare Monoculture Jatropha Plantation											
Years	0	1	2	3	4	5	6	7	8	9	Totals
Yield (kg/hectare)	0	7	136	183	230	279	326	373	420	420	2374
Farm Price (USD/kg)	$0,19	$0,19	$0,19	$0,19	$0,19	$0,19	$0,19	$0,19	$0,19	$0,19	$0,19
Revenue Total	$0,00	$1,39	$25,47	$34,27	$43,07	$52,33	$61,13	$69,93	$78,73	$78,73	$445,06
Table: Net Margin Over 10 Years, One Hectare Monoculture Jatropha Plantation											
Years	0	1	2	3	4	5	6	7	8	9	Totals
Net Result (USD)	-$165,78	-$118,92	-$59,48	-$56,29	-$66,90	-$46,55	-$40,36	-$34,16	-$27,35	-$27,35	-$643,14

  - Profitability monocrop convert to USD (higher estimate yields);

Table: Revenue Over 10 Years, One Hectare Monoculture Jatropha Plantation											
Years	0	1	2	3	4	5	6	7	8	9	Totals
Yield (kg/hectare)	0	7,41	135,85	190,19	380,38	760,76	950,95	1141,14	1368,38	1368,38	6303,44
Farm Price (USD/kg)	$0,19	$0,19	$0,19	$0,19	$0,19	$0,19	$0,19	$0,19	$0,19	$0,19	$0,19
Revenue Total	$0,00	$1,39	$25,47	$35,66	$71,32	$142,64	$178,30	$213,96	$256,57	$256,57	$1.181,90
Table: Net Margin Over 10 Years, One Hectare Monoculture Jatropha Plantation											
Years	0	1	2	3	4	5	6	7	8	9	Totals
Net Result (USD)	-$165,78	-$118,92	-$59,48	-$55,22	-$31,25	$23,34	$50,32	$77,31	$110,28	$110,28	-$59,10

2. Findings/ GTZ Kenya

- Highest estimated yields: 1’368 kg/ha/yr
  - Small scale farming
  - Trend → yields increase up to year 8
  - Monocrop, 8 yrs old, fertilized, well maintained:
  - Variation in yields 420 – 1’368 kg / ha/yr

- Conclusions / recommendations:
  - “we recommend that Jatropha should not be promoted among smallholder farmers as a monoculture or intercropped plantation crop”
  - “The only type of Jatropha plantation that we can recommend for smallholders at this time is the fence”

2. Findings/ Tanzania

- ICRAF (Economic analysis of JCL plantations in Northern Tanzania, Wahl *et al*., World Agroforestry Centre -2009)

- 5 year investment:
  - At 3000 kg/ha → NPV of $ 65,-/ha (= total financial gain)
  - At 2000 kg/ha → NPV of $ 9,-/ha

- Conclusion
  - For Northern Tanzania: “do not sacrifice scarce fertile land to a risky investment like Jatropha”
  - “Jatropha hedges, low in opportunity costs are a proven additional source of income ”

2. Findings/ profitability

- Average market price: $ 0,10/kg dry seeds
- 4 to 4,5 kg seeds for 1 liter of oil

- Production costs per liter oil (Mozambique – FACT project)

– Pressing	$ 0,36	31%	
– Transport	$ 0,22	19%	
– Seeds	$ 0,38	32%	**(at seed price 8,7 $cents/kg)**
– Profits	$ 0,21	18%	
– **TOTAL**	**$ 1,17**	**100%**	

- Production costs industrial scale (after Mitchell 2008)
  - Oil Extraction 14% / Transport 10% / Seeds* 55% / profits 21%
- CDM – biogas use can add $ 0,06/ kg dry seeds (see next slide)
- Maximum sustainable price for Jatropha seeds:
  - **Only** when CDM – biogas add extra value in the process chain
  - Seeds needed for oil ($ 0,16) + CDM/biogas bonus ($ 0,06) = $ 0,22 / kg
  - With reference fossil fuel diesel price of $ 1,17/liter (excl. taxes)

(*seed price $ 0,16/ kg)

2. Findings/ profitability

- CDM can add 2 $ cents / kg of seeds (FACT)

1 kg zaden	Replacement of CO2	
0,20 kg oil	0,63 kg CO2	Replacing diesel
0,80 kg presscake	0,32 kg CO2	(0,32 m3 biogas = 0,18 m3 methane–replace diesel)
3 kg hull	0,0	Not included/ not used
plant (roots-shoot)	1 kg CO2	Disregarding emissions due to land use change!
Total CO2 ± 2 kg	$ 0,03 (at $ 15/ t CO2)	Minus 33% overhead/ costs **$ 0,02**

Density methane: 0,656 kg/m3 – CO2 replacement: 2,8 kg CO2/kg methane

- Biogas production can add 4 $ cents/kg seeds (FACT)

1 kg zaden		$ Cents/ kg
0,8 kg presscake	0,400 m3/ kg	
0,32 m3 biogas	1,5 kWh/ m3 biogas	
0,48 kWh	$ 0,25 / kWh	$ 0,12
	Minus Production costs 70%	**$ 0,036**

Findings/ profitability

Many scenario's have been calculated, conclusion:

- Low input JCL cultivation – low costs, low yields
  → no profits or even losses
- High input JCL cultivation – high costs, high yields
  → Revenues not high enough to cover costs, losses especially in first years
  → On a 10 year investment, no or low earnings
  → With high inputs many alternative crops are possible, with higher earnings

→ FACT spreadsheets on profitability are available

→ Do you know a succesful business case (unsubsidized) please let us know!

3. Ongoing research

- Research
  - Domestication/ genetic improvement
  - Optimization of plant management (technology packages for small farmers)
    - Pest & Disease management
  - Added value in the chain
    - Jatropha oil processing (filtering, degumming, biodiesel)
    - Bio-refinery: Soap, Presscake, Biogas, Charcoal, Proteins, Chemicals, Construction materials,
    - Carbon offsets (CDM)
  - Yields & Economics
    - Input costs
    - Large scale plantation agriculture vs. Low input smallholder agriculture
    - Maximum seed prices that can be paid

3. Ongoing research: preliminary results

- Scientific studies
  - Low yields
  - Pests and diseases higher than anticipated
  - More inputs than expected
- Domestication
  - Effort to develop high yielding varieties
    - Backcrossing with other Jatropha species
    - Higher yields possible (but with necessary inputs)
  - Field implementation takes more time

Private research findings are not often shared!

4. Business cases

- Many initiatives failed and stopped
- Existing business still highly dependent on subsidies

- New project developments
  - Many based on unrealistic assumptions in economic feasibility studies

- Requirements that could make Jatropha feasible:
  - Low wages required (limiting implementation in Latin America!)
  - Lack of profitable alternative crops
  - Sufficient natural water supply
  - Irrigation generally too expensive
  - Low land prices
  - Relatively fertile land
  - High market prices for seeds or oil

4. Business cases

- Continued use of unrealistic assumptions
  - High yields (which we all hope for of course;-)

Años de la plantación	1	2	3	4	5	6	7	8	9	10	Promedio
Rendimiento (t/ha)	0.5	3.2	4.9	6.2	7.6	7.6	7.6	7.6	7.6	7.6	6

Tabla 14: Rendimiento promedio anual de la Jatropha
Fuente: SNV, 2009 - Comunicación personal

  - Low inputs, etc, etc.
- Business claims of high yields
  - Not independently assessed!
  - Using high inputs (fertilizer, irrigation, agro-chemicals, manhours)
  - Economic feasibility doubtfull

5. Development organizations on Jatropha

Increasing criticism:

- GTZ (see findings Kenya)
  - “we recommend that Jatropha should not be promoted among smallholder farmers as a monoculture or intercropped plantation crop”
- ICRAF (World Agroforestry Center)
  - “advises not to sacrifice scarce fertile land to a rather risky investment becaus of insecure prospects…”
- Friends of the Earth:
  - ‘It is shameful this so-called “wonder crop” is replacing food production in a country where two-thirds of the population depend on food aid,’ - Hannah Grifi – 2010

6. Future developments

- Increasing market value of Jatropha?
  - Peak oil leading to higher PPO prices
  - Bio-refinery
    - Higher prices
    - Potential Nutrient losses
  - CDM
  - Use of residues
    - Presscake (detoxification)
- Reducing production costs
  - Improved varieties
    - Higher yields
    - Better harvest index
  - Mechanization
  - Uniform ripening

6. Recommendations - research

- Continue with well maintained research plots
  - Research into inputs, yields and profitability
  - Investigate relation plant age and yields
  - Mechanical harvesting/ uniform ripening
  - Intercropping
- Jatropha processing
  - Filtering, degumming,
- Biorefinery research
  - Detoxified seedcake as animal feed
  - Proteins
- Economical feasibility of Jatropha
  - Peak oil might lead to higher market prices for seeds
  - CDM, nutrient losses and fertilizer needs, biogas, etc.
  - Economic feasibility of biorefinery

6. Recommendations – implementing projects

- Avoid risks for farmers!
  - Pay them to grow / maintain Jatropha for research (when yields are not sufficient)
  - Engage farmers only when there is clear evidence that Jatropha is profitable

- Put large scale developments on hold untill there is significant evidence of economic viability!

Thank you for your attention.

Please let me know your Comments – Questions

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