EUROPEAN COMMISSION
RESEARCH DIRECTORATE-GENERAL

Directorate E – Biotechnologies, Agriculture, Food

Report:

Expert Meeting Jatropha, Brussels 07/12/07

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Scientific officers in the European Commission: Hans-Jörg Lutzeyer, Piero Venturi

1. Introduction

On the 7th of December the Directorate General Research of the European Commission organized a expert meeting in Brussels with the purpose to exchange knowledge on the recent developments that take place in biofuels and particularly in Jatropha. The meeting further aimed to discuss to what extent research supported by the EU could contribute to sustainable development of *Jatropha curcas*.
A brief background paper was produced (Annex 1) and a number of experts invited (Annex 2), three of whom were asked to give presentations. The papers presented at the meeting as well as those provided as contribution to the workshop are attached (Annex 3). The papers were authorized by the authors to be published on EU-AgriNet (http://ec.europa.eu/research/agriculture/events_en.htm). This report gives a brief outline of the presentations, the discussions and the recommendations.

2. Development of the Meeting

Morning Session

Tour de Table

Due to the short time of preparation not all senior experts on Jatropha could attend. The group consisted of a mix of Jatropha experts, a number of researchers for specific areas (Fraunhofer Institute), Industry (Bayer) and European Commission staff. The meeting was chaired by Hans-Jörg Lutzeyer, EC, DG Research

Presentation of the EU Policy Framework Agriculture and Biotech activities in the FP7 Piero Venturi, EC, DG Research

In this presentation the seventh Framework program (FP7) was explained with respect to the biomass and biofuels R&D: what are current activities and how is it organized, what is the available budget, what do the strategies and plans look like. The EU fosters the R&D in biomass crops and forestry, the bio-refinery concept to increase crop output, and supports the evolvement of strategic industry-led *Biofuels Technology Platforms* to bring about strategic research agendas. This meeting can be considered a specific expert consultation to get precise ideas about specific research issues in preparation of the work programme.

Presentation of Reinhard Henning, bagani consult

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The presentation of Mr. Henning included mainly 5 points:

1. The Jatropha plant;
2. The Jatropha activities (1987 – 2007) of Mr. Henning;
3. High yielding plants;
4. Ecology Aspects;
5. Economic Aspects;

The objective of the presentation of Mr. Henning, besides introducing the plant and worldwide Jatropha activities, was to show how the economic feasibility depends on the selection of high yielding plants for Jatropha plantations.

It is very clear, that plants from seeds have a large biological variation and that it is necessary to select high yielding plants and to multiply them vegetatively (by cuttings) to get an economic feasible production rate of fruits per ha. It is also important to consider an optimum spacing of plants, depending on water and nutrient availability and operational aspects, like planting at a distance, which allows people to pass between the plants to harvest them manually.

Fruits and flowers on a high yielding, early fruiting tree (7 months old) in Cambodia

The plant

Jatropha (*Jatropha curcas* L.) is a multiannual plant which grows for more than 50 years. It is not known, until which age the production of seeds is economically feasible.

It is a small tree or big bush which grows up to a hight of about 6 m. The plant resists to long periods of drought (7 to 8 months in Mali) with a rainfall of more than 600 mm during the rainy season, but can also grow well in a tropical climate with permanent rainy conditions. The flowering is permanent during the rainy season. Since the fruit development takes 4 months, ripe fruits are developed until about 4 months after the end of the rainy season.

Many figures concerning the economic calculation of Jatropha curcas L. as a crop for non-edible plant oil are not very well established. Many non-realistic and too optimistic figures are published in the internet, just to make Jatropha presentable in a business plan for investors.

Planting density and yields

During a Jatropha conference in Wageningen in March 2007, experts agreed on a general acceptable production yield of 3 to 5 metric tons of dry seed per ha (of plantations in full production).

The optimal tree density is close to 1300 plants per ha. A density of 2 500, as mentioned vey often, seems to be to high. Grown-up plants (3 years and older) don’t allow people to pass between the plants to harvest the fruits. A distance between the rows of 3 m seems very important, which gives a number of plants per ha of 1 300, if the distance of the plants within a row is 2.5 m, and 1 700 plants, if the distance within a row is 2 m.

Harvesting

The economic feasibility of Jatropha oil production depends very much on the manual work needed to harvest the fruits (seeds). Under conditions of a long rainy season, harvesting has to be done manually, because fruits are continuously ripening – a problem for any mechanical harvesting. However, if water availability can be controlled a more uniform ripening can be achieved, eventually mechanical harvesting like with coffee in Brazil could be an option.

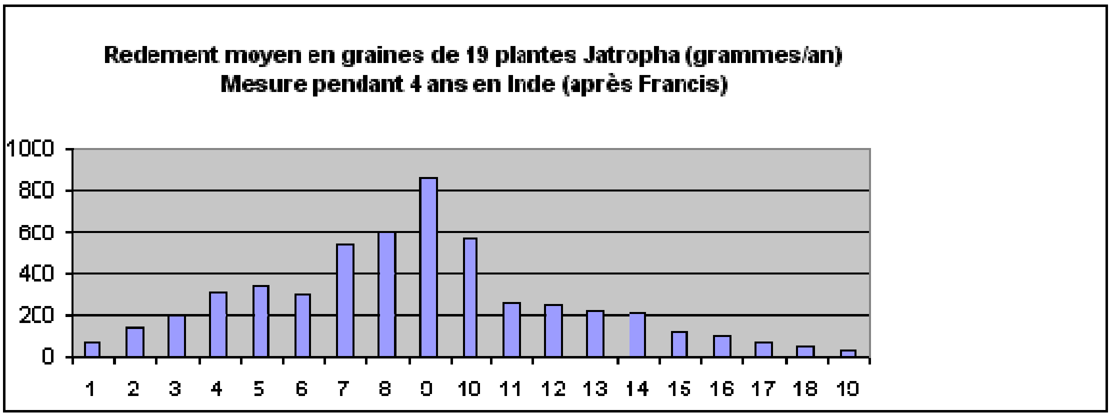
Harvesting operations are much more efficient with high yielding varieties, much more fruits can be collected per working hour.

Maintenance of the plants/plantations

The yield of a plant depends mainly on the number of branches and on the genetics of the plant. The number of branches is important, because the inflorescences develop only at the end of branches. To improve the number of branches, the plant has to be pruned. If a branch is cut back, 3 to 5 new shoots will be developed below the cutting. This process can be repeated all 6 to 8 weeks in the first 2 to 3 years. The result will be a very bushy plant with many branches and many fruits, if the genetic basis of the plant allows.

High yielding plants

If a plantation is grown from randomly sampled seeds, all plants will be different. Only few will be high yielding, most low to medium yielding plants, following a normal distribution (see table below:)



Only 1 plant out of 19 plants has a good yield. To establish a good yielding plantation, these good yielding plants have to be identified and multiplied.

Plant multiplication

The multiplication of plants can be done by seeds, by cuttings and by tissue culture.

It the plants are multiplied by seeds (the simplest and cheapest method), genes are recombined. The resulting plans will have a big variation in yield (see high yielding plants). However, a breeding programme with targeted pollination could lead to elite varieties.

Under current conditions, vegetative multiplication of high yielding individuals is the first choice. To make sure, that new plantations are high yielding, good yielding plants have to be identified and need to be multiplied vegetatively (like fruit trees) by cuttings or by tissue culture (like oil palms).

Multiplication by cuttings is a very easy, but also a very slow process. If large plantation have to be established one plant will only lead to about 100 to 500 new plants (clones). The clones will have the same yield as the mother trees.

If tissue culture can be applied, one selected plant can give rise to thousands of new clones. However, up to now no laboratory is known, which could handle tissue culture for Jatropha.

Some economic estimations:
This table shows (if opened as a file on the computer to work on the spread sheet) the key factors of the costs of oil production: price of Jatropha seed (this price depends on the time needed to harvest a certain amount of seeds). The costs of investments (local price of expeller) does not play an important role in the economy of oil production.

Economic estimation of JCL oil production in Cambodia (Mr. Hak, Banteay Meanchey)

Installation costs of plantation as well as storage and transport are not considered

Basic data

Working hours per day:	8	hours/day
Working days per week:	5	days/week
Working weeks per year:	45	weeks
Working days per year:	225	days/year
Minimal wage per day:	5000	Riel
Minimal wage per hour	625	Riel
Exchange rate for 1 USD:	4000	Riel
National currency:	Riel	Riel
Price of Jatropha seeds per kg	380	Riel/kg
Extraction rate with mechanical expeller:		
(kg seeds for 1 liter of oil):	4,55	kg of seed / l of oil
Diesel consumption of expeller	2,00	liter per hour
Extraction capacity of expeller	250	kg seed per hour
Extraction rate of expeller	22	%
Production rate of expeller	55,00	liters oil per hour
Working time to extract 1 liter of oil with expeller	0,04	hours
Persons working with the expeller:	2	persons
Misc. time for oil extr. (buying spare parts, transport of seed & oil, etc)	0,25	hours/liter
Local price of expeller (1500 USD, Hak bought from nephew):	6000000	Riel
Depreciation of the expeller per 1 liter of oil:	135	Riel
Actual diesel price:	3200	Riel
Life time of expeller	10	years

Cost of oil production with expeller (without plantation, storage & transport):

Purchase of seeds + cost of working time extraction 1 l oil + depreciation	**2040,80**	**Riel**
	0,51	**USD**

Research priorities

1. **Identification of high yielding plants worldwide;**
   the knowledge of such plants is important to establish gene banks as a source of germplasm for the establishment of high yielding plantations;
2. **Establish the technology of tissue culture multiplication of Jatropha plants;**
   this technology is successfully applied in the improvement of the yield of oil palm plantations in SE Asia and Africa;
3. **Establish plantations of high yielding plants and measure the yield per ha;**
   the establishment of such plantations gives the basis for future research on the correlation of yields and agricultural basic inputs, like water and fertilizer;
4. **Selection of plants with high oil content in the seeds;**
   in a second phase of research, plants within the population of high yielding plants have to be selected, which have a high oil content in their seeds;
5. **Selection of plants with a high natural ramification capability;**
   the number of branches determines the yield of the Jatropha plants. The long term objective of research has to be to find plants which have the genetic basis, to produce well ramified plants to reduce the workload of pruning the plants.

The presentation was well appreciated as it provided a basic knowledge on the history and state of the art in Jatropha. After the presentation some questions were raised about the details.

Presentation of the Wageningen Agricultural University by Raymond Jongschaap

The presentation was based on a recent publication of the same R&D group (Plant Research International) called *Claims and Facts on Jatropha curcas L.* All claims found in gray and official publications and internet on Jatropha were summarized and next argumentation and facts were given to qualify or disqualify the claims. After the presentation many questions were raised and some more ideas on R&D issues were gained.

State of the art on breeding and genetic improvement of *Jatropha curcas* L.

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Figure 1 Wageningen UR - Plant Research International presentation at Expert seminar *Jatropha curcas*, EU DG Research, Brussels, December 7th, 2007.

Summary of presentation

J. curcas is a wild species and its genetic base and global distribution are unknown. Where Central America seems to be the region of agricultural genetic diversity and the base from which the species has spread over the world, there are serious indications that *J. curcas* natural distribution area can be found in the Northeastern part of South America (Brazil). Traditional uses of Jatropha curcas include functions like erosion control (wind, water), living fence, herbal medicine, soap, fertilizer, and as a pesticide or repellent.
The lately introduced role for *J.* curcas as a serious candidate for bio-energy production on marginal soils in tropical regions (30 N, 35 S), seem to be hyped and based on a variety of claims (Table 1 and Table 2), which in combination with a function of high oil production are **falsified** by Jongschaap *et al.* (2007).

In general, there is a tendency to extrapolate *J. curcas* potentials by multiplying observation from singular, elderly *J.* curcas trees to plantations on a per hectare base (neglecting competition effects and increased susceptibility to pests and diseases). This leads to enormous overestimations of the crop's potential. Expectations are further increased by extrapolating these results to the millions of 'available' hectares of marginal lands, thereby neglecting sub-optimal growth conditions (water availability, soil fertility and soil (chemical) properties) in relation to (oil) productivity. If these 'waste' or marginal lands actually are available or occupied by other land use and people, (land tenure) is another difficult issue. Competing claims for land and its resources can be expected.

Table 1 Claims on J. curcas: good for People and Planet?

People	Planet
▪ Enables local / rural development ▪ Generates income ▪ Does not compete with food production	▪ Reclaims marginal soils ▪ Conserves, protects and improves soils ▪ Protects against erosion ▪ Production of CO_2 neutral bio-fuel

Table 2 Claims on J. curcas: low inputs and high outputs, thus highly profitable?

Profit	
Low input	**High output**
▪ Low nutrient requirements ▪ Grows well under saline conditions ▪ Drought tolerant ▪ Low water use or high water use efficiency ▪ Requires low labor inputs ▪ Tolerant or resistant to pests and diseases	▪ *J. curcas* is an energy crop ▪ Grows seeds with high oil contents ▪ Provides oil of high quality ▪ Provides high oil yields

It is argued that the various claims may be **correct** for traditional use of *J. curcas*, with regards to inputs and requirements and environmental effects. However, in combination with high oil yield production, these claims seem to be **incorrect** with regards to the required inputs (water, fertility and labor), and susceptibility to pests and diseases (mono-crop, plantations).

Current research on Jatropha curcas

The focus on *J. curcas* has never been on oil production so far. At the moment, there is a clear lack of benchmark descriptions (Genetic variability (G), Environment (E) and Performance (G x E)). Furthermore, there is a need for integration of the available scattered knowledge on, and experiences with, crop performance of different *J.* curcas provenances in different environmental settings and under different management interventions.
It is assumed that current research issues comprise the search for elite (high producing) *J. curcas* accessions, a search for agronomic optimizations and genetic improvement for specific locations. At the moment, there is no scientific evidence (available) for the existence and performance of elite (high producing) *J. curcas* accessions. Current (advanced?) research is not visible and not publicly available, but apparently owned by a few private companies who have no intention sharing it.

Beside the sustainability issue (removal of nutrients), important (research) issues are 1) *J. curcas'* genetic base, 2) Viable crop production systems and 3) The relation between 1 and 2, and yield components on an area base (oil yield or raw material per ha).

In Table 3 research issues of the workshop are presented and categorized in sustainability issues, genetics and breeding, agronomics and productivity research.

[Remark: I could not make out the tags / stick-ups from the photographs, please fill in Table 3 accordingly].

Table 3 Research issues (no particular order!) raised at the Expert seminar on *Jatropha curcas*, DG research in Brussels, December 7th, 2007.

Sustainability	Genetics/Breeding	Agronomics	Productivity

Priority areas for EU research

To integrate the scattered experience and observations on *J. curcas*, priority research areas may include the characterization and preservation of the genetic base and to link it with crop characteristics (especially yield components) that define oil production on an area base.
Yield components research may be plant specific, such as dry matter distribution, female-male flower ratio, seed size, seed oil content, oil quality and toxicity.
Additional research should focus on oil production on an area base, such as number of branches, number of flowers, number of fruits, number of seeds per ha. The timing component should also be priority research, such as for flower induction and synchrony in maturing to enable mechanical harvesting.
For the above, it is essential to characterize sustainable and viable production systems for large scale (bulk) production for and small scale production (enhancing rural development and alleviating poverty).
Furthermore, attention should be given to low or non-toxic *J. curcas* accessions, for which the protein rich by-products (press cake) will have multiple applications, such as animal feed and/or other valuable components through the bio-refinery concept. Research into low or non-toxic accessions may be focused on Mexican *J. curcas* accessions, or in GM-techniques, such as tilling (knocking out) responsible genes for toxicity.

Questions and remarks

The below questions and remarks were made, which have been integrated in the summary given above where possible, and have been provided to Winfried Rijssenbeek / FACT / the Netherlands for the overall summary

1. (Dr. Hans-Jörg Lutzeyer / EU DG Research / Brussels) In earlier days, large institutions such as CGIAR or CIRAD have taken the responsibility for acquiring a knowledge base and research on specific crops like e.g. coffee, cacao and oil plants. Is (1) something similar possible or likely to happen with *J. curcas*, or (2) is a more consortium like approach desirable?
See answer by Dr. Hans-Jörg Lutzeyer / EU DG Research

2. (… / Italy) Recent (unpublished) studies show that there is a large variability in *J. curcas* seed circulating in the world. The genetic base of the so-far researched provenances seems small.
True observation, and as long as the genetic base of *J. curcas* is unknown, and more insight is lacking in available genetic diversity, it is difficult to place the scarce observations on crop performance.

3. (… / Italy) Patents on molecular marker techniques, such as AFLP may impede the research development process of *J. curcas*. However, more molecular marker techniques are available.
True, although AFLP is widely known and applicable throughout the world, the use of other techniques may obtain the same results.

4. (Prof. Dr. Harinder Makkar / University of Hohenheim / Germany) By researching 23 provenances from India, a small genetic base was found; however, the expression of the genes was highly variable and is not understood, even within fields.
This is a large problem, and a reason to 1) continue the search for genetic variability in places of origin, 2) maintain and protect it and 3) to provide freely to interested

5. (Dr Ajay Koli / IRES / UK) In AFLP / RAPIDS analyses of 36 *J. curcas* provenances from all over the world, it was found that the genetic variability is low. Inter specific hybridization seems the way forward.
The (*J. curcas*) world is waiting for these kind of observations and results, with good benchmark descriptions, to benefit those working with the crop.

6. (Dr Ajay Koli / IRES / UK) How long can we stick to the thought that because of *J. curcas*' toxicity it will not compete with food production?
This argument cannot be maintained for long, as soon as the production of *J. curcas* oil is economically viable, it will definatley compete with food crops and will put an extra demand on (natural) resources.

7. (Reinhard Henning / Germany) As a crop *J. curcas* looks a lot like coffee. Can we take advantage from earlier research in coffee?

8. (…) How much is known on *J. curcas* breeding and its success?

9. (…) Why do we only look at *J. curcas* oil and not at *J. curcas* whole plant production?
One of the key elements of *J. curcas* is its perennial growth on marginal areas. This means that the removal of all biomass with its nutrients may deplete soils to an extent where even *J. curcas* will not survive anymore. By removing the oil (only), soil fertility can be sustained if nutrient cycling is secured, e.g. by leaving crop residues in the field and by returning press cakes to the soil.

10. (Dr Rainer Janssen / WIP renewable Energies / Germany) From the Ouagadougou workshop in Burkina Faso, several questions were raised by farmers: a. What soil/climate conditions are optimal b. What is the oil content of the seed c. What technologies are available for seed harvesting d. What to do with the oil
For a) and b) and other crop requirements, see Daey Ouwens *et al* (2007): http://www.fact-fuels.org/media_en/Position_Paper_on_Jatropha_Curcas) and Jongschaap *et al*. (2007): http://www.fact-fuels.org/media_en/Claims_and_Facts_on_Jatropha_-WUR). Seed harvesting is done by hand, as mechanical harvesting is impeded by asynchrony in maturing seeds. Oil can be used directly as Pure Plant Oil or, through transesterification, converted into bio-diesel.

11. (Dr Ida-Bagus Kesawa Narayana/ Frauenhofer / Indonesia) We are looking at *J.* curcas for dry area development in Indonesia. How drought tolerant is *J. curcas* exactly? What is the relation between drought and (oil) productivity of *J.* curcas? Are there any accessions that do better than others?
To survive, J. curcas requires at least 300 mm year-1 and to produce seeds it requires at least 600 mm year-1. Relation between rainfall and productivity depends on soil properties as well. Although Jatropha is seen as a plant which can grow on marginal and dry soils it produces better on good soils and with good rainfall and fertilizer; i. e. if the side effects of Jatropha plantation, like erosion control, are to be used, Jatropha can be planted on marginal soils. But if Jatropha is used as a cash crop to produce seeds (and oil), marginal soils are too poor to asure a good production rate. Then Jatropha should be supplied with enough water and fertilizer (no input – no output). So if the Government of Indonesia wants to use the dry zones, it can plant Jatropha in areas with more than 600 mm of rainfall (better 800). But it should be made sure, that the genetic properties of the plants are good, otherwise they cannot produce a good yield, even if the soil and water conditions are good.

12. (Winfried Rijssenbeek / FACT / Netherlands) Focus should be on studying intercropping systems (what crop, timing and pruning): is there any genetic reaction of *J. curcas*? Same for symbioses of *J. curcas* with (nitrogen fixing) *Trichodermae* and *Mycorrhizae*.

There is a clear distinction between large scale and small scale production systems. Both systems will have their pros and cons, e.g. for the bulk production of bio-fuels, or for rural development and poverty alleviation. Intercropping systems look promising to overcome the unproductive years, and to more easily integrate *J. curcas* in traditional production systems.
The symbioses of *Trichodermae* and *Mycorrhizae* seem promising on those soils lacking nitrogen, a characteristic of many of the marginal lands that are foreseen for *J. curcas* production.

13. (… / … / …) Is *J. curcas* a global cash crop, and if 'yes', will it loose its properties to respond to local circumstances (drought tolerance etc.), once fully domesticated?

At the moment *J. curcas* is not a global cash crop. However, the rate of interest in the crop is so high that *J. curcas* may become such a crop. Proper care is needed to guide the development process and to avoid degeneration of the genetic base, which may be a problem for a cross-pollinating species, such as *J. curcas*.

14. (... / … / …) Is there any analogy with rapeseed development with regards to its toxicity?

15. (Hasan Giire / Awdal Development Organization / Netherlands) Knowledge on *J. curcas* is so little, and the information that is known, seems to be 'trapped' in European (research?) institutions. How can we create (local) knowledge centers for local development and exchange?

16. (… / … / …) What is the comparative advantage of *J. curcas* over other crops like castor (*Ricinus communis*) or *Euphorbia*?

See Table 1 and 2 with remarks in combination with oil production

17. (… / … / …) With regards to the sustainability issue of returning press cake and crop residue to the soil: what effect does this have on soil flora and fauna?

It is assumed that phorbol esters decompose within 6 days (Jongschaap *et al.*, 2007), but the effect on soil flora and fauna is not known.

18. (… / … / …) If press cake and crop residues can be used as bio-pesticide (see above), what options do we have for other plant components, like curcins?

The bio-refinery concept, in which plant components are singled out and utilized, seems to be an economically viable option to increase the use of *J. curcas* considerably. However, as soon as the plant is used for more than oil production alone, sustainability issues for the removal of nutrients are at stake.

References

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Afternoon Session

Presentation Global Position of Jatropha, by Winfried Rijssenbeek, FACT

The presentation touched on a number of topics: Global position of Jatropha, Competitiveness of Jatropha, Utilization routes, and Sustainability criteria. After the presentation many questions were raised. They are discussed briefly hereunder.

How would the second generation biofuels (biomass celluloses and hemi-celluloses conversion to sugars and then to ethanol) influence the position of Jatropha? Can Jatropha compete with that conversion and /or can it be used as a feedstock in that process? In the discussion following, it became clear that the costs for the Jatropha oil are found to be between let's say 0.45 to .55 USD/liter, so not very low compared to similar crops or current ethanol production costs.

Jatropha might be used as a short rotation biomass crop (harvesting of all biomass every year or two years), but no testing of such crop management system has been done. It should be noted that fast growing biomass systems can yield up to 50 to 100 tonne of dry matter/ha /yr using high inputs. This dry matter can be converted to liquids, thermally (o.a. Fischer Trops) or biologically (enzymes). Currently these conversion paths are in in a R&D stage. However, solid biomass can currently be used directly in thermal power stations (co-fuelling with coal or single).

In China Jatropha is grown on higher altitudes. After checking with Prof. Harinder Makkar, it was found that Jatropha is grown in the southern part of China at 800 to 1200 m above see-level. This is possible due to the effect of the massive plateau of Himalaya on temperatures. This effect makes that temperatures are higher in that area than normal. The temperatures are said to range from 12 to 30 degrees C. Jatropha can normally grow on higher elevations, but growth and productivity seem less (Experiments by OCTAGON in Guatemala, 2005).

Professon Harinder Makkar supported the observation that normal oil crops have seed cake as a high value end product; Jatropha has not as it is toxic for animals. Detoxification efforts and initial results show that detoxification is possible, but work is to be done to make this an economically viable route. Operating costs in China of Jatropha were quoted to be 400 USD/ha, while in India it is 200 USD/ha. Costs depend very much on the expected yields, as picking the fruits contributes substantially to this cost. For high yield Jatropha production cost have been calculated as 230 USD/ha/yr using the country conditions of Mali. It should also be said that if labor costs are more than 2 USD/day, the feasibility of Jatropha production dwindles. Production systems have therefore to be checked against any risk to include child labour or other enforced systems of cheap labor.

The note on the fact that Jatropha as a new plant is at an early stage of development and that it can be yielding much more in future, is correct. R&D will however take time, and R&D on other oil crops can still make those crops produce more over the same time. For oil palm it was mentioned that there are certified hybrids that can yield 10 tonnes of oil/ha /yr at peak production. Jatropha highest yields seem to be around 3 tonnes/ha after 3 years. But this figure (from OCTAGON, 2007) is yet to be verified independently.

It was noted that Rapeseed also started as an industrial crop, but that its oil also was processed to become edible. Indeed the issue is not looking at energy only, but taking the concept of bio refinery, producing value added products for different markets (cosmetics, plant protection, polymers, etc). An example was mentioned of high quality phorbol esters, fetching a price of 2000 US$/gram? (to be checked).

According to Thomas Ziegler of Bayer, Jatropha crop protection needs were considerably less than other cash crops. At the start 35 USD was mentioned to be needed, once the canopy is closed a value of 17 USD/ha/yr was used. This was found to be a little on the low side, when compared with figures of 80 USD/ha/yr given for Nicaragua by N. Foidl during the Jatropha Seminar in Wageningen, March 2007. In Nicaragua fungus attacks entering the pruned branches seemed to be major problem.
Dr Ayay from IRES, commented that the flowering periods are not well understood and that proper attention should be given to this issue. It is correct that Jatropha, if high input cultivated (using irrigation, optimal nutrient inputs), can produce continuously and therefore make harvesting time consuming. One peak harvest period might be more interesting.

Discussion on R&D needs in Jatropha and need or possibility for an EU role.

First Hans-Joerg.Lutzeyer lined out the reasons why the EU might be interested to link or to support R&D activities in Jatropha. Next, a round was made in which participants could comment. The participants were requested to mention their views on networking and R&D topics.

Diego Breviarion noted that from preliminary R&D, it is found that the genetic variation of Jatropha is not so wide, however the phenotypes are quite different in character. He suggested that gene expression studies are needed. Since this phenomena is unusual, the EU can be challenged to work on this.

A number of participants noted that not only the detoxification of Jatropha cake is an important issue to work on, but also to optimize the use of other products (including the toxic substances).

According to the Thomas Zeigler Jatropha could be made an industrial crop, if politicians are interested “to do so”. Such R&D to improve yield levels and tackle the toxicity issue would require a long term effort (12 to 15 years).

Ayay Kohli presented his University of Newcastle and its associated organizations to be implementing R&D, and further expand R&D in the breeding aspects, agronomy of the plant, and LCA. The Jatropha flowering system is a major hurdle to be understood. The university already has cooperation with other EU institutes, as well as with Indian partners.

One of the participants suggested that Jatropha R&D could also be taken on as a model for an R&D approach of a wild plant brought to a commercial crop. Since Jatropha is basically a wild crop, it could be conceived as an example for other wild but promising crops not studied and improved yet. The model should thus include the high tech approaches that are available today, the cooperation and networking between R&D institutes, etc..

Axel Kraft noted that a network in Jatropha exists already, and can be furthered. What is needed to find out is whether there is a viable market, what is on the ground really. There is a lot of talk but acreages are not big and the oil is not easy to get. In R&D there are three regions Latin America, Asia (R&D in India and China) and Africa. It seems that in Africa R&D is not so much developed.

Dieter Janssen, WIP made a clear remark on the R&D needs for Africa. He focused on the special R&D needs for Africa.

Dana Bacovky indicated that there are clear differences in R&D needs, if you compare Jatropha for small scale farming and use with large scale biofuels production. It might be leading to different R&D agendas.

Hasan Girii stressed the needs for biofuels in Africa: the climate and soil conditions favor Jatropha to be produced in Africa (some are planning to grow it in the South of Italy or Spain or Portugal). There is a need for African R&D on the plant to make it a vital crop for Africa, as this region does not have easy access to fossil fuels.

Gerassimos Apostolatus of the EU said a lot of information is available. He recommended to look at R&D centres in Brazil (EPAMIG, EMBRAPA) India, Nigeria and Kenya and China. USAID (University of Florida) has already produced many publications on the topic. So possibly the focus might be more on systematization of R&D and demonstration of the technology.

Hans-Jeorg Lutzeyer rounded up the first round by explaining how R&D on Jatropha would fit the 2 policy objectives of the EU:

1. Since the EU objectives for biofuels are quite ambitious it is essential to make sure a broad range of technologies and biofuel sources are available to minimize competition between food and fuel and to avoid price peaks for certain fuel sources. Jatropha is obviously an under researched plant, it has both a potential as biofuel source and a plant to foster development of marginal rural areas to alleviate poverty;

2. The Millennium Development Goals are clearly aiming at poverty reduction, employment generation, etc.. Jatropha has a potential as a small farmers crop that can be used directly in the community as well as on a national or export scale. This potential requires also R&D to optimize the crop in the local farming systems and have sustainable yield.

On the first notion some comment was made that it is doubtful if we in the EU will be able to get the biofuels from Asia or Latin America, as Asia has its own ambitious targets and Brazil is already aiming to deliver to the USA, and Japan. If the EU wants to get its share it might be wise to bring in investments, and technology. Africa is the likely continent to look for biofuels, but care should be taken as sustainability might be foregone by investors, aiming to reduce costs.

On the second objective it was found that this might require other research priorities (agronomic practices using e.g. intercropping, low input, local seed selection, local oil pressing technology, small scale uses, in genetics, breeding of more resistant plants, using less water, fixing of nitrogen, etc..) Large scale export oriented production would require reducing labor input in harvesting, mechanization of pruning, weeding, in genetics, aiming at shortening crop periods, higher oil contents, consistent yields, and propagation systems. Aya gave an example of India where the crop was used as a fertilizer to restore soil fertility enabling small farmers, normally engaged as labor to big farmers, to grow crops on their own land. The period here was not first year yield, but improvement over the 5 to 10 years.

It was further repeated that Jatropha is to be seen as a raw material producing crop and that energy is only one of its applications (high volume market, but low price). Again it was said that only if politicians aim at strategic research investment into Jatropha, it can become a potential commercial crop after some 10 to 15 years.

Cards with R&D priorities

The participants were requested to put down their R&D priorities on small papers so that they could be put on the wall and a tentative analysis be made.
It seemed that the priorities could be grouped into four items

No	Sustainability
1	Understanding Jatropha influence on food production
	Study Jatropha agronomy under conditions of poor soils and poor climatic conditions
	Study Jatropha using good (agricultural) soils and conditions
	and see how it influences food production
2	Set -up a local knowledge centre on Jatropha: agronomic practices, propagation, etc..
3	Cooperate with Embrapa as an R&D centre that has done work on Jatropha before
4	Make Jatropha C. a local crop
5	Improve the energy efficiency of fuel production from Jatropha (efficient. presses, use of biogas out of cake, etc..)
6	Analyze total utilization strategies
7	Cooperate with African Countries to ensure sustainability using local criteria for small scale production
8	Research plantations in Africa and creation of a data base on Jatropha

No	Agronomic practices
1	Disease and pest resistance and biological control
2	R&D on Jatropha oil quality variations

3	Intercropping: plant competition in plantations
4	Study the variability between individual plants in terms of yield and between crop stands
5	Study mechanical harvesting
6	Study the yield under different climatic and soil conditions (in Africa)
7	Research on pest and diseases
8	Plantation size and objective: small scale for rural development versus large scale for oil
9	Best cropping systems with Jatropha (which intercropping best and how)
10	Improved plantation schemes e.g. agro forestry
11	Characterize sustainable viable production systems with Jatropha
12	More understanding Jatropha production yield response to growth factors
13	Micro propagation
14	Costing of Jatropha different schemes of production and uses of products [1]
15	CDM issues and potential studies[1]

No	**Raw Material**
1	Detoxification procedures development
2	Toxicity: economics of processes (e.g. 121 dC for 30 min)
3	Biogas production from by products (energy and fertilizer)
4	Utilization of the fruit caps
5	Investigate pesticides and repellents use of Jatropha
6	Biomass utilization in composites, natural pesticide composite
7	Jatropha oil utilization
	Coatings and thermoplastics
	Fine chemicals
	Specials
8	Detoxification of cake and other uses
9	Improving Jatropha based fuel for better CFPP (cold filtered plugging point) and viscosity
10	Pharmaceuticals identification and extraction
11	Using Jatropha oil for painting glue and polymers
12	Toxicity issues: does it remain in polymers, after refining after heat treatment 60 or 180 to 240 DC
13	Total crop utilization
	leaves for gasification
	oil seeds for biodiesel
14	Enzymatic conversion of Jatropha oil to partial glicerid biodiesel
	currently similar production plant under construction in Brazil (company Vital)
15	Use of present Jatropha oil for biobased diesel (almost identical to conventional diesel by:
	Hydrogenation
	catalytic (thermal) processes

No	**Genetic breeding**
1	Reduce variability (increase uniformity)
2	Higher productivity and yield and improved oil content using genetic improvement
3	Inventory genetic data base
4	Seed: original and germplasm bank
5	Improvement on drought tolerance for desert area with gen. engineering
6	Provenance trials:
	with selected accessions

[1] added from prof Makkar's presentation

	with improved accessions
7	Characterize saline and drought tolerance and low water use and exploit this for other crops
8	Identify molecular markers affecting seed and oil yield (genes proteins metabolites)
9	Breeding and optimize yield components (seed volume and oil content)
10	Genome studies
11	Study transformation:
	regeneration in vitro
	Agrobacteriam
	biolistics
12	Study flowering
	Asynchronous
	environment dependent
	male female ration
13	Flowering
	uniformity
	harvesting
14	Gene expression studies Jatropha as model for R&D
15	Preserve genetic database
16	Concentrating crop harvesting period with genetics
17	Nitrogen fixation

It can be seen that quite some similar priorities came out and some overlap between the groups occurs. Looking at the priorities from the angle of small scale production and utilization and of large scale export oriented investment schemes, also priorities can be separated accordingly.
A first tentative separation is given below.

R&D for small scale use and application
Demonstrations of cropping systems
R&D plantations both stand alone, hedges and intercropping systems
Local knowledge centers in African countries
Seek cooperation with existing centers of knowledge in EU and outside
Optimize use of Jatropha both in production as in use
Set local criteria for sustainable production
Disease and pest resistance and biological control
Study the variability between individual plants in terms of yield and between crop stands
Study the yield under different climatic and soil conditions (in Africa)
Best cropping systems with Jatropha (which intercropping best and how)
Nitrogen fixation using adapted bacteria, or plant roots

R&D for large scale
Study the variability between individual plants in terms of yield and between crop stands
Study the yield under different climatic and soil conditions (in Africa)
Study mechanical harvesting
More understanding Jatropha production yield response to growth factors
Reduce variability (increase uniformity)
Higher productivity and yield and improved oil content using genetic improvement
Micro propagation

Much of the **raw material R&D** priorities seem to be valid for large scale, but might be also attractive for smaller scale, if there would be market outlets. Detoxification of the cake is both for large and small scale relevant a topic. On the **genetics** priorities many are useful for both small and large scale, but some might be more interesting for large scale, such as uniformity of yield and high predictability, pest and disease tolerance in mono-cultures, micro propagation, etc.. For small scale, issues like drought resistance, simple seed selection and improvement, disease resistance in intercropping, etc.. might be more relevant to be studied.

Conclusions and recommendations

In the meeting a wide range of expertise areas was represented, with experts partly having expertise in Jatropha and party not. This enabled a lively exchange of ideas.

A first conclusion of the meeting is that EU supported R&D in Jatropha can be justified for two reasons:

- The EU Biofuels strategy requiring considerable quantities, and therefore R&D to develop the system and chain.
- EU contribution to Millennium goals: poverty alleviation is one of the main carriers and since Jatropha qualifies as a crop that can be beneficial for small farmers, the EU might give due attention to R&D for production and use of Jatropha.

The presentations held on the topic gave a realistic picture toward the potential of Jatropha, more than anticipated. Similar to the position paper of the Jatropha seminar in Wageningen (March 2007) the Jatropha experts present, concluded that **for small scale farmers the crop can be beneficial.** This is even more so if they become part of the chain (rural electricity production or local fuel supply) or if they can convert the raw material to added value products, like lamp oil or soap.

For small scale production and use a number of R&D priorities are identified:

1. R&D on stand alone plantations, hedges and intercropping systems
2. Demonstration of systems (production and use, complete chain)
3. Local knowledge centers in African countries, and networking with other R&D centres
4. Set local criteria for sustainable production
5. Disease and pest resistance and biological control
6. Study the yield under different climatic and soil conditions (in Africa)
7. Nitrogen fixation for Jatropha

For **large scale** production **much more scientific research** is needed to overcome a number of current hurdles. Solutions are needed to reduce crop variability in the field and between fields, low crop yield predictability, pest and disease pressure, harvesting and pruning costs, low flower ratio's m/f, long flowering periods, etc.. Currently production costs for high yielding Jatropha are higher than those for palm oil per liter. These hurdles make the drivers for R&D in both genetics and agronomic practices, as listed above.

A **bio-refinery concept** is to be promoted for Jatropha as a species: R&D for products needs to be carried out and Jatropha's competitiveness for such products needs to be evaluated. Large scale production of Jatropha can be suitable for production of such bio refinery materials in special markets (e.g. cosmetics, insecticides), when requiring high standards and substantial volumes. Small scale production of Jatropha can be interesting for small special markets (e.g. fair trade soap).

Detoxification of the Jatropha cake can have benefits for small- and large scale production of Jatropha and R&D is to be encouraged. It will provide a higher added value for the cake, as fodder.

For large scale production of Jatropha **sustainability criteria are different** as for small scale. Large investments by EU players require strict application of criteria with respect to labor conditions, biodiversity , etc… Therefore it is recommended to set out different sets of criteria and have these developed and tested.

Finally it is recommended to study the **CDM[2] effects and mechanisms** that can be supportive for both small scale and large scale investments.

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[2] Clean Development Mechanism under the Kyoto Protocoll

Annex 1-1 Agenda:

EXPERT MEETING ON JATROPHA
BRUSSELS, 7 DECEMBER 2007

DG Research, Square de Meeus 8, Room 8 E

Agenda

9.45 – 10.00	**Coffee**
10.00 – 10.15	**Welcome, objective and working method of the workshop (DG RTD)**
10.15 – 10.30	**Tour de table** Brief introduction of participants, covering the institutional background, the experience and interest in Jatropha,
10.30 – 11.00	**State of the art, ecological and agronomic characteristics of Jatropha overview of the development of the sector – (Reinhard Henning, 'Reinhard.Henning@t-online.de')**
11.00 – 11.30	**State of research on breeding and genetic improvement (Raymond Jongschaap, 'raymond.jongschaap@wur.nl')**
11.30 – 12.30	**Discussion**
12.30 – 13.30	**Lunch (DG RTD canteen, ground floor)**
13.30 – 14.00	**State of the art sustainability criteria, global position, competitiveness - optimising the composition of the raw material for utilisation (Winfried Rijssenbeek, w.rijssenbeek@rrenergy.nl)**
14.00 – 14.30	**Discussion**
14.30 – 16.15	**Identification of ongoing research, short-term research needs and mid-to long-term strategic research needs**
16.15 – 16.30	**Conclusions**

Presentations, see web page:

http://ec.europa.eu/research/agriculture/events_en.htm

Annex 1-2 Background Note

EUROPEAN COMMISSION
RESEARCH DIRECTORATE-GENERAL

Directorate E – Biotechnologies, Agriculture, Food

Brussels, 30 November 2007
E 02 PV / E 04/HJL D(2007)

EXPERT MEETING ON JATROPHA
BRUSSELS, 7 DECEMBER 2007

DG Research, Square de Meeus 8, Room 8 E

Background
The tropical shrub *Jatropha curcas* is an oil crop that raised interest in several tropical regions over the world. The oil from the seeds can be processed for different purposes from biodiesel production to fine chemicals or pharmaceuticals. The remaining press cake contains two different toxins. Before it can be used as animal feed detoxification is necessary. However, in the centre of origin, in Latin America less toxic varieties exist, which could be used in a breeding programme.
The plant is adapted to low rainfall conditions and is grown widely in small holder agriculture as hedgerow in agro-forestry or agro-pastoral systems, for example in the Sahel. Compared to other oil crops it seems to compete less with food crops. It has a potential to contribute to income generation in marginal areas. Therefore it could have fewer problems than other oil plants to be considered environmentally and socially sustainable.
However, the yield is low, the production labour intensive and the production costs are very high. Due to non-uniform ripening of the seeds they are hand-picked like coffee berries.
What about climate change mitigation? If *Jatropha* is grown in intensive agricultural systems with nitrogen fertilisation all advantages of a renewable energy source might be lost, like with other first generation bio-fuels. A recent study by the Nobel laureate Paul Crutzen shows that ethanol from maize or oil from rapeseed generate 0,9-1.7 times the climate impact of fossil diesel mainly due to losses of nitrous oxide.
Several *Jatropha* development projects had been started in the 80`ies. Very few seemed to have sustainable success. Some have been abandoned, like in Nicaragua.
Recently interest came back. In different parts of the world development projects started, like the "Daimler-project" in India, plantations by investment companies in Madagascar, village-based plantation in Cambodia linked to small-scale power-plants, plantations in Indonesia, plantings to control erosion in China and in the border region of Haiti and Dominican Republic.
The purpose of the expert meeting is to consider these developments and to discuss to what extend research could contribute to a sustainable development of *Jatropha*. Some research issues are probably already taken-up. We will ask the participants to take stock of existing and planned research projects, and to identify mid- to long-term research issues which could be taken-up eventually by the EU research framework programme. EU research projects need the cooperation of several partners. Therefore research questions which can be best addressed in a collaborative research endeavour are of specific interest.
In order to give sufficient room to discussions and to avoid duplications in sequences of presentations we decided to focus on three main presentations only.
If you have specific bullet points for specific consideration of the speakers please send them in advance to the speakers (in copy to us Hans-Joerg.Lutzeyer@ec.europa.eu , Piero.Venturi@ec.europa.eu).
Please focus on 5-10 bullet points only.

Annex 2 List of participants

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7 DECEMBER 2007

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