

## 6 PROJECT IMPLEMENTATION

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### 6.1 Introduction

Once the feasibility of a jatropha project has been established, the actual project can be realized. This can be done in many ways and it involves many decisions. A project designer will have to take important decisions on the ownership model (who owns the plantations? who owns the processing plant?), on the production model (how will the production chain look like?) and on the financing model (how are plantations, processing plant etc. financed?). This chapter provides an overview of the options and indicates which option is more appropriate, given a certain context. Finally, this chapter offers insight into the main criteria that have to be taken into account if the promoter intends to design a sustainable jatropha project.

### 6.2 Ownership, Production and Finance models

Jatropha project designers focusing on the implementation phase will have to make several strategic decisions about who will own the production facilities, what products to include in the chain and how to finance the different components of the enterprise. These decisions determine to a large degree the social impact and sustainability of the production chain to be promoted. This chapter aims to describe the most important options, with the respective advantages and disadvantages.

As stated before, this manual will only focus on small- and medium-scale initiatives (up to a total of 1000 ha, in smaller parcels) whose main objective is to improve living conditions of small farmers and their families. This excludes models based on the purchase of large areas of land for jatropha monocultures, in which the role of the local population is reduced to the supply of cheap labour.

#### 6.2.1 Ownership

Participation of the small producer in the jatropha production chain varies widely among jatropha projects worldwide. Ownership is in this section defined as the economic participation of small farmers in the different stages of the production chain. Ownership matters, because it can be the difference between receiving a fair price or being exploited. But if conditions are not right, ownership may lead also to corruption, inefficiency and entrepreneurial failure.

This section first gives an overview of the different ownership models, each with its own advantages and disadvantages. Recommendations about choosing the most appropriate model are also given, based on the opportunities and constraints that the local context presents.

##### 6.2.1.1 Ownership models

When describing the role of small farmers in the production chain, three pure ownership models and two hybrid models can be distinguished, based on two criteria: the ownership of

the plantations and the ownership of the processing plant. The following table gives an overview of the ownership options.

**Table 6-1 Overview of ownership models**

Model	Plantations owned by		Processing owned by	
	Farmers	Processing enterprise	Farmers	Third party
<b>Pure models:</b>				
A. Pure plantation		X		X
C. Pure outgrowers	X			X
E. Pure farmer-owned	X		X	
<b>Hybrid models:</b>				
B. Plantation with outgrowers	X	X		X
D. Farmer participation in processing plant	X	(X)	X	X

### **1. Pure plantation model (model A)**

In the *pure plantation model*, a single (often foreign) company buys large areas of land (thousands of ha are not uncommon) and establishes jatropha plantations managed directly by the same company. This model is particularly used in Latin America, where 44% of all jatropha initiatives are managed as large, single-owned plantations [1]. Given the extremely high start-up costs for land purchase, most promoters negotiate long-term concessions or lease agreements with (local) governments or former landowners. As mentioned above, this model will not be further discussed, because it does not involve small, independent farmers.

### **2. Pure out-grower model (model C)**

In the *pure out-grower model*, a private (national or foreign) biofuel processing and marketing enterprise signs contracts with farmers for the production and supply of jatropha seeds. The central enterprise generally pre-finances part of the plantation investment of outgrowing farmers in exchange for the exclusive right to buy seeds from these farmers. Some processing enterprises create funds for social projects in the communities of their out-growers.

The processing enterprise is not necessarily an external or capital-intensive enterprise. An example of a pure outgrower model that is community-owned are the Multi-Functional Platforms (MFP) in Western Africa. The platforms are generally owned and operated by a local entrepreneurial group (often women). Farmers bring their jatropha fruits to the dehuller and press of the platform, pay for the service but remain owner of the oil and presscake. The processing enterprise may or may not be engaged in the marketing of the oil and presscake. In this way a service is provided to the community and local employment and income is created. These platforms may also co-exist with a central processing facility, in which the platforms play the role of local collection centres. When referring to the sustainability of these platforms, the importance of organizational capacity and technical skills at community level cannot be overemphasized. More information on Multi Functional energy Platforms can be found at: <http://www.mfrfp.com/>.

### **3. Pure farmer-owned enterprise (model E)**

Pure (100%) *farmer-owned* processing enterprises are extremely rare. In this model, jatropha producing farmers are 100% owners of both the processing and marketing facilities. This can be in the form of a cooperative (in which the “surplus” is distributed according to the

production supplied by each member) or as a private enterprise (in which profits are distributed according to the value of shares held by each owner). The latter is especially appropriate in countries where the term cooperative has a connotation of corruption and inefficiency. To avoid a dominance of one or more large farmers in the private enterprise, BYSA in Honduras has opted to include in their statutes an article that makes it impossible for one single person to own more than 5% of all shares.

The main reason for relatively few farmer-owned jatropha enterprises is the lack of confidence of investors (including banks) in jatropha ventures. It is expected that in the near future, once more field evidence about the crop's yields becomes available, more member-based enterprises, such as cooperatives, will invest in jatropha ventures.

#### **4. Plantation with outgrowers<sup>4</sup> (model B)**

The central *plantation with outgrowers* is an intermediate model between model A (pure plantation) and model C (pure outgrowers). It is the most common model worldwide. According to a survey conducted in 2008 by GEXSI among 240 jatropha projects in 55 countries, two-thirds of all jatropha projects involve small farmers, mostly in combination with a larger plantation managed by the promoters themselves [1].

The popularity of this model is due to the combination of low-cost and reduced risks. Working with outgrowers reduces start-up costs significantly (no land purchase required). On the other hand, depending completely on outgrowers is considered a high risk by external investors because of the lack of control over the feedstock. The combination of operating an own plantation to secure a minimum of feedstock, and contracting outgrowers to increase the occupancy rate of the processing equipment, is considered by many external investors to be an attractive combination.

#### **5. Partial farmer participation in processing plant (model D)**

Jatropha initiatives in which farmers are co-owner of the processing enterprise are rare but do exist. One example is the BYSA enterprise in Honduras [2], which is set up as a private enterprise with 49% of its shares owned by jatropha-producing farmers and the remaining shares by a local development NGO [3], who will sell the shares gradually to farmers as the enterprise matures (transition to model E). BYSA is – according the above mentioned GEXSI study – the only initiative in Latin America that does not follow model A or B [4]. Another example is Mali Biocarburant, which is 20% owned by a farmers association [5]. In order to facilitate the purchase of shares by poor farmers, part of the payment for seeds to farmers may take place in the form of shares.

#### **6.2.1.2 Appropriate ownership models**

As explained in the previous sections, the economic participation (in terms of ownership) of jatropha farmers in the biofuel production chain is the lowest in model A, and the highest in model E. While model E. may be the most preferable from the social point of view (maximum distribution of added value among the final target group, farmers), the sustainability may suffer if there is no local capacity in key technical and management areas.

The following table gives an overview of the main factors influencing the choice of the ownership model. Obviously, these factors are context indicators, not absolute conditions. A

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<sup>4</sup> “Outgrowers” are defined in this document as independent (often small) farmers that supply jatropha seeds to an external processing facility, mostly on contract basis.

distinction is made between more centralised ownership models (A, B, C) and models with more participation of small farmers (model D and E).

**Table 6-2 Overview of main factors determining the choice of ownership model**

Factor	Favours A-B-C model	Favours D-E model
Local management capacity	Poor	Good
Local technical capacity	Poor	Good
Market	Mainly overseas	Local
Land distribution	Unequal	Equal
Previous experiences with farmer-owned enterprises (e.g. coops)	Bad	Good
Local investment capital	Unavailable	Available
Grants for capacity building for small farmers and processing enterprise	Unavailable	Available

### 1. Ownership models B and C

It is clear that the B and C models tend to be less risky options in a context with low technical, managerial, organizational and marketing capacities (all typical features of a developing area context). The participation of a well-reputed commercial party who has these qualities can compensate for capacity deficiencies at the local level. The participation in the B and C models of non-profit parties<sup>5</sup> and social venture capital<sup>6</sup>, with a clear and genuine vision of poverty alleviation, can increase chances of positive social impact.

In case the jatropha initiative is financed from (semi) commercial sources, B and C are probably the most acceptable models to start with for all parties involved, especially in capacity-deficient areas such as sub-Saharan Africa. The challenge in these B and C models is to ensure fair conditions for the (small farmer) outgrowers. SNV is active in developing the Inclusive Business concept in Latin America, Africa and Asia, and can be an interesting party to ensure a fair distribution of benefits between the investor and small, outgrowing farmers<sup>7</sup>.

In a low-capacity context, FACT considers models B and C to be acceptable transitional models, to bridge the period in which local capacities are built or strengthened as a necessary condition to create a viable processing enterprise. However, FACT recommends in the longer run to strive for ownership models that integrate small farmers, not only as suppliers, but also as shareholders in the enterprise.

<sup>5</sup> The participation of development NGOs in jatropha projects involving small farmers is quite common: DED, GTZ (both German), SNV, HIVOS, FACT, KIT, STRO (all Netherlands) are just a few of the many non-profit organizations active in this field. There are also various reports of commercial enterprises making use of field structures of NGOs in their promotional network (see Zambia pag. 62). In these cases, NGOs use commercial capital to provide loans to their target group and finance part of their own activities. In fact, the social and physical assets of rural development NGOs, such as their detailed knowledge of the local context, their experience with rural credit, their existing field structures (offices, extension workers, vehicles etc.), the confidence built among farmers and ability to call for well-attended meetings can become of increasing commercial interest, paving the path for more and more mixed (profit – non-profit) alliances in the near future.

<sup>6</sup> Social venture capital is a form of venture capital investing that provides capital to businesses deemed socially and environmentally responsible. These investments are intended to both provide attractive returns to investors and to provide market-based solutions to social and environmental issues.

<sup>7</sup> For more information on SNV's inclusive business approach, see e.g. <http://www.inclusivebusiness.org/>

The transition of outgrowing farmers from a B or C model to a D or E model, may occur naturally once local capacities have developed sufficiently. Farmers may see opportunities to engage in processing activities (independent from the central processing enterprise), thus increasing their incomes. It has to be ensured that farmers (outgrowers) are not tied into strangling contracts with the promoter (central processing enterprise) aimed at maintaining a relationship of dependency and exploitation. Exploitative conditions in contracts are mainly related to duration (e.g. 30-year exclusive purchasing rights) and price (determined arbitrarily and exclusively by the promoter). These conditions make it difficult for farmers to organize their own enterprise in order to increase their earnings.

## 2. Ownership models D and E

In a more developed situation, where basic technological, managerial, organizational and marketing capacities are locally available, the farmer-owned models (D and E) tend to be more appropriate because they offer more guarantees for a fair distribution of the benefits generated in the production chain.

Alternatively, in case this context does not exist, but the initiative has access to grants, especially for capacity building interventions at both the enterprise (technical, managerial) and farmer (agricultural) level, one may opt for model D or (in case of a strong existing farmer-owned organization) model E. In this case it is important to ensure that the project has sufficient duration to reach the break-even point of the processing enterprise (at least 5 years).

### 6.2.2 Production models: the jatropha value chain

In absence of significant economies of scale, small biofuel initiatives face the challenge to take full advantage of all (sub) products in their production chain. The different production options are revised in the following sections, starting with the most basic chain (producing jatropha oil and presscake), followed by an overview of the extended production chain, including a large variety of end and intermediate products (including biogas, soap, electricity, biodiesel, edible oils, and others). In each section the minimum conditions are discussed that determine the viability of each chain extension.

#### 6.2.2.1 The basic jatropha biofuel production chain

The basic jatropha production chain has two end products: oil and presscake.



Figure 6-1 Jatropha bio fuel production chain

Main products of the basic biofuel chain:

#### Jatropha pure oil (JPO)



In the most basic production chain, JPO can be used in a blend with fossil diesel fuel in conventional (non adapted) stationary diesel engines (see section 5.2.2). Other low-tech applications of JPO include artisan soap production and the use as a substitute for kerosene in oil lamps (as in the FACT project in Mozambique). In a less low-tech context, 100% JPO can be used in adapted diesel engines. See section 5.2.2 for more information on the technical details.

#### Presscake



Although it may be optimal from the nutrient balance point of view to recycle the presscake back to the jatropha fields, from the business point of view there may be more profitable options. There is no (or not yet) a price premium for organically produced jatropha oil<sup>8</sup>, while there are significant price premiums for certified organic crops such, as coffee. The sale of presscake to certified organic producers (which may be present among the very jatropha farmers) should therefore be studied as an option.

It is unlikely that small-scale biodiesel production (less than a few hundred litres per day) will become a feasible activity to be added to this basic chain. For that to happen diesel prices need to be very high or there need to be cheap and large feed stock sources (e.g. used vegetable oil) and a premium market for organic fertiliser must be found.

#### 6.2.2.2 Main factors determining feasibility of the basic biofuel chain

The economic and technical feasibility of the basic jatropha chain depends mainly on three factors:

1. High competing diesel/kerosene prices;
2. Presence of one large fuel consumer<sup>9</sup> or many small ones<sup>10</sup>;
3. Access to a (premium) market for organic fertiliser.

At least two of these three conditions should exist in order for the basic biofuel chain to be viable. In isolated areas, where fossil diesel supply is unreliable or expensive, the basic chain can be profitable even at a small scale [6]. JPO can be used in diesel engines driving electricity generators, water pumps or agroindustrial equipment (such as grain mills). The advantage is that with relatively modest investments, significant impact can be achieved. Small islands or very isolated areas that cannot be reached by road or with a reasonable population may comply with these conditions.

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<sup>8</sup> The exceptions always confirm the rule: e.g. Diligent Tanzania sells at a premium price JPO to Tanzanian safari companies to drive their modified vehicles. The use of this biofuel contributes the safari companies' image of a green and socially responsible enterprise.

<sup>9</sup> Example of one large consumer is a stationary diesel engine for electricity generation that can be adapted (or use a diesel/PPO mix (see FACT's demonstration project in Garalo, Mali).

<sup>10</sup> An example of many small consumers is the use of JPO in oil lamps. The simplest functional design is the Jatropha Binga Lamp. It was demonstrated during the FACT organised workshop of November 2008 in Chimoio, Mozambique, by Chrispen Zana of GTZ-AMES. See: <http://www.jatropha.org/lamps/princ-burning.htm> for a description of the functioning of the lamp.

Areas with reasonable access and normal diesel prices do not enjoy the natural protection of an isolated area. It is therefore recommended to look for additional ways to take advantage of all products and sub products of the production chain, of the infrastructure established and of intercrops produced by jatropha farmers. The following section will give a fairly complete overview of the options to extend the basic biofuel chain.

### 6.2.2.3 The extended production chain

The basic production chain described in the previous section can be expanded almost infinitely with a large number of linked activities, which increase the value added in the chain. It is impossible to give a precise indication of the minimum production level required to make these additional components profitable. Local conditions such as diesel price, market for (sub) products, availability of repair and maintenance services, investment costs etc. are often more important factors than the size of the plantations.

However, as a rule of thumb, one has to think of a minimal production level of 250 ha of mature jatropha plantations in order to make extensions of the basic chain economically feasible, together with a reasonable technical capacity and potential consumers within the target region.

As for location of the processing site, it is recommended to look for locations that are both close to farmers (reduce transport costs), close to potential larger consumers (heavy transport, grain drying installations, sawmill) and close to a certain basic technical capacity (car mechanics, repair of agricultural machinery). Sites near small cities that play a role as service centre for the surrounding rural areas, often comply with these conditions.

#### **1. Biogas**

The first candidate to expand the production chain is a biogas installation. Biogas is a mixture of 25-35% CO<sub>2</sub> (carbon dioxide) and 65-75% CH<sub>4</sub> (methane) which can be burned directly to generate heat or combusted in engines to generate mechanical energy or electricity. The presscake left after pressing jatropha seeds still contains a significant amount of oil<sup>11</sup>, which is a favourite feedstock of the methane-producing bacteria. Other sources for biogas production, such as waste plant materials, cattle manure and animal remains, are generally also available in rural areas. Fast growing grasses (if the climate is suitable) may be cultivated to complement the biodigester feedstock, in case the free feedstock supply is irregular and/or unreliable.

An important question to answer before investing in a biodigester, is: what to do with the biogas produced? One important limitation is that the transport of biogas to clients outside the production facility is technically difficult and expensive [7]. In the context of small-scale production, the biogas should therefore be used on site. In spite of this limitation, many options remain. The viability of these options depends to a large degree on the existing demand of both the processing enterprise and other enterprises in the same region. The more industrially developed the area is, the easier it will be to use the gas in a profitable way. Some options to use the energy produced from biogas, are:

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<sup>11</sup> Mechanical small-scale oil extraction has in general an efficiency of 70% or less, which means that even if the theoretical maximum oil content of the seeds is 38%, the mechanical press will not be able to extract more than some 20-25%.

**Table 6-3 Options to use the energy produced from biogas**

Energy form	For internal use	For external use
Heat	Drying installations (e.g. drying jatropha fruits before dehulling)	Heat-intensive local industries that are willing to relocate to the processing site (e.g. grain drying installations, soap-making, baking, etc.).
	Biodiesel processing (e.g. boiling water out of WVO, distillation of methanol, heating oil before chemical reaction)	
	Cooking (on-site restaurant)	
Mechanical Power	Oil extraction	Mechanical energy intensive local industries that are willing to relocate to the processing site (e.g. sawing,).
	Dehulling	
	Moving-belt conveyer, etc.	
Electricity	Office supplies and lightning	Electricity intensive local industries that are willing to relocate to the processing site (e.g. milk collection point with cooling equipment, ice cube making, etc.).
	Most heat and mechanical energy using equipment mentioned above can also be run on electricity <sup>12</sup> .	Selling to the grid (national or local electricity distribution company)

N.B. The flow chart in Figure 6-6 gives several other ideas on how to use biogas energy.

In general, one should first try to satisfy the internal energy needs of the processing facility, and secondly try to attract industries that are willing to relocate to the site. Selling electricity to the grid is – in economic terms - generally the least interesting option and may also involve substantial bureaucracy. If attracting other energy-efficient business to the biogas production site forms part of the business plan, this should be taken into account in the acquisition phase of the site and the design of the facilities.

Factors that contribute to the viability of the biogas component are:

- Standard energy sources (electricity, fuel) are expensive or not available
- Cheaper alternative energy solutions (e.g. hydropower) are not feasible
- Year-round availability of feedstock (humid, little fibre, concentrated)
- Feedstock is available at no or very low cost<sup>13</sup>
- Sufficient water is available<sup>14</sup>
- Sufficient energy demand of local industries and the population in general
- Government policy and legislation favours the entrance of new suppliers of electric energy (market for excess energy production)

<sup>12</sup> Although using electricity is always less efficient than using direct heat and mechanical energy, in the short run the use of electricity is often more practical and cheaper (requiring less investments). Replacing electric energy by direct heat and mechanical energy may form part of a later exercise, once the processing facility is up and running.

<sup>13</sup> This generally means that there is no alternative use for the feedstock, e.g. as animal fodder, and that transport costs are minimal. It is also important to look at possible profitable uses of the foreseen feedstock in the future, since this may affect availability. Finally, there should be sufficient margin to pay the suppliers of the feedstock some minimum amount, since they will start charging for the feedstock once it becomes clear that it is used productively. Having access to various sources of feedstock in sufficient amount will keep this effect manageable.

<sup>14</sup> E.g. a 160 kW biogas installation will need some 30 m<sup>3</sup> water per day. Only a small part of the water is consumed in the process. Waste water from a biogas installation is an excellent fertilizer when used for irrigation. It may even be sold as a liquid fertilizer.

## 2. Biodiesel

A second logical extension of the jatropha biofuel chain is biodiesel production (also called *transesterification*). For a technical description of the biodiesel production process, please see section 5.2.4.

In many countries, the production and marketing of biodiesel is regulated. The quality has to comply with certain standard quality norms<sup>15</sup> and its marketing has to follow certain predetermined channels. Although these regulations are comprehensible from the consumer protection point of view, they often impede small biodiesel producers from selling through the regular market. This is because the equipment needed to produce this quality is too expensive and because marketing through the existing network of fuel-mixing installations and fuel stations absorbs an important part of the margin.

Moreover, the production of biodiesel is more expensive than the production of pure plant oil (PPO). This means that a biodiesel producer is more sensible to changes in feedstock or fuel prices, than a PPO producer. Given the highly unstable world market prices for fossil oil<sup>16</sup>, this is a very important argument in favour of PPO, especially for small producers, who generally have smaller margins than large biofuel producers.

FACT therefore recommends biodiesel production only in two cases:

1. if the production has reached sufficient scale to justify the investment in a high-tech biodiesel equipment that guarantees fuel quality standards are met<sup>17</sup>
2. if the internal demand of biodiesel is sufficiently large and the internal user(s) accept that the fuel does not always comply with standard norms.

In the latter case, cheaper equipment is available or can be built on site<sup>18</sup>.

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<sup>15</sup> Generally adaptations or copies of the American ASTM D 6751-07 or the European EN 14214:2003 norms.

<sup>16</sup> Oil prices surged from 35 US\$ per barrel in 2003 to 146 US\$ in July 2008, falling back again to 37 US\$ in December 2008.

<sup>17</sup> As an indication: the smallest biodiesel equipment of AGERATEC (Swedish manufacturer of professional biodiesel equipments) has a capacity of 1000 ltr per day and costs about 80 000 EUR. If working 250 days a year that would require an input of 250 000 ltr per year of oil. This is equivalent to 250 ha mature jatropha plantations producing 4 000 kg per year per ha with an oil extraction rate of 25%.

<sup>18</sup> A wealth of information on low-tech biofuel production can be found on <http://www.journeytoforever.org/biodiesel.html>. The equipments used in the FACT project in Honduras were built according to the instructions published in a manual elaborated by Whitman Direct Action: [http://www.whitmandirectaction.org/downloads/documents/biodieselguide\(espagnol\).pdf](http://www.whitmandirectaction.org/downloads/documents/biodieselguide(espagnol).pdf)

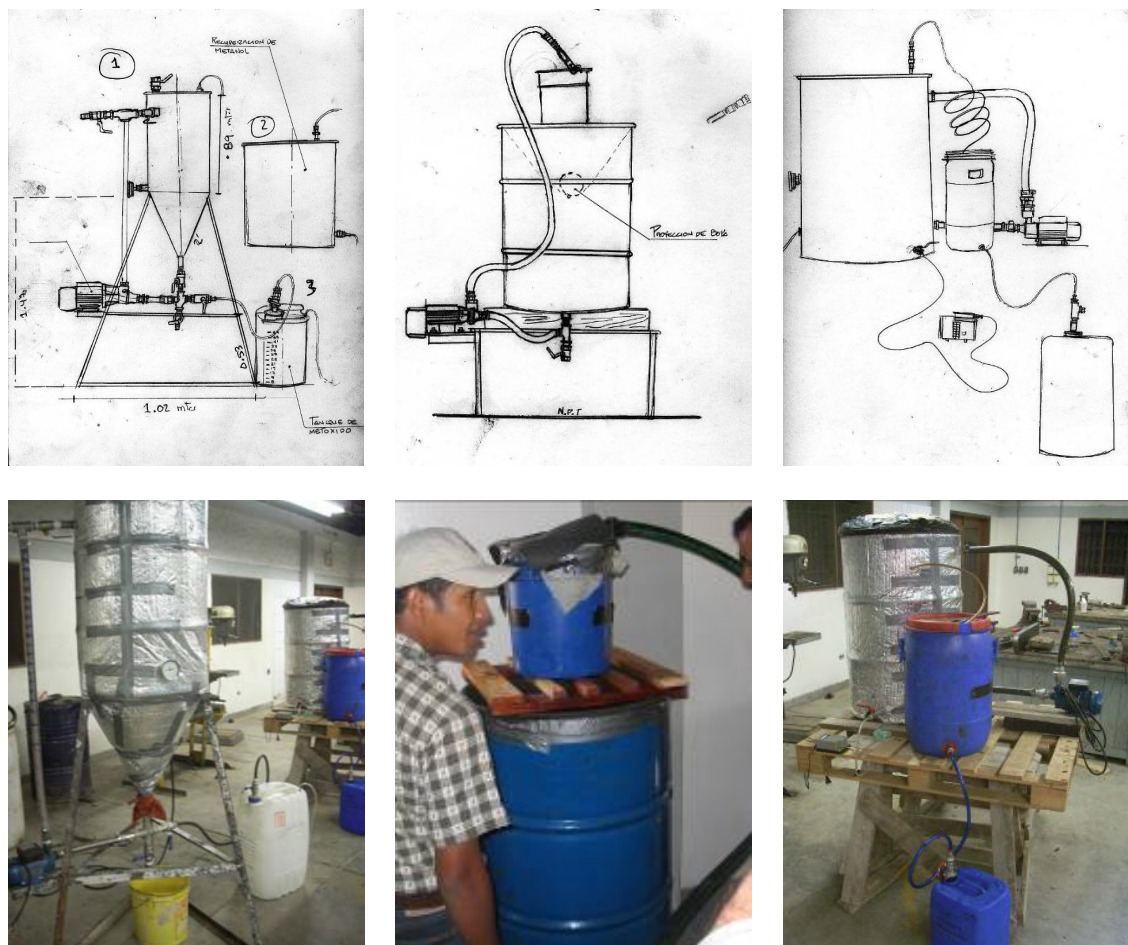


Figure 6-2 Images (drawings and pictures) of locally built biodiesel equipment in Yoro, Honduras

Factors that contribute to the viability of small-scale biodiesel production are:

- Fossil diesel fuel is expensive.
- Availability of cheap sources of waste vegetable oil or even animal fats<sup>19</sup>.
- Presence of a local technical capacity to ensure repair and maintenance.
- Reliable availability of methanol and KOH or NaOH at reasonable prices.
- Legislation permits the local production and internal use of biofuels (e.g. at the level of a cooperative, an association etc.), thus avoiding the marketing through regular gas stations.
- Government tax policy that stabilizes fuel prices.

### 3. Soap

A third extension of the jatropha biofuel chain to be considered is soap production. Soap can be produced both from virgin jatropha oil (JPO) and from glycerine (a by-product of the biodiesel process). Soap is traditionally made from jatropha oil in many regions in Latin America, Africa and Asia. Women are especially active in this activity. The soap is believed to have medical properties against skin diseases.

<sup>19</sup> Some professional biodiesel equipment manufacturers do not guarantee quality norms if other feedstocks are used than virgin vegetable oil.

Soap-making is a relatively easy process (see section 5.2.3): it involves heating the oil and a reaction with NaOH (in case hard soap is desired) or KOH (soft soap). Colorants and perfumes can improve market acceptance.

When using glycerine to make soap, before starting the process it is important to boil off all remaining methanol. Methanol is toxic for humans and highly inflammable, so boiling should take place outside in a safe place and no fumes should be inhaled.

When using crude glycerine to make soap, it is important to know that getting rid of the unattractive (brownish) colour and typical smell of glycerine is quite difficult, especially in case it comes from a batch of used vegetable oil. Soap made from VVO glycerine can best be sold as a cheap and effective cleaning product to car mechanics and other workshops that work with grease. They generally do not mind the unattractive colour and smell, but appreciate the strong degreasing properties of the soap. Another possibility is to supply to the bottom-end clothes washing soap market segment. In that case the soap has to be cheaper than any of the existing brands. The purification of glycerine for pharmaceutical or cosmetic purposes is not a viable option at small scale.

Soap made from pure jatropha oil can be marketed through niche markets for natural health and beauty products, or even the fair trade (export) market. If accompanied with the right marketing effort, this activity can be highly rewarding.

#### **4. Diversification with edible oils**

Complementing the above-described biofuel chain with the production and processing of edible oils can be an important strategy to stabilise the income of the processing enterprise and offer short-term alternatives to farmers.

Why edible oils?

- The presscake of edible oilseeds is often **easy to sell** locally (to cattle, pork or chicken farms), is highly nutritious and has therefore a good value<sup>20</sup>.
- Moreover, edible oil processing requires largely the **same infrastructure and skills** as the biofuel seeds processing<sup>21</sup>: this leads to efficiency gains when contracting technical personal (same person can operate, maintain and repair edible oil and jatropha press) and when sharing certain equipment (e.g. use jatropha biogas in drying installation for grain and edible oil seeds).
- Thirdly, jatropha **farmers** need short cycle crops to **stay motivated** to maintain the jatropha plantations. Instead of paying farmers to weed their jatropha plantations, investing in an edible oil crop may be more attractive for both the promoter and the farmer.
- In an environment of unstable petrol oil prices, the diversification of a biofuel processing enterprise towards edible oils tend to **increase the stability** of the business. The reason is that the lower price limit of edible oils are determined by production costs of large scale intensive oil crop farming, which is higher than the average production costs of diesel fuel production (see Figure 6-3 below). In other words, the price bottom for biofuels is lower than that of edible oils. Edible oil producers, like biofuel producers, benefit from the ups of the petrol oil price, but do not suffer as much from the downs of the petrol oil market. Edible oil producers can switch to biofuel in case petrol oil prices rise sharply and they can switch back to edible oil if fuel prices fall beneath their production costs. It is this

<sup>20</sup> In the case of some edible oils, like soya, the presscake is even the main product.

<sup>21</sup> Although production lines of biofuel and edible oils need to be separated for obvious reasons.

flexibility that gives more stability to a mixed edible oil/biofuel business, as compared to a 100% biofuel business. To compensate for the lower efficiency levels of small farmers compared to large-scale, highly mechanised oil crop farming in e.g. Argentina and Brazil, it is important to ensure that the processing enterprise can sell the edible oil and presscake directly to end-users (e.g. oil to restaurants or agroindustries: presscake to dairy farm cooperatives, chicken and pig farms). In this way, the shorter marketing channels can compensate for the lower efficiency levels of the small farmers. This is especially necessary in times when the edible oil market hits the price bottom (b).

- Finally, almost all oil yielding short cycle crops can be planted towards the end of the rainy season. They generally need sufficient water in the beginning of their production cycle, but prefer dry conditions towards the end of the cycle. It can therefore be planted on the same land as the staple crop and would not require additional land to cultivate. Moreover, crops like sunflower tend to draw nutrients from deeper soil layers to the surface, thus preparing the soil for the next staple crop.

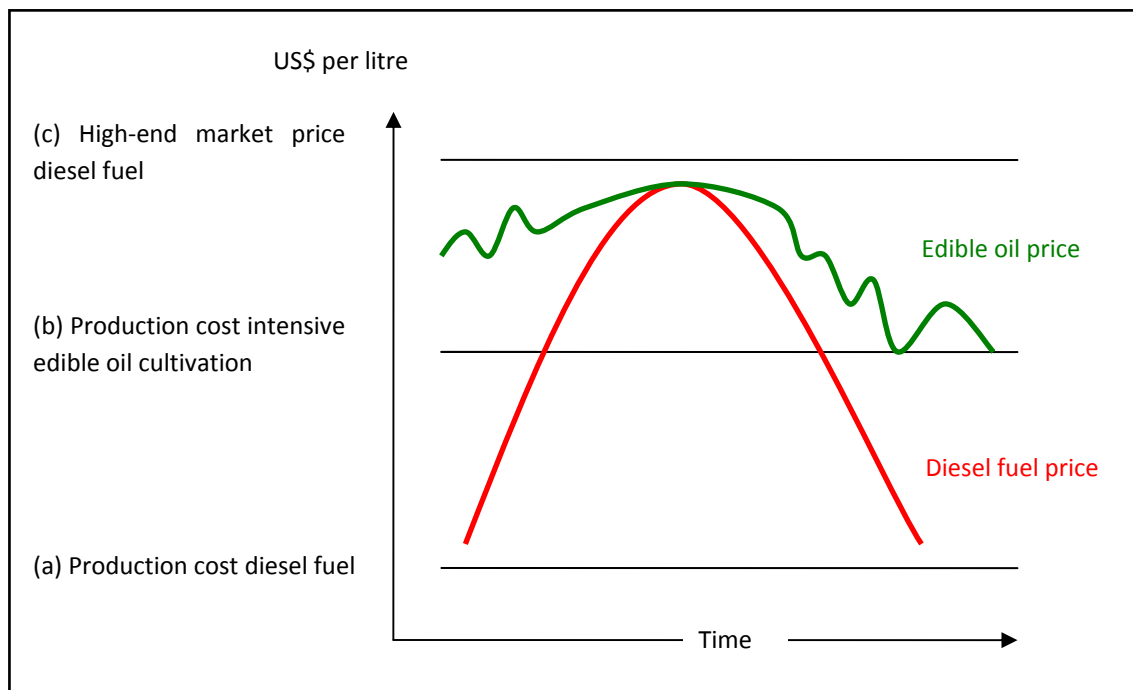


Figure 6-3 (Fictitious) visualisation of different price bandwidths of edible and petrol oil prices.

The following table gives example of a mixed cropping scheme including jatropha, a basic grain (e.g. corn) and a short cycle edible oil crop (e.g. sunflower, sesame, etc.).

Table 6-4 Example of a mixed jatropha-edible oil cropping scheme

Month	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	Etc.
Season (rainy/dry)	D	D	D	D	D	R	R	R	R	R	R	R/D	D	D	D	D	D	R	
Jatropha (permanent)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Basic grain crop						X	X	X	X	X	X							X	
Short-cycle oil crop											X	X	X	X					

**Caution!** When changing from pressing non-edible oils (such as jatropha) to edible oils, great care should be taken to clean the press thoroughly and not to use the first batches of pressed edible oil for human consumption, because of the toxicity of the jatropha.

***Which edible crops to use?***

The main edible oils that grow in the same climate conditions as jatropha are: sunflower, groundnut, soy, sesame, groundnut and cotton. However, many local species may also grow well. Rapeseed generally grows in the tropics at altitudes (> 1000 m) that are not optimal for jatropha. The choice of the crop depends mainly on soil suitability, climatic conditions and local market demand.



**Figure 6-4 Weed control and post harvest activities in soy bean production in Yoro, Honduras**



**Figure 6-5 Land preparation, sowing and harvest of sesame seed**

Figure 6-6 below gives an overview of the different possibilities to extend the jatropha biofuel chain. The easiest way to read the figure to start with the basic jatropha biofuel chain (in green), followed by an expansion with a biodiesel processor (in yellow), an expansion with edible oil crops and cattle fodder (in red), the expansion with a biogas installation (in blue), and finally the addition of a grain-drying installation (in black). Obviously, the expansion process can follow another order and can only include a few of the expansions mentioned here.

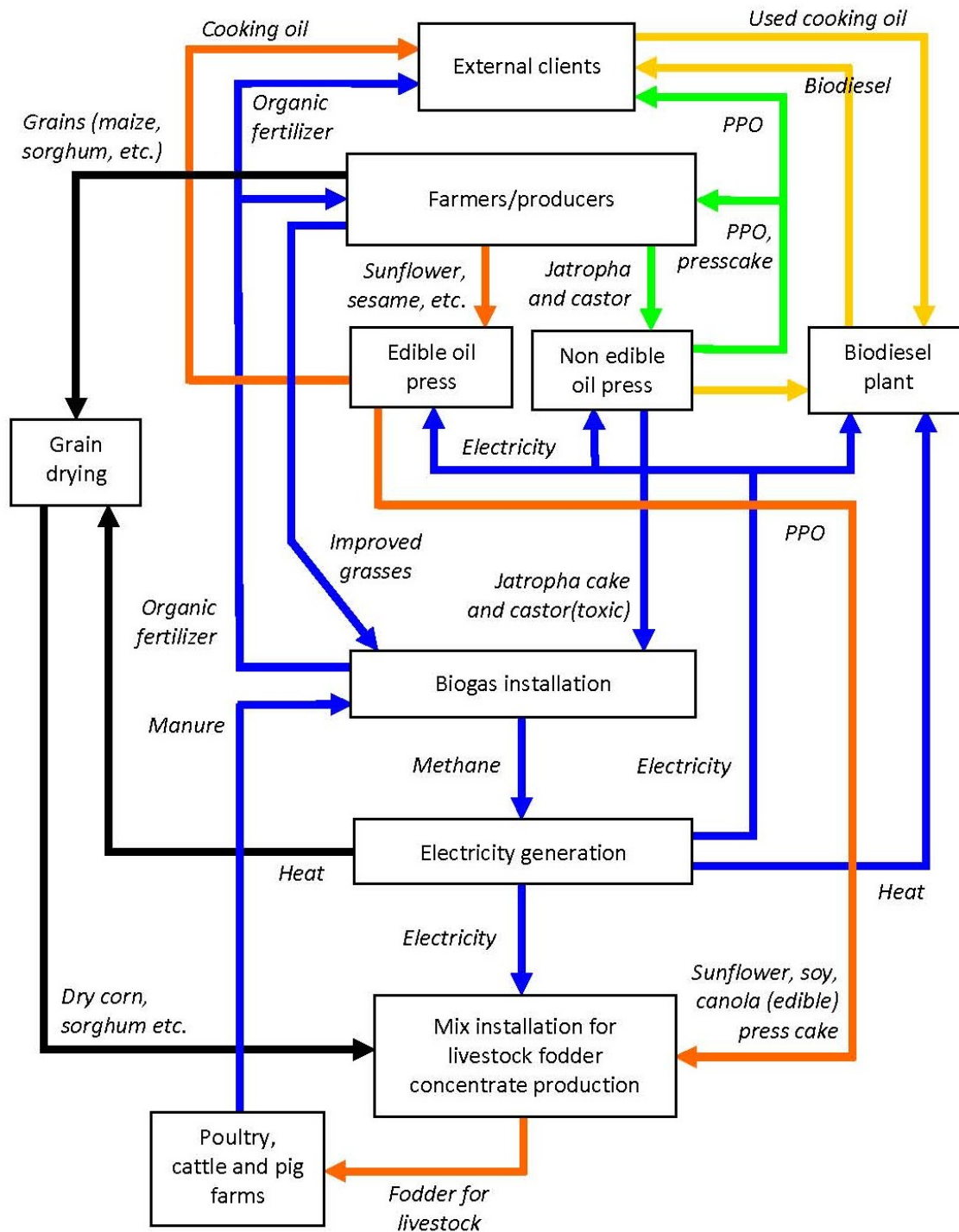


Figure 6-6 The integrated biofuel chain

## 6.2.3 Financing models

### 6.2.3.1 How to finance farmers' plantations

#### **1. Introduction**

The agricultural component is the backbone of the jatropha biofuel chain. Within this component, the financial scheme offered to farmers is one of the most important factors determining the success of the undertaking.

Designing viable and acceptable financing schemes for jatropha is a challenge for several reasons. In the first place, it is a new (cash) crop for many regions. Second, it is a perennial crop that takes several years to become fully productive. Finally, its price development is uncertain because it follows the highly volatile oil market. For these reasons, special attention needs to be given to the way the jatropha introduction is financed.

Promoting jatropha among small farmers requires diligent planning, a well-designed financial scheme, good knowledge of local customs and production patterns, and - most of all - patience. Experiences of outgrower promotion schemes show that massive promotion among farmers, promising large profits, but only contributing seeds and occasional visits by promoters, do not work [8]. Small farmers expect seed material, fertilizer, support in pest and weed control, an acceptable loan agreement, a stable market and close guidance.

In this section, three standard schemes to finance the jatropha introduction among farmers will be described. The three models are:

1. Outgrower finance scheme
2. Joint venture between promoter and farmer
3. Conventional loan scheme

It is not the purpose of this section to give an exhaustive overview of possible finance schemes. However, it is hoped that by describing these three schemes, the reader will be able to choose the scheme that best fits the context and adapt it to local conditions. In practice one will find many variations and hybrids of the mentioned schemes.

In order to be able to compare the models, the following assumptions have been made for all models:

- The jatropha plant starts producing from year 3 onwards
- The promoter of the system is also (co-) owner of the oil-processing facility (press)
- Promoter has sufficient demand to sell all oil produced
- Technical assistance is provided to the farmers without cost

During the introduction phase (in which many uncertainties still exist), it is recommended that the technical assistance be provided free of charge. In the expansion phase, technical assistance may be included in the promoter's contribution, especially in the case of commercial (non-subsistence) farmers.

#### **2. Outgrower finance scheme**

In this model farmers contribute their land and labour, while the promoter contributes seeds, initial fertilizer and technical assistance. This finance model is common in (but not exclusive for) outgrower (B and C ownership models) schemes. Technical assistance is provided for free, while planting material and fertilizer is provided in the form of a loan. All contributions are in

kind, so no money flows take place between the promoter and the farmer until year 3, when the outgrowing farmers sell their first jatropha seeds to the promoter. Typical in this scheme is that the loan is repaid with the seeds produced by the farmers. This means that the repayment time of the loan is not fixed: it depends on the productivity of the outgrowers' plantations.

**Table 6-5 Example Outgrower Financing scheme**

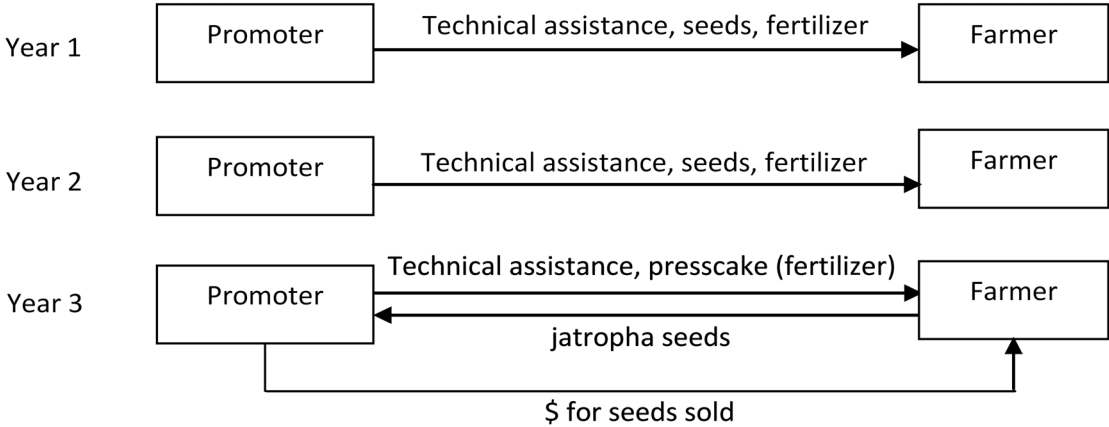
Input	Year 1		Year 2		Year 3	
	Contribution of		Contribution of		Contribution	
	Promoter	Farmer	Promoter	Farmer	Promoter	Farmer
Land		X		X		X
Labour		X		X		X
Seed	X					
Fertilizer	X		X			X
Techn. ass.	X		X		X	
Output	Year 1		Year 2		Year 3	
	Income for		Income for		Income for	
	Promoter	Farmer	Promoter	Farmer	Promoter	Farmer
Seeds						X(1)
Oil					X	
Press cake					X(2)	X(2)

Notes:

1. Preferably the promoter signs an agreement with the farmers in which:
  - The farmer agrees to sell all production to the promoter; and
  - The promoter agrees to buy all the production of the farmers at a fixed price per kg or at a price directly linked to the fuel price.

In order to maintain the motivation of the farmers it is recommended to not retain 100% of the value of the seeds as a loan repayment, but e.g. 30% and pay the remaining 70% to the farmer.
2. See section 6.2.2 (basic jatropha biofuel production chain) on the use of jatropha presscake. Depending on the market situation, the presscake can be sold to third parties (resulting in higher price per kg for farmers) or returned to the farmers (resulting in lower costs for farmers).

The following flows take place during the first three years.



**Figure 6-7 Product, service and money flows in the outgrower finance scheme**

The advantages of this model are:

- Its simplicity: no financial flows take place until year 3. This is useful when working with a large number of small farmers.
- Subsistence farmers, who are often resistant to loans, may find this an acceptable model.
- Risk for the farmer is small: the promoter guarantees to buy at a fixed price any quantity produced.

The buying and price guarantees can only be given if there is an economically viable processing facility operating. This is only possible if sufficient production volume is supplied.

The disadvantages are:

- Risk lies mainly with the promoter.
- Farmers may not have a clear idea of the market price of their product.
- There is no compensation for the work of the farmers during the first 2 years.

Factors that may contribute to the success of outgrower financing schemes are:

- Clear, enforceable contracts: farmers know that intentional non-compliance will have consequences
- Finance covers an integrated jatropha cultivation system (jatropha and intercrops)
- Promoter is the only buyer of jatropha seeds in the region
- Significant and well-balanced contribution of all parties involved

### 3. Joint venture

This model is implicit in the farmer-owned (models D and E) business models described in section 6.2.1.2. Farmers share in profits (or in case of a cooperative, in the surplus) according to the share value they possess (in case of a capitalistic enterprise) or the amount of seeds they have contributed (in case of a cooperative enterprise).

**Table 6-6 Example of joint venture investment plan**

Input	Year 1		Year 2		Year 3		Total	
	Contribution of		Contribution		Contribution			
	Promoter	Farmer	Promoter	Farmer	Promoter	Farmer	Promoter	Farmer
Land		1		1		1		3
Labour		10		5		5		20
Seed	1						1	
Fertilizer	3	7	3	7	3	8	9	22
TA	donated		donated			donated		
Processor					30	15	30	15
<b>Total</b>	<b>4</b>	<b>18</b>	<b>3</b>	<b>13</b>	<b>33</b>	<b>29</b>	<b>40</b>	<b>60</b>
Output	Year 1		Year 2		Year 3		Total	
	Income for		Income for		Income for			
	Promoter	Farmer	Promoter	Farmer	Promoter	Farmer	Promoter	Farmer
Oil					30	45	30	45
Presscake					10	15	10	15
<b>Total</b>					<b>40</b>	<b>60</b>	<b>40</b>	<b>60</b>

But also in the B and C (outgrower) models, there may be room for negotiating a joint venture. In this case, the promoter and farmers agree to distribute the results of the investment (seeds, oil, press cake and the income generated with their sale), according to the contribution of each

investor. In order to do this, the contribution of each party has to be valued. In the following a numeric example will be presented (numbers are fictitious).

The advantages of this model are:

- Risk is more equally shared between farmers and promoter.
- More interesting for farmers with entrepreneurial spirit because potential rewards are higher.

The disadvantages are:

- More intensive in-field follow-up is necessary in order to prevent farmers from reporting less harvest than they actually have. This risk is less threatening if the promoter is the only buyer of jatropha seeds in the region.
- Administration is more complex than model 1.
- There is no compensation for the work of the farmers during the first 2 years.

Factors that may contribute to the success of jatropha joint ventures:

- Clear and enforceable contracts.
- Strict follow-up during the growing process.
- Significant and well-balanced contribution of all parties involved.

#### **4. Conventional loan scheme**

In this model, a financial institution (possibly subcontracted by the promoter) issues loans to the farmers. The loans should preferably be limited to inputs (seeds and fertilizer), while farmers contribute land and labour. Also a grace period of at least 2 years should be considered, until the plantation becomes productive. In these two cases loans for labour may be considered:

- Subsistence farmers who replace other (less rewarding non-edible) crops for jatropha. This transition may result in a temporary decrease in their income until the jatropha plantation becomes fully productive.
- Commercial farmers who contract external labour.

The main difference between the first (outgrower) finance scheme and the loan scheme is that in the first scheme there is not an agreed fixed repayment per year (payment takes place according to production levels). Moreover, repayment in the first model takes place exclusively in kind (jatropha seeds), while in the conventional loan scheme, payment is probably in money. In the conventional loan scheme an interest rate is charged to cover the administrative and financial costs. In the outgrower finance scheme, the credit administration costs will probably be taken into account by the promoter when determining the purchase price of the seeds. Another important difference is that in case of an unintentional complete loss (e.g. a flooding) in the first two schemes, the farmer will probably only lose the labour invested, while in conventional loan scheme the farmer will have to pay, on top of this loss, his (seed and fertilizer) debt.

Another important aspect of the conventional loan scheme is the repayment conditions. To avoid that farmers lose interest in the crop, it is important to leave a significant part of the income to the farmer during the first production years, even if he still has to pay a large debt. This implies a risk-sharing agreement between the promoter and the farmer. That is, if production is lower than expected, the farmer receives less income and the promoter recovers his loan at a slower rate. This does, of course, not exclude taking action against farmers that

deliberately eliminate plantations. Supporting the farmer in establishing an intercrop next to the jatropha is another important strategy to maintain the interest of the farmer.

The advantages of the loan model are:

- More price transparency: farmers receive market price for their product.
- No need for intensive monitoring in the field.
- Possibility to give transitional consumptive loans during the first 2 years.
- Less financial risk for the promoter.

The disadvantages are:

- Administrative capacity to administrate loans must be created, if not already existing.
- The loan administration (especially if a financial institution is involved) has a high cost, which in the end translates to lower prices paid to the farmers.
- Subsistence farmers may be resistant to loans.
- Higher loss for farmers in case of bad harvest.

Important factors that may influence positively the repayment rate of loans:

- Feasibility studies are based on realistic yields.
- Good credit administration capacity (with promoter or financial institution).
- Loans are issued in kind (seeds, fertilizer).
- Repayment in kind (seeds) is accepted.
- Good quality seed is provided.
- Producers with experience in cash crops are selected.
- Technical assistance is provided.
- Regions are selected in which there are no other jatropha seed buyers (avoids the deviation of returns).
- Farmers introduce jatropha as an additional crop, on top of other, more traditional (cash) crops.

### **5. Conclusions on farmer financing**

The choice for a finance scheme 1, 2 or 3 is basically determined by the attitude of the farmers and the promoter (or financial institutions) towards the risks. The attitude of the farmer towards risk can often be estimated by such factors as a) access to alternative income sources (the more alternative income sources the farmer has, the easier the farmer will accept risk of engaging in a new crop), b) the economic position of the farmers (more income means more capacity to cope with risk) and c) the growth of the farmer's operations (subsistence farmers tend to consider security - zero risk – as more important than income growth).

In general terms, one can expect subsistence farmers to be risk-averse and inclined to scheme 1 (outgrower). More commercial farmers (small, medium or large), with several income sources and with an entrepreneurial spirit, may be attracted to model 2 (joint venture). Possibly, these farmers are also willing to co-invest in the processing facility. Many of these farmers will also be using diesel- powered equipment. If this is the case, farmers not only generate extra income but also make important savings on their fuel bill.

Scheme 3 (conventional loans) seems to be an appropriate option in the expansion phase when good seeds are available, yield predictions are reliable and appropriate agricultural practices have been determined and adapted to the local context.

As mentioned before, within one project different financing schemes may be applied, depending on the characteristics of the target groups. For example, in order to assure that there is a minimum production to make a press facility viable, a mixed model may be applied in which one larger farmer works in a joint venture with the promoter (scheme 2) and a large number of small farmers (*out-growers*) have a buying agreement according to scheme 1.

All finance models face the difficulty of how to bridge the first two years of the plantation, when no significant production can be expected. Practice shows that farmers are tempted to clear plantations when they see better opportunities, or simply neglect plantations in absence of an immediate stimulus<sup>22</sup>. A simple solution is to provide credit (or contract a labour squad) for weeding the plantations. A better and more productive solution is intercropping: using the empty space between the jatropha rows to cultivate short-cycle crops. The weeding and fertilizing of the intercrop also benefits the jatropha plantation. This requires more investment than just weeding, but on the other hand it generates an immediate income (and thus a loan repayment capacity). The investment may also be financed from conventional sources of finance if it concerns crops with a track record in the region. Any of these strategies requires additional investments. However, the cost of not implementing any of the above strategies is likely to result in a much higher capital loss in the form of loss of plantations.

The *Gota Verde* project has developed a number of credit administration documents and tools that are available upon request through FACT.

#### 6.2.3.2 How to finance the processing enterprise

Many jatropha projects invest too early and too much in the processing facility. This is largely due to over-optimistic crop yield projections, although the short time horizon of project funders, and their preference for visible physical field structures and the lack of field information also play a role.

As explained in chapter 2, plantations enter in commercial production from year 3-4 onwards. During the first 2-3 years a small-scale jatropha initiative (planting up to 150 ha per year), can operate with a very small processing unit, consisting of one or two small presses, several manual dehullers, a filter unit and some storage facilities. Two or three engines may be adapted (see next section) for demonstration purposes that help market introduction in later years.

In chapters 3, 4 and 5 an overview is given of the technical options for each piece of equipment. Total cost can be limited to less than US\$ 20,000. This excludes the technical assistance needed to install equipment and train personnel. If the initiative has an ownership structure with farmer participation (model D. or E.), this technical assistance may be obtained in the form of a grant from development organizations (see annex E.4).

Furthermore, it is recommended to look first for abandoned agroindustrial installations that can be refurbished and rented. Alternatively, one of the participating farmers may be willing to contribute to the social capital of the enterprise in the form of a temporary or permanent site with existing buildings.

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<sup>22</sup> This problem cannot be underestimated. E.g. in the FACT project in Honduras (*Gota Verde*), more than 40% of the plantations established during year 1 and 2 were lost by year 3, of which at least half can be attributed to the neglect of farmers (floodings and water logging were other important factors).

It is not recommended to buy land and build installations from year 0 onwards, unless the project is funded by investors with a long-term (10 years or more) vision. Even then, it is more prudent in the first years to invest in the establishment of the plantations and give incentives to farmers to maintain them, than in building processing facilities with an overcapacity.

Once commercial operations take off (from year 4 onwards), the processing enterprise will have accumulated sufficient information and experience to write a convincing business plan that supports the purchase of its own site and more powerful processing equipment.

For potential funding sources, please see annex E.

### 6.2.3.3 How to finance engine adaptations

As explained in the previous sections, the use of PPO as a diesel substitute reduces considerably the complexity and the cost of biofuel production. Moreover, most of the technical problems with PPO technology are related to low outside temperatures, which is obviously less of a problem in tropical regions that are apt for jatropha cultivation. PPO technology is therefore considered appropriate for small-scale biofuel initiatives in developing countries. However, the use of PPO as a diesel substitute requires an engine adaptation (see section 5.2.2 for more technical details). Therefore, the introduction of PPO technology encounters two important barriers: (a) lack of confidence and (b) the upfront cost for the user.

#### ***Ad (a) How to overcome the initial lack of user confidence?***

The recommended market introduction strategy is to start early in the project development (before commercial production takes off in year 4) with adapting engines that are 100% controlled by the promoter of the project (project or enterprise cars, tractors, trucks, irrigation pumps, etc.). This allows the enterprise (and/or local technicians) to gain experience in the functioning of the PPO technology, in solving the most common problems and to start investigating the possibility to assemble local adaptation kits. If insufficient oil is locally available for these internal experiments, one can look for local oil sources, such as refined palm oil. The import of industrial quantity vegetable oil is another possibility to gain experience. Waste vegetable oil of good quality (low acid degree) may also serve the purpose<sup>23</sup>.

This period of internal experimentation and capacity building may take 2-3 years (the same period the plantation takes to become productive), because some technical problems present themselves only after prolonged use of PPO. If no PPO-diesel expertise exists locally, the enterprise will need to hire (expensive) foreign expertise to build it locally. Again, this expertise (possibly together with the experimental kits) may be negotiated without costs from development organizations for enterprises following the D and E ownership models (see annex E for organizations with expertise in this area). During the experimentation phase, local car mechanics need to be trained in the installation, maintenance and repair of adapted diesel engines. Once the enterprise has built sufficient local capacity in these areas, it can start commercial market introduction (see point (b) below).

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<sup>23</sup> Some manufacturers of PPO adaptation kits do not recommend the use of waste vegetable oil (WVO) because it tends to have a higher acid value. The acid value depends mainly on how long the oil has been used and at what temperatures. The acid value can be determined by using the same titration method used in biodiesel production. The following article gives a fairly complete overview of the issues to take into account when using WVO as a diesel substitute  
[http://journeytoforever.org/biodiesel\\_svo.html](http://journeytoforever.org/biodiesel_svo.html).



**Figure 6-8 Images of the October 2008 workshop for car mechanics in Yoro, Honduras, carried out by Niels Ansø of the Danish PPO specialized enterprise Dajolka ([www.dajolka.dk](http://www.dajolka.dk)).**

***Ad (b) How to overcome the high upfront cost of adaptation kits for users?***

Commercial adaptation kits may cost as much as US\$1000-\$1500 for small cars. However, with sufficient local demand kits may be assembled for \$250-\$300 from locally available spare parts. Even at this cost, the initial investment is an obstacle for many potential users. In order to overcome this obstacle, the BPE may consider a lease construction in which the BPE pre-finances the engine adaptation and sells the PPO fuel at a guaranteed price that is slightly lower than local fossil diesel prices. The time needed to recover the investment depends largely on the quantity of fuel consumed and the diesel price level. It is recommended to start with large industrial users, such as agroindustrial equipment (grain dryers, sawmills, etc.), busses, trucks, tractors, electricity generators etc. because they use large quantities of fuel, resulting in relatively low marketing and distribution costs per litre of oil sold. As the oil production increases, so too can the number and type of clients (private, industrial, heavy transport).

In the longer run (especially if fossil fuel prices rise significantly), it is expected that diesel engine manufacturers will offer models that are directly compatible with PPO fuel.

**6.2.3.4 Project Funding Sources**

From the previous sections, it has become clear that building a profitable biofuel chain demands considerable investment in the establishment of plantations, the installation of equipment and the technical capacity of local personnel and support services. Finding sources of finance for these investments is a challenging task.

The first place to look for investment funding is among the (future) owners of the BPE. Contributions do not necessarily have to be in the form of cash. Underused assets such as land, buildings, vehicles, machinery etc. can be meaningful contributions to the enterprise. The more the future owners are willing and able to contribute to the total investment, the less difficult it will be to find the corresponding co-financing. The co-funders need to be convinced that the promoters believe in their undertaking. The willingness to risk their own capital is the strongest indicator of that belief.

When looking at external sources, the access depends first of all on the ownership model that is chosen. Table 6-7 gives an overview of which sources are more accessible, according to the

ownership model. In all cases it is presumed that the promoters present a good quality, optimistic business plan.

**Table 6-7 Potential to obtain access to funding sources, per ownership model (1 = most difficult access, 5 = best access, in comparison with other ownership models)**

Ownership model → Funding source ↓	Model A	Model B	Model C	Model D	Model E
Grants <sup>24</sup>	1	2	3	4	5
Loans	3	3	3	1	1
Venture capital:					
- Conventional	5	5	3	2	1
- Social	1	2	3	4	5

NB1. Income generated from CO<sub>2</sub>-reduction mechanisms is not considered grants. Sources for CO<sub>2</sub> reduction can be found on <http://www.sef-directory.net/>.

NB2. The valuation reflects an order, in comparison with other ownership models. They do not pretend to give absolute or proportionate relative differences between the models.

The reasons for these valuations have been explained largely in the section about ownership models. Social venture capital and grant givers give high importance to the social benefits of models D and E (income generation for small farmers). Conventional finance sources such as banks (loans) and profit maximizing investors seek the best possible combination of limited risk and high efficiency.

The destiny of the funding also varies highly according to in the ownership model, as reflected by Table 6-8:

**Table 6-8 Comparison of destiny of investments, per ownership model (1 = least investment, 5 = most investment, in comparison with other ownership models)**

Ownership model → Funding destiny ↓	Model A	Model B	Model C	Model D	Model E
Land purchase	5	4	0	0	0
Technical assistance farmers	0	3	5	5	5
Techn. ass. Enterprise dev't	1	1	1	4	5
Plantations <sup>25</sup>	5	4	3	2	1
Processing equipment <sup>26</sup>	5	5	5	3	3

Conventional capital sources (bank loans and conventional venture capital) are not considered in this manual because they are more appropriate for Models A and B, which do not or only

<sup>24</sup> Including technical advisory.

<sup>25</sup> The funding needs per ha of plantation tends to be lower in the case of model D and E because farmers generally contribute their own labour. On the other hand, the risk of plantations being abandoned is higher in the case of models D and E. In the end, the investment per ha that reaches full production may be similar for all models.

<sup>26</sup> Investments in equipment tend to be lower for Models D and E because their markets are generally local or even internal, while models A,B and C generally produce for export markets with high quality standards.

scarcely involve small farmers. Of course, this does not mean that these sources are not feasible for models C, D and E. Please consult your local bank branch for more information.

6.2.3.5 Alternative financing schemes

In this section, two alternative finance schemes will be described that are considered appropriate to develop in combination with a project that builds a jatropha production chain. The first scheme shows that biofuel production can actually increase food production using the production capacity of the jatropha plantations as a guarantee. The second scheme describes how the processing enterprise can create additional, cheap working capital that also helps to boost sales.

**1. Using Jatropha to increase access to credit for food crops**

In the food-fuel debate, fuel crops are often blamed for affecting food production. In this section an example will be given of how an integrated financing model for biofuel and food crops can actually stimulate food production. The model described below is especially relevant for enterprise models D and E (farmer (co-) owned processing enterprise) and in a context of underutilization of arable land.

Many farmers only cultivate part of the arable land they possess. When one asks a small farmer why he does not plant all of the land with food crops, one of the main obstacles mentioned is generally the lack of **access to credit**. Financial institutions are very reluctant to finance basic grain production, especially to small farmers who tend to consume (and not sell) a large part of their production. As a result, many farmers sow with a minimal of inputs<sup>27</sup> or are forced into deals with middlemen or loan sharks that rake in a large proportion of the farmer’s margin.

Jatropha can provide a stable financial basis to make small farmers independent from (unwilling) financial institutions or (exploitive) loan sharks and middlemen, although initially external support remains necessary. Pivotal to the strategy is the Biofuel Processing Enterprise (BPE). External funding may come from private investors or bank loans contracted by the BPE, which in turn administers the loans to small farmers. The strategy involves:

**Table 6-9 Using jatropha plantations to increase access to credit for food crops: strategy description of per actor**

Year	BPE	Farmers
1-3	BPE gives in-kind support for the establishment and maintenance of jatropha plantations (land preparation, seeds, fertilizer,).	Farmers are stimulated to grow food crops in between the jatropha rows <sup>28</sup> .
4 -50	BPE gives loans in-kind for maintenance of jatropha plantation and for food production <sup>29</sup> .	Farmers repay the loan in the form of jatropha seeds and (if the farmers wishes so) basic grains.

<sup>27</sup> In fact, this explains large part of the low land productivity in many developing countries.

<sup>28</sup> The presence of a rural development NGO or state entity that is willing to provide loans for basic grain production, would be a great help.

<sup>29</sup> The value of the food production loan is determined on the basis of the expected value of the jatropha harvest for the same year.

This approach is still in its design stage in Yoro, Honduras. It will be implemented when jatropa plantations have become fully productive and new investments funds are available.

The model has various advantages:

1. Administration of the loan by the BPE instead of a financial institution reduces financial risks in several ways:
  - The risk of self-consumption of grains (and thus lack of cash at the moment of paying their debt) is eliminated. Farmers can consume (or sell to third parties) as much corn as they want because the value of the jatropa harvest is sufficient to cover the entire value of the loan.
  - The risk of loan deviation or robbery is reduced because all transactions take place in kind (or locally circulating vouchers).
  - The risk of farmers selling jatropa to third parties is small because – at least for the moment – these third parties do not exist.

Fewer risks can be translated into lower financial costs for the farmers. In order to limit the credit risk further, the value of the loan can be limited to – for example – 50% of the value of the expected jatropa harvest of that year.

2. The model gives loan access to farmers that normally are not considered by financial institutions. The BPE offers a collective guarantee (production capacity, buildings, a well-founded business plan, assured markets) that individual farmers cannot offer.
3. The BPE can obtain discounts for buying inputs at wholesale prices. The costs of BYSA for administering the loans to farmers can be covered largely by this discount.
4. The BPE can also act as a trader for grain for the farmers as an additional task, it only requires more investment in a storage facility for grain at the BPE
5. In case the BPE also produces animal fodder, basic grains are an important ingredient (as well as edible oil presscake of possible other crops promoted by the BPE). The added value that derives from this transformation, puts BYSA in a position to offer higher prices for basic grains than most middlemen.

A voucher system, as described in the following section, may facilitate these transactions. The BPE issues loans in the form of vouchers to farmers, who can go to predetermined distribution points to withdraw their agricultural inputs. This reduces the BPE's need for (cash) working capital and thus decreases its financial costs.

## **2. Vouchers for local economic development**

An innovative way for a BPE to raise working capital is the issuing of biofuel-backed vouchers. These vouchers are basically debt of the BPE to the bearer of the voucher. The voucher gives the bearer the right to buy biofuels from the BPE for the amount mentioned on the voucher. The BPE can issue the vouchers in two ways:

1. Purchases of the BPE: e.g. buying seeds from farmers, paying transport services, payment of personnel.
2. Loans of the BPE to farmers (or other local economic players).

In practice the issuance will be a mixture of vouchers and national currency. The proportion of vouchers that is acceptable for the receiver depends on the expenditure pattern and on incentives given by the BPE (e.g. bonus payment, lower interest rate on loans etc.). The introduction of vouchers is only feasible when the production has reached commercial levels and the BPE has gained a significant level of trust and confidence among the local (economic) players.



Figure 6-9 Example of the local currency issued by the BYSA processing company in Yoro, Honduras

The advantages of this voucher system for the BPE are multiple:

1. Increase of the working capital at zero cost (the emission of a voucher is in financial terms equivalent to receiving a loan at 0% interest).
2. Increase of sales: each voucher spent into emission is a secured sale in the future.
3. More security: vouchers are not very popular targets for thieves and assaulters. The vouchers can only be spent locally, which increases chances of being detected<sup>30</sup> if stolen.
4. More institutional image building. The vouchers draw the attention of users and media, resulting in free publicity and positive image building.

The financial advantage for the BPE and the impact on the local economy can be enhanced by promoting a wider local trade network (shops, transport services, hairdressers etc.) that accepts the vouchers. In that sense, the voucher system can also be considered to be a tool to maximize the impact on the local economy of the wealth created by the biofuel chain.

For examples of working voucher systems in developing countries, please go to [www.stro-ca.org](http://www.stro-ca.org)

### 6.3 Sustainability of *Jatropha curcas* activities

*Main author: Winfried Rijssenbeek*

#### 6.3.1 Introduction

The sustainability of biofuels has become a great issue since interest in and the production of biofuels has increased significantly during recent years, because of soaring oil prices in 2007-2008 and stimulus programs of governments. The reasons for encouraging the production and use of biofuels by the government are threefold: mitigation of climate-change, support for domestic farmers and maintenance of energy security [1].

Unfortunately not all impacts can be qualified as positive. Due to the rapid growth of the sector, attention to biofuels was intensified and the impacts became more visible.

<sup>30</sup> In fact several counterpart organizations of STRO in Central America have been victim of theft and armed assaults. In all cases the vouchers have been left or thrown away.

Government and governmental organisations fear that unsustainable production of biofuels will lead to negative impacts on the lives of the poorest because they will experience lack of water, loss of land, reduced food security and less biodiversity [2]. Because of this, production of biofuels should meet a set of requirements leading to sustainable production, transformation and use. The requirements set out as guidelines, criteria and indicators are currently still being improved.

Many southern countries with low fossil fuel reserves have high expectations of biofuels. Biofuel is often seen as a panacea, as it offers a good opportunity for these developing countries or regions to have an independent energy production and to spend less on foreign exchange. Furthermore, the development of biofuels as a sector promises employment in rural areas. Currently, it seems that the attitude towards biofuels has become less positive in the richer northern countries. Whether southern countries will arrive at the same conclusion is doubtful, simply because the promise of being less dependent on fossil fuel imports, generating employment, and increasing export opportunities still remains.

It should be clear that FACT has included this chapter in the manual, with two objectives:

1. Sustainability is a must for all stakeholders, whether it concerns small or big projects. The aim is that jatropha activities can be sustained in the long term and that the benefits to those involved will be equitable and sustained.
2. For different players different sustainability criteria should be applied: a larger export scheme of jatropha has to adhere to different criteria than that of a small holder, producing on one ha. As FACT, we realise that the criteria that will be discussed are most of the first sort: applicable for larger scale.

FACT recommends only taking those that also apply for smaller scale, as they can be handy and useful as well.

### 6.3.2 Sustainability criteria and initiatives

There are a number of initiatives led by different parties that have seen first drafts and concept notes. Some have moved further to more detailed indicators. Some are biomass specific, others only include the production part of biofuels. Some focus only on one plant species, while others are directed only at export type of projects. Often these initiatives were started in OECD countries, as their governments demand sustainability as a condition of initiatives being financed or supported through their environment climate change funding.

It is not possible to discuss all of these drafts and notes. The most important ones - the roundtable discussion on biofuels and the Cramer Criteria - are discussed in annex E.5. As a result of this ongoing discussion, the international expert workshop on jatropha, FACT prepared a position paper on how business should best move in the field of jatropha. In this position paper the People Planet and Profit criteria were translated to the production of jatropha [3].

FACT follows the 3-P principle '*People, Profit, Planet*' in its work, emphasizing the need for food security, positive impact on the environment and income generation by local producers. A starting point was the establishment of sustainability criteria developed for the Government of the Netherlands (the so-called 'Cramer Criteria'). Under its programme, FACT will monitor the applicability of these criteria and work towards the further improvement thereof, taking into account other sustainability criteria under development, such as from RSB and more elaborated NEN 8080 criteria.

### 6.3.3 Tentative criteria for sustainable development of large scale jatropha production

#### People:

- No destruction of rural communities and villages or social structures.
- No infringement of common lands or traditional user rights.
- No displacement of people.
- Enhancement of local employment or income generation of local people.
- Decent wages to be paid.
- Preferably no dependency of a sole income source of people (risk avoidance).

Respect for the local people's livelihoods, resources use, their points of view and traditional rights is a must. Projects should improve local people's welfare and well-being. Ideally, they should include local ownership or partnership in the product chain. Risks of monoculture and only one income opportunity should be avoided, for both the involved population and the project management.

#### Planet:

- Take care on what is real waste or idle land.
- Minimal and no lasting environmental pollution in production by agro-chemicals and fertilizers.
- Greenhouse gas balance; net emission reduction compared with fossil reference, inclusive that of the application.
- No monoculture.
- No selection of lands with high biodiversity importance.
- Intercropping preferable, especially in the earlier years.

A careful analysis should be made on the land use, the nutrients and water uses for a large-scale project. In many instances, project implementers only find out later that the land planned for cultivation was already in use, e.g. in shifting cultivation as free pasture land, etc. The production of biofuels can learn a lot from food production: no monoculture, correct and timely application of plant nutrients, existing land use and soil classification maps, intercropping, alley cropping, etc. Biodiversity and conservation areas of today and likely of the future should of course be avoided.

#### Profit:

- Prepare clear business plans, based on conservative/proven data.
- Company profits preferably should be reinvested in the country.
- Jatropha should be, in the first instance, used to supply internal markets. Local use is more energy efficient and there is always enough internal demand.
- Company profits sharing with farmers, and farmers receiving decent payment.
- No excessive company profits.
- Income stability is as important as income height: diversification of the biofuel chain (e.g. intercropping edible oils) can help the enterprise to survive times of low fuel prices.

All the plans should be viable to all stakeholders concerned: a net profit for all stakeholders can be differently defined for each one. Some will see the profit in employment generation, whereas others might see the benefits of rural affordable modern energy. Such sustainable viability might require a sound legislative framework for food and fuel crops that might include minimum prices (safety net prices), accessible savings and credit schemes and training and extension.

Sustainability of income can also be for a target, by turning producers into stakeholders in the processing chain of the biofuel crop to a commercial fuel.

The issues are relevant for jatropha, but can also be applied to other biomass. Biomass options - when applied on a large scale - can have serious drawbacks. To mitigate their negative effects, a long set of criteria need to be established. FACT argues, therefore, that it is more effective to design a biomass operation in developing countries straightaway for the development of the local economy and adhere to the sustainable development goals:

- Poverty alleviation
- Biodiversity
- Environment
- Socio-economic development
- Participation of local stakeholders

This will more easily create an operation that is sustainable and, if successful, can be scaled up and checked regularly for sustainability using the Cramer Criteria or RSB and others.

#### **6.3.4. Conclusion**

FACT contributes to the discussion on sustainability from the multi-faceted practise of its pilot projects. What becomes clear is that “THE” sustainability problem does not exist, nor does “THE” solution exist. In each context biofuel initiatives result in changes in many areas, some positive, some negative. Many farmers and local NGOs feel that in small-scale initiatives with farmers the positive effects seem to outweigh the negative effects, although further investigation is necessary to prove this point.

General discussions on whether biofuel-driven development is good or bad have limited relevance without specific information on the region’s land and labour availability, the ownership structure of the initiative, market situation etc.

In general, it can be concluded that entrepreneurs of large-scale plantations should be much more aware of the possible impacts of their project during the development phase. Large-scale projects can more easily do harm to the environment and, on a longer term, the contribution to social and economic development will not exist unless it’s an objective of the project developers. When considering starting with jatropha production, feasibility studies based on sufficient, conservative and reliable data are important. Jatropha under current oil prices is likely to offer minimal margins. Furthermore, yields are often very context dependent. It is therefore recommended to start small scale to build up the required knowledge for a viable production and market development of jatropha end products, taking into account the sustainability criteria. Presently, there are practitioners that state that their jatropha project or business is sustainable. However, independent verification of these projects’ sustainability has yet to emerge. The verification brings some complexity, as sustainability criteria are still under development by various players and have not been tested sufficiently yet.

FACT supports sustainable development of biofuel production placing income generation for small farmers and the rural population as the highest priority. FACT supports initiatives for local use and applications. When the market is not for export and only for local use, it should be understood that it would very hard for these small farmers and local workshops to fulfil the western ISO-based standards for quality that are now being developed for the Cramer Criteria (e.g. NTA8080). This group has a very large potential, since about 70% of populations in Sub

Sahel Africa live in rural areas for example. FACT, therefore, strongly recommends that the criteria developed for export-oriented companies, will *not be applied* to the farmers. That is, in an out growers scheme it should be the aggregator or buyer and processor who will have to comply with the sustainability criteria. If these refer to the outgrowing scheme, the aggregator will have to support the farmers with the necessary conditions to adhere to those standards

Furthermore, FACT recommends national governments in developing countries should not apply these export-oriented sustainability standards for local producers under pressure of international bodies. Of course national governments can set their own standards and FACT recommends these standards to be feasible for rural people, small farmers and workshops, not imposing them with all type of conditions that only bring bureaucracy, and no output. To set up projects by local organisations that are socially, economically, environmentally and technically viable already requires major efforts. FACT recommends setting standards in the planning phase as some of the standards can be relatively simply addressed without consequences.

#### 6.4 References

1. GEXSI, [http://www.jatropha-platform.org/documents/GEXSI\\_Global-Jatropha-Study\\_ABSTRACT.pdf](http://www.jatropha-platform.org/documents/GEXSI_Global-Jatropha-Study_ABSTRACT.pdf) (p.14).
2. “Biocombustibles Yoro Sociedad Anónima”, a biofuel processing enterprise promoted by the FACT-Gota Verde project. See [www.gotaverde.org](http://www.gotaverde.org) and [www.fact-foundation.com](http://www.fact-foundation.com)
3. FUNDER (Foundation for the Development of Rural Entrepreneurship). See: [www.funder.hn](http://www.funder.hn).
4. GEXSI (2008), “Global Market Study on Jatropha, Final Report – Abstract”, p. 28. [http://www.jatropha-platform.org/documents/GEXSI\\_Global-Jatropha-Study\\_ABSTRACT.pdf](http://www.jatropha-platform.org/documents/GEXSI_Global-Jatropha-Study_ABSTRACT.pdf)
5. See <http://www.malibiocarburant.com/>
6. See: [http://www.fact-foundation.com/media\\_en/Major\\_findings\\_seminar\\_Chimoio](http://www.fact-foundation.com/media_en/Major_findings_seminar_Chimoio) for a report on the major findings of Chimoio Workshop, Nov 2008.
7. Although some literature suggests small-scale biogas bottling is not impossible. See: [www.idosi.org/wasj/wasj1\(2\)/12.pdf](http://www.idosi.org/wasj/wasj1(2)/12.pdf) for a feasibility study on a facility in Pakistan.
8. See for example the experience in Zambia: [http://www.umb.no/statisk/noragric/publications/master/2008\\_lars\\_olav\\_freim.pdf](http://www.umb.no/statisk/noragric/publications/master/2008_lars_olav_freim.pdf) (p. 30)
9. Perspective: “Jatropha biodiesel fueling sustainability”, WMJ Achten and others, Biofuels, bioproducts & biorefining, ISSN: 1932-104X, 2007
10. Small-scale Production and Use of Liquid biofuels in Sub-Saharan Africa: Perspectives for Sustainable development, Background paper no. 2, UNDESA, Commission on Sustainable Development, New York, 2007

11. Jatropha literature and perspectives review: Main potential social and environmental impacts arising from large-scale plantations, May 2008, Proforest ltd.
12. FACT position paper

#### **Recommended literature for sustainability**

1. Beleidsnotitie milieu en hernieuwbare energie in ontwikkelingssamenwerking, Ministry of Foreign Affairs, November 2008
2. FACT reactie op “Heldergroene Biomassa”, Stichting Natuur en Milieu, [www.fact-foundation.com](http://www.fact-foundation.com), 30 januari 2008
3. Empowering rural communities by planting energy, Roundtable on bioenergy enterprise in developing regions, background paper, UNEP, 2008
4. Roundtable on Sustainable Biofuels, Global principles and criteria for sustainable biofuels production, version zero, école polytechnique fédérale de Lausanne, Energy Center, 2008. Title: Version Zero - Principles for sustainable biofuels Version 0.0 (August 2008) RSB-Steering Board (<http://cgse.epfl.ch/Jahia/site/cgse/op/edit/lang/en/pid/70341>)
5. The state of food and agriculture, biofuels: prospects, risks and opportunities, FAO, 2008, ISSN 0081-4539
6. Discussion Note: Sustainable Biomass for Poverty Reduction etc, 19/07/07 tbv Food and Energy Workshop WR
7. 2 product philosophy prof. Kees Daey Ouwens

## E. PROJECT IMPLEMENTATION

### E.1 Multilateral funding agencies

The following multilateral agencies provide programs to accelerate and facilitate investments in renewable energy programs. The support can consist of grants, loans or guarantees.

Agency	Name Program	Website	Focus / conditions
European Commission (EC)	ENRTP <sup>18</sup>	<a href="http://ec.europa.eu/europeaid/where/worldwide/environment/working-documents_en.htm">http://ec.europa.eu/europeaid/where/worldwide/environment/working-documents_en.htm</a>	Environmental protection
	GEEREF	<a href="http://ec.europa.eu/environment/jrec/energy_fund_en.htm">http://ec.europa.eu/environment/jrec/energy_fund_en.htm</a>	Renewable energy; fund of funds: no direct project funding
Global Environment Facility (GEF)	Small Grant Program (SGP)	<a href="http://sgp.undp.org/">http://sgp.undp.org/</a>	Projects up to 50 000 US\$
	Medium-Sized Projects (MSPs)	<a href="http://www.gefweb.org/interior_right.aspx?id=16674">http://www.gefweb.org/interior_right.aspx?id=16674</a>	Projects up to 1 million US\$
	Full-Sized Projects (FSPs)	<a href="http://www.gefweb.org/interior_right.aspx?id=16674">http://www.gefweb.org/interior_right.aspx?id=16674</a>	Projects over 1 million US\$
World Bank	Climate Investment Funds (CIF)	<a href="http://www.worldbank.org/cif">www.worldbank.org/cif</a> <a href="http://go.worldbank.org/58OVAGT860">http://go.worldbank.org/58OVAGT860</a>	
Global Village En. Prog. (GVEP)		<a href="http://www.gvepinternational.org/funding/">http://www.gvepinternational.org/funding/</a>	See website
AfDB (African Development Bank)	FINESSE	<a href="http://finesse-africa.org/">http://finesse-africa.org/</a>	FINancing Energy Services for Small Scale Energy Users
	Clean Energy Investment Framework (CEIF)	<a href="http://www.afdb.org/en/topics-sectors/sectors/environment/climate-change-mitigation/">http://www.afdb.org/en/topics-sectors/sectors/environment/climate-change-mitigation/</a>	See website
ADB (Asian Dev't Bank)	Clean Energy Program	<a href="http://www.adb.org/Clean-Energy/funds-partnerships.asp">http://www.adb.org/Clean-Energy/funds-partnerships.asp</a>	Various funds, see website
IADB (Inter-American Development Bank)	FOMIN	<a href="http://www.iadb.org/mif/We_fund.cf?lang=en">http://www.iadb.org/mif/We_fund.cf?lang=en</a>	Latin America, enterprise development, mixed grants/loans possible
	SECCI	<a href="http://www.iadb.org//secci/">http://www.iadb.org//secci/</a>	Latin America
BCIE	ARECA	<a href="http://www.bcie.org/spanish/banca-inversion-desarrollo/desarrollo-competitividad/areca.php">http://www.bcie.org/spanish/banca-inversion-desarrollo/desarrollo-competitividad/areca.php</a>	Central America, "Acelerando las Inversiones en Energía Renovable en Centroamérica"
SICA	AEA	<a href="http://www.sica.int/energia">http://www.sica.int/energia</a>	Central America, grants up to 50 000 EUR
UNEP	SEFI	<a href="http://www.sefi.unep.org/">http://www.sefi.unep.org/</a>	Organises funders; no direct project funding
UNIDO	Renewable and Rural Energy	<a href="http://www.unido.org/index.php?id=o24839">http://www.unido.org/index.php?id=o24839</a>	See website

<sup>18</sup> Thematic Programme for Environment and Sustainable Management of Natural Resources, including Energy.

## E.2 Development organisations

The following list gives an overview of development organizations (both private and public) that have funding lines for renewable energy projects in particular. Development organizations generally provide grants. The project must have clear social objectives and innovative elements (pilot project or demonstration project) in order to be successful. For large scale replication, social venture capital may be a more appropriate source. The following gives an overview of some of the many funding sources.

Agency	Name Program	Website	Focus / conditions
REEEP		<a href="http://www.reeep.org/">http://www.reeep.org/</a>	See website
UN Foundation	Clean Energy Development	<a href="http://www.unfoundation.org">http://www.unfoundation.org</a>	See website
Senternovem (The Netherlands)	Daey Ouwens Fund	<a href="http://www.senternovem.nl/daeyouwensfund/index.asp">http://www.senternovem.nl/daeyouwensfund/index.asp</a>	Small-scale RE projects in LDCs. € 100,000 – 2,500 000. Max 50% of costs
Dutch Ministry of Foreign Affairs	Private Sector Investment Program (PSI)	<a href="http://www.evd.nl">http://www.evd.nl</a>	Investment subsidy (50-60%) for investments in developing countries
Shell Foundation		<a href="http://www.shellfoundation.org">http://www.shellfoundation.org</a>	See website
Energy Foundation		<a href="http://www.ef.org">http://www.ef.org</a>	Only China (and USA).
Blue Moon Fund	Rethinking Consumption and Energy	<a href="http://www.bluemoonfund.org">http://www.bluemoonfund.org</a>	Asia and Latin America
Rockefeller Brothers Fund	Cross-Programmatic Initiative: Energy	<a href="http://www.rbf.org">http://www.rbf.org</a>	Only South Africa and China (and USA)

Many development organizations that do not have a particular focus on renewable energy projects, have funded such projects in the past.

## E.3 Social Venture Capital

The past year the number of private funding institutions that invest in sustainable and socially responsible enterprises in developing countries has increased. Some focus specifically on renewable energy, such as E+Co, Triodos Renewable Energy for Development Fund and the African Bio-Energy Fund. Other finance a broader range of entrepreneurial activities. Large energy companies, pension funds etc. are also known to have co-invested in Jatropha undertakings in developing countries, as part of their Corporate Social Responsibility. These institutions do generally not provide grants but shareholder capital or loans. The list of organizations providing social venture capital is long and growing. For an updated list of organizations with a special focus on sustainable energy, see the Sustainable Energy Finance Directory (<http://www.sef-directory.net/>). For a member list of the European Social Investment Forum (Eurosif), see:

[http://www.eurosif.org/member\\_affiliates/list\\_of\\_member\\_affiliates](http://www.eurosif.org/member_affiliates/list_of_member_affiliates).

### Useful Links:

The **Sustainable Energy Finance Directory** is a free-of-charge online database of lenders and investors who actively provide finance to the sustainable energy (renewable energy and energy efficiency) sector worldwide. Free registration is required.

<http://www.sef-directory.net/>

For a list of bilateral development banks and agencies that deal with Renewable Energy projects, see: <http://go.worldbank.org/X33QHLOH70>

For a list of Ethical Banks that may be interested in investments in ecologically sustainable and socially just enterprises: [http://en.wikipedia.org/wiki/Social\\_Investment\\_Forum](http://en.wikipedia.org/wiki/Social_Investment_Forum)

The World Bank Renewable Energy Toolkit (REToolkit) provides a broad set of tools to improve the design and implementation of renewable energy (RE) projects.  
<http://go.worldbank.org/Y20OGSRGH0>

Natural Resources Canada provides the **RETScreen Clean Energy Project Analysis Software**. This free software that can be used to evaluate the energy production and savings, costs, emission reductions, financial viability and risk for various types of Renewable-energy and Energy-efficient Technologies (RETs). Free registration is required.  
<http://www.retscreen.net/ang/home.php>

Presentation of Fundraising for renewable energy projects by Judy Siegel, President, Energy & Security Group, April 19, 2006.  
[http://www.abanet.org/enviro/committees/renewableenergy/teleconarchives/041906/Siegel\\_Presentation.pdf](http://www.abanet.org/enviro/committees/renewableenergy/teleconarchives/041906/Siegel_Presentation.pdf)

“Overview of existing funding schemes for renewable energies” by Dr. Christine Wörlen, Head of Renewable Energy Department, German Energy Agency (DENA). Conference on Renewable Energies for Embassies in Germany, Berlin, June 26, 2007.  
[http://www.dena.de/fileadmin/user\\_upload/Download/Veranstaltungen/2007/07/2.3\\_Overview\\_of\\_existing\\_funding\\_schemes\\_dena\\_Dr\\_Ch\\_Woerlen.pdf](http://www.dena.de/fileadmin/user_upload/Download/Veranstaltungen/2007/07/2.3_Overview_of_existing_funding_schemes_dena_Dr_Ch_Woerlen.pdf)

“Innovative Financing Mechanisms for Renewable Energy Systems in Developing Countries”, Norberth Wolgemuth, *UNEP Collaborating Centre on Energy and Environment, Denmark*  
<http://www.earthscape.org/r2/ES14477/won01.pdf>

#### E.4 Technical Assistance

We hope that this manual contributes to the dissemination of realistic and reliable information on how to design and run a Jatropha project. If you wish more information on specific subjects, the FACT website ([www.fact-foundation.com](http://www.fact-foundation.com)) contains a large and well-selected literature section on many specific subjects related to the jatropha production chain. The wider internet is of course also a powerful information source, but beware for (often commercial) websites that state unrealistic yields and oversimplified descriptions of the biofuel chain. However, even with all this information available, the step from knowing to doing is often big to make alone.

**Commercial enterprises** engaged in establishment of jatropha plantations may be interesting as a source of information, market for seeds or source of finance (especially ownership models B and C). The five largest are<sup>19</sup>:

Enterprise	Website	Geographical focus
D1-BP Fuel crops	<a href="http://www.d1bpfuelcrops.com">www.d1bpfuelcrops.com</a>	Asia and Africa
Mission Biofuels	<a href="http://www.missionnewenergy.com">www.missionnewenergy.com</a>	Asia
Sunbiofuels	<a href="http://www.sunbiofuels.co.uk">www.sunbiofuels.co.uk</a>	Ethiopia, Tanzania
ESV Bio-Africa Lda	<a href="http://www.esvgroup.com">www.esvgroup.com</a>	Mozambique
GEM Biofuels	<a href="http://www.gembiofuels.com">www.gembiofuels.com</a>	Madagascar

<sup>19</sup> Source: [http://www.jatropha-platform.org/documents/GEXSI\\_Global-Jatropha-Study\\_FULL-REPORT.pdf](http://www.jatropha-platform.org/documents/GEXSI_Global-Jatropha-Study_FULL-REPORT.pdf)

The following **development organizations** may be able to provide free or low-cost technical assistance to initiatives which involve small farmers. For more information, please consult their websites and, if existing, their representative in your country.

Organization	Area of expertise	Website	Jatropha pilot projects
DED (Germany)	Jatropha cultivation, PPO technology	<a href="http://www.ded.de">www.ded.de</a>	Honduras, Peru, Sudan
GTZ (Germany)	Jatropha cultivation, PPO technology	<a href="http://www.gtz.de">www.gtz.de</a>	Africa and Lat. Am.
Engineers without borders (Int'l)	Soap making, engine adaptation, oil filtration	<a href="http://www.ewb-international.org/">www.ewb-international.org/</a>	Mali, Uganda, Tanzania,
Full Belly project (USA)	Manual Jatropha dehullers	<a href="http://www.fullbellyproject.org">www.fullbellyproject.org</a>	Honduras, Mali
STRO (The Netherlands)	All stages from project formulation to evaluation	<a href="http://www.stro-ca-org">www.stro-ca-org</a> <a href="http://www.gotaverde.org">www.gotaverde.org</a>	Central America
Practical Action	Technical advisory	<a href="http://practicalaction.org/practicalanswers/technical_enquiry_service.php">http://practicalaction.org/practicalanswers/technical_enquiry_service.php</a>	Free online technical enquiry service

### Government promoted National Jatropha Programs

The largest jatropha initiatives at this moment are actually government promoted poverty reduction schemes that generally promote outgrowing schemes target among small farmers selling to regional (public or privately owned) processing firms. The Indian and Chinese schemes are, due to the size of their population, the largest in absolute terms. Some of these schemes are highly controversial due to the food-fuel conflict that rises when planting vast areas with Jatropha as a monocrop. Some programs also have very little funding in comparison to their ambitious targets and have to be considered rather as political statement than as a real driving force. Please inform with your Ministry of Agriculture or Ministry of Energy if such a jatropha program exists in your country and what facilities it offers.

### E.5 Sustainability of Jatropha projects

*Main author Mara Wijnker*

When looking at the sustainability of Jatropha projects, most of the issues mentioned within the sustainability criteria of the Cramer commission and RSB are important. The issues can also be arranged according to the fields that are most commonly used to define sustainability, namely environmental, social and economic issues. Some of the issues belong to two or even three of the fields, but are mentioned in only one. Instead of a conceptualisation as criteria, the issues are here discussed in view of the potential impact on Jatropha projects.

Environmental	Social	Economic
Biodiversity	Workers rights	Wages
GHG emission	Working relationships	Improvement of income
Land use	Community involvement	Commercial interests
Impact on soil, water, air	Land rights	Food vs. Fuel / Transport

**Table: sustainability aspects of Jatropha projects**

“Jatropha projects” need to be explained better. When considering sustainability, a distinction between small scale (up to for ex. 1500 hectares of Jatropha plantations) and large scale, monoculture plantations should be made. Large scale plantations imply making use of economies of scale with higher level of mechanisation and therefore employing fewer people, acting out of commercial interest.

As the impacts of large scale, monoculture plantations are much larger, these are discussed here. At the end a comparison is made between the impacts caused by large and small scale plantations

Next to the area of the plantations, there are many other characteristics that should be taken into account when looking into detail at Jatropha projects, like the technologies used, number of (local) people involved, organisational system (own plantation, outgrowers or cooperation) etc. This paragraph will give a brief overview of general applicable sustainability aspects of Jatropha projects, as mentioned in the table above.

### **E.5.1 Environmental aspects**

#### **1. Biodiversity and conservation areas**

Biodiversity is an important issue in all plantations made for production of bio fuels as usually this is done in monoculture and after clearing of the land. Therefore, the impact on the biodiversity depends on previous land use and intensity of production. If the land was previously covered with primary natural vegetation it is different as when it was recently cropped before or left some time as bad land. The impact on biodiversity can for most countries be mapped out. In most countries all sort of maps have been prepared with areas with high biodiversity potential. Often this coincides with the countries protection of areas with special nature conservation values, that cannot be used. In fact, often it requires all these high value and protected areas to be projected on one map. As a result the zones left out of the biodiversity/conservation/protection areas might be considered for production.

In some cases some of the protected areas however allow for planting of trees for the local population, for animal protection and so on. A case of Tanzania projecting all the claimed areas showed that most area of the country was not available for Jatropha plantations.

A good example is the study of Pro Forest Ltd. that looked at *savannah woodland, miombo woodland, mopane woodland or dryland forest* biodiversity [3].

Biodiversity can be changed positively or negatively when wasteland only covered with little vegetation is replaced by Jatropha. (Ref Kumar on Jatropha workshop of FACT). The Jatropha plants might improve soil structure over time providing a habitat for some species, reducing some others. Biodiversity is about the variety of species in a habitat. In some cases it is difficult to assess the balance.

#### **2. GHG emissions**

GHG emissions of Jatropha can be in the plant production area, in the conversion to a fuel, in the distribution to the end user in the form of electricity, soap, bio-fertilizer, or other end products. Some of the end products result on more GHG emissions as others. Eg. 90% of the lifecycle GHG emissions of Jatropha biodiesel are a result of the end-use.

In each of these production parts of the chain, different conditions can rule per project. It is therefore not possible to refer to one Life Cycle Analysis (LCA) outcome for Jatropha. Each project will have to be done using the typical conditions of the project. In order to compare the different effects of different Jatropha planting projects it is important that one LCA methodology is arrived at over time. This will help the Jatropha practitioners community to choose the best options balancing economics and GHG emission reductions. A number of LCA's and CO<sub>2</sub> emission estimation methods have been developed by different research institutions. Such as University of Leuven, Belgium, EMPA<sup>20</sup>, which is an interdisciplinary research and services institution for material sciences and technology, Switzerland, Chiang Mai University<sup>21</sup>, Thailand, etc..

When looking at the LCA's some factors seem to be more prominent as others. Herunder some will be discussed.

- GHG emissions of changing land-use for Jatropha production should also be taken into account, as the site is cleared of its original growth. Magnitude of contribution to the carbon emissions depends very sharply on the kind of original land. It can be expected that when changing wasteland, the carbon sequestration in the soil will be improved, while changing woodland into Jatropha plantations, GHG emissions are caused.
- Plant nutrients needs to be used in some amount as the soil will become poorer from production of Jatropha plants. It is possible to use the Jatropha press cake as an organic fertilizer, but then the cake will have to be brought back from the processing unit to the land where Jatropha was produced. Depending on the organisation of the project, this is possible or not, with transportation costs as an important parameter. From a sustainability point of view this is a good option. If organic fertilizer can be used, or fertilization with N fixing leguminous cover crops can be applied, this is to be preferred above chemical fertilizer, as especially the production of chemical N fertilizer requires a lot of energy, which today is most fossil based.
- Biodiesel production increases the amount of GHG emissions compared to the production of oil as an additional step is added, in which chemicals and more energy is used. Furthermore, this is also an expensive step in the process and slightly complicated as some processing equipment needs to be used. For these reasons small scale projects in rural areas usually produce only bio-oil. When looking at the energy balance, the production of biodiesel does not gain as much in energy as is used during its production. So, from the energy balance point of view, it's less beneficial to add this step.

### **3. Impact on soil, water, air**

In marginal land Jatropha will have a positive influence on the state of the soil as it will improve the vegetative structure and biodiversity and the roots will provide a structure protecting against soil erosion. The reverse can be expected when woodlands or savannah lands are changed into Jatropha plantations though.

Furthermore, when no nutrients are brought back to the plantations after harvesting, the soil will become poorer. So Jatropha's impact on the soil will be depending on what was the previous vegetation, what are the cultivation techniques of Jatropha, etc.

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<sup>20</sup> Simon Gmünder (EMPA)M. Classen, R. Zah P. Mukherjee, S. Bhattacharjee (Winrock India)**Life Cycle Assessment (LCA) of Jatropha-based Rural ElectrificationCase Study: Village Ranidhera, Chhattisgarh**

<sup>21</sup> Life Cycle Management of Jatropha Bio-Diesel Production in Thailand, [Sate Sampattagul1](#), Chonticha Suttibut, Sadamichi Yucho and Tanongkiat Kiatsiriroat, Faculty of Engineering, Chiang Mai University Thermal System Laboratory, Department of Mechanical Engineering, Faculty of Engineering, Chiang Mai University, Thailand 50200 Corresponding Author: [sate@eng.cmu.ac.th](mailto:sate@eng.cmu.ac.th)

Jatropha can survive in climates with a steady rainfall of at least 600.. To bear fruits more rain is needed though. Depending on the climate no irrigation might be necessary although yields can be improved much through sufficient water supply. Use of water can be limited for Jatropha, it will then shed its leaves, and can resist drought. However with no leaves no serious photo synthesis takes place.

Jatropha plantations can be used to introduce water catchment methods as well, such as earth boundaries and small dams on sloping terrain, contributing to a raise in ground water level with all beneficial results. This was a common use of Jatropha in some Sahel countries.

Most important impact on air has been discussed in previous the section, but here there relation is to be made with not only the emissions of the agricultural and transport activities for Jatropha establishment and operation, but also in the area of combustion of Jatropha PPO in engines and the processing in Biodiesel and its use as well as in the biogas use from the Jatropha press cake.

### **E.5.2 Social aspects**

Because of the labour-intensive way of harvesting Jatropha, jobs can be created for communities. Large scale plantations create work for local inhabitants. When harvesting will be done mechanically though, in the near future, less employment creation can be expected, but higher wages. In the longer run mechanised harvesting is a condition for social progress. Harvesting labour cost is the single most important cost item in jatropha oil production. The low labour productivity in harvesting makes that profitable jatropha production is currently only feasible in very low income countries (< 2,50 US\$ per day). This is insufficient to provide decent living standards. Moreover, labour shortages are to be foreseen if plantations expand and other (more productive) economic sectors develop.

Job creation does of course not necessarily imply that working conditions are good. If the number of people within the area willing to work within the plantations exceeds the necessary number of people, management of the plantation will have a strong position and doesn't necessarily have to take care well of his/her personnel in terms of wages, labour conditions etc.

Setting-up processing facilities by investors, local or foreign, also can create jobs for communities, and if there is a long term involvement of communities it would ensure long term stability.

FACT's project in Mali is a good example of this as production of Jatropha, production of oil and electricity production and use are integrated in the village area of Garalo, whereby project ownership has been established in the village. Another example is BYSA, the Honduran biofuel processing enterprise that is owned 49% by supplying farmers and 51% by a non-profit rural enterprise development institution (FUNDER). Within small scale projects community ownership and continuous involvement is necessary to make a project sustainable. In large scale projects, the relations with farmers might be less tight, e.g. in the case of seasonal contracting of workers involvement of the community might be minimal.

### ***Land rights***

Because of the large commercial interests of foreign companies influencing governments of Southern countries, sometimes rights of people living in remote areas are ignored. Often the government owns the land and rents it out to foreign companies who might be paying more

than sufficiently. People originally living or working at these lands might then be evicted. Therefore most sustainability criteria add the land right issue, stating that the local land rights and ownership (formal and informal) should be respected.

### **E.5.3 Economic issues**

Most important is the financial sustainability of a Jatropha project. This depends on a number of issues as the world market price of petrol oil, government policy (e.g. fuel subsidies), the local wage level to be paid to either farmers or seed pickers, costs of transport for seeds and oil/diesel, investment costs of equipment and their efficiency, whether land needs to be cleared, whether irrigation is necessary etc. Furthermore, a reliable and not overoptimistic prediction of the yield is important. Further reference is made to Chapter Economic and Financial aspects (peter)

Wages cannot be high as margins to make a profit out of Jatropha oil are small. Small farmers are usually paid per kilogram of delivered seed. If farmers decide to cultivate Jatropha next to their "normal" crops an increase in income can be expected, creating possibilities for development. If local people are working for large scale plantations, their benefit will mostly likely be reduced to their daily wage.

Because of the large interest for use of biofuels in general and Jatropha curcas L. specifically, it is likely that politics will be influenced. Furthermore, if large commercial investors are interested in using for example areas that can be used for food crops as well, commercial interests can become more important than social/environmental impacts.

#### **1. Food vs Fuel**

For farmers it is a decision based on economic reasoning whether they will produce food or fuels. For a country as a whole, or even the world it can become an issue to stimulate farmers to grow food instead of fuels if a lack of food crops exists, see ref [9]

On the controversy of fuel and food, it is clear the issue can play in wrongly designed projects that are focussing on large scale production of biofuels which are often geared to export. However, if in projects of biofuels production and use the local population is served, and attention is paid on combining food and fuels including intercropping, improved food seeds, recycling of nutrients, improved agricultural practices, the same acre can deliver more food and also biofuels as in most current low productivity conditions. In e.g. the FACT projects in Honduras, Mozambique and Mali; the Gota Verde, ADDP Mozambique, and with Mali biocarburant company and MFC agricultural extensionists are promoting this approach.

Where successful intercropping can be developed, Jatropha production will be able to go hand in hand with food production. Furthermore, Jatropha can grow on marginal land which is not used for food production. Often there are other, more important barriers to (efficient) food production, than just the availability of land. Access to credit is known to be such a barrier in the case of small farmers. In chapter 6 an example is given of how jatropha plantations of small farmers can be used as a collateral in a staple crop financing scheme, even without involvement of financial institutions.

The food versus fuel discussion is not very relevant when farmers decide to use land that was not in use before for food production and specifically if this is land that cannot be used properly for food production because of its poor soil. Very small scale plantations as well as use of Jatropha in hedges does not confine to this discussion as well.

The discussion becomes relevant when a large amount of fertile land is used and especially when this land used to be cultivated for food production.

In the view of FACT it should be left to the farmers to decide what to farm, based on informed choices and their balancing of returns and risks. In some cases farmers might use even a strategy to produce a crop that can be used for both

## **2. Transport**

In general more transport during each of the steps in the production phase contributes to more GHG emissions as well as to additional costs. It depends very much on the magnitude of the area that is covered within a project and whether seeds are processed solely central or also decentralised/mobile. For large scale production careful planning on the logistics is needed. For smaller plantation activities small, manual dehullers (separating the seeds from the rest of the fruit) are cheap and have a large capacity (see section 3). They permit farmers to add extra value to their product, while at the same time reducing transport costs. Here again a balance is to be found.

## **3. Impacts compared**

The Table above provides in short an overview of the impact of small scale and large scale plantations on the different fields that define sustainability. Normally big large scale projects have proportional big impacts, but many small activities might also have a big impact when counting all together. As clear from the above, it is not easy to make general judgements on effects of one big project or many small projects that are producing the same. Normally one large scale production of *Jatropha* should have positive scale effects, but this might be lost due to less motivated staff, bureaucratic inefficiencies, etc.. Many small projects with motivated small entrepreneurs might also gain benefits of scale effects when buying through e.g. a producers association.

The large scale projects that want to be delivering biofuels to the EU market, will have to abide by the sustainability criteria. This will more or less aim to bring them under strict

Frame work similar to EU. The extra costs might be compensated by the higher price for sustainable biofuel. Producers for other markets, local or other regional markets, might not have to abide. Also small farmers might also understand less of the criteria and take wrong decisions, like cutting down forests or enter in conservation areas, to cultivate *Jatropha* as it was suggested a profit crop.

**The Round Table on Sustainable Biofuels:** This initiative is initiated by the EPFL (École Polytechnique Fédérale de Lausanne and has both businesses as R&D and practitioners amongst its participants. The principles touch the following aspects of activities in biomass legality, Consultation, Planning and Monitoring, Climate Change and Greenhouse Gas, Rural and social development, Food security, Conservation, Soil, Water, Air, Economic efficiency/ technology/ and continuous improvement, and Land Rights. Details of the criteria can be found in the annex.

The WNF has as part of the RSB aimed to set up a working group on *Jatropha*. In 2008 a first workshop was held in Brussels on this special *Jatropha* production and conversion sustainability. Reports that are strongly recommended to look at are: Sustainability standards for bioenergy of WWF.

*Legality*

1. Biofuel production shall follow all applicable laws of the country in which they occur, and shall endeavor to follow all international treaties relevant to biofuels' production to which the relevant country is a party.

Key guidance: Includes laws and treaties relating to air quality, water resources, soil conservation, protected areas, biodiversity, labor conditions, agricultural practices, and land rights, including for instance ILO, CBD, UNFCCC, and the Universal Declaration of Human Rights. This standard can go beyond national law, but cannot contradict or contravene national law.

*Consultation, Planning and Monitoring*

2. Biofuels projects shall be designed and operated under appropriate, comprehensive, transparent, consultative, and participatory processes that involve all relevant stakeholders.

Key guidance: 'Biofuel projects' refers to farms and factories producing biofuels. The intent of this principle is to diffuse conflict situations through an open, transparent process of stakeholder consultation and acceptance, with the scale of consultation proportionate to the scale, scope, and stage of the project, and any potential conflicts. The RSB will develop a scoping process to help determine the extent of the stakeholder consultation based on key criteria. Where many farmers are engaging in the same activity in the same area, there should be flexibility for a group of farmers to combine their work.

*Climate Change and Greenhouse Gas*

3. Biofuels shall contribute to climate change mitigation by significantly reducing GHG emissions as compared to fossil fuels.

Key guidance: The aim of this principle is to establish an acceptable standard methodology for comparing the GHG benefits of different biofuels in a way that can be written into regulations and enforced in standards. The overriding requirement is therefore a methodology that is not susceptible to subjective assumptions or manipulation. The fossil fuel reference shall be global, based on IEA projections of fossil fuel mixes.

*Human and labor rights*

4. Biofuel production shall not violate human rights or labor rights, and shall ensure decent work and the well-being of workers.

5. Key guidance: Key international conventions such as the ILO's core labor conventions and the UN Declaration on Human Rights shall form the basis for this principle. Employees, contracted labour, small outgrowers, and employees of outgrowers shall all be accorded the rights described below. 'Decent work', as defined by the ILO, will be the aspirational goal for this principle.

*Rural and social development*

6. Biofuel production shall contribute to the social and economic development of local, rural and indigenous peoples and communities.

*Food security*

7. Biofuel production shall not impair food security.

*Conservation*

8. Biofuel production shall avoid negative impacts on biodiversity, ecosystems, and areas of High Conservation Value.

Key guidance: HCV areas, native ecosystems, ecological corridors and public and private biological conservation areas can only be exploited as far as conservation values are left intact and can in no case be converted. Definitions of these terms and an appropriate cut-off date will be developed by the RSB.

#### *Soil*

9. Biofuel production shall promote practices that seek to improve soil health and minimize degradation.

#### *Water*

10. Biofuel production shall optimize surface and groundwater resource use, including minimizing contamination or depletion of these resources, and shall not violate existing formal and customary water rights.

#### *Air*

11. Air pollution from biofuel production and processing shall be minimized along the supply chain.

#### *Economic efficiency, technology, and continuous improvement*

12. Biofuels shall be produced in the most cost-effective way. The use of technology must improve production efficiency and social and environmental performance in all stages of the biofuel value chain.

#### *Land Rights*

13. Biofuel production shall not violate land rights.

The Cramer commission has in 2007 produced a report on the topic of biomass sustainability that at the time was considered state of the art. [ref;;;;] Their report has used sustainability criteria prepared for different biomass sources. For the discussion some essential parts of the report can be highlighted, it becomes clear that:

- The commission has searched to link to existing criteria for sustainable development, rather than inventing the wheel again.
- Many of the criteria still need to be elaborated to operational indicators.
- Greenhouse gas balance; net emission reduction compared with fossil reference, inclusive of application, is at least 30% for now, and up to 50% from 2011.
- In the competition with food and other basic needs, the commission assumes that the biomass will be exported rather than used locally. There should be insight into the availability of biomass for food, local energy supply, building materials or medicine.
- Biodiversity is now focussed on plantations not being located close to protected areas; other aspects still to be elaborated.
- Economic prosperity criteria are limited to ensure that no negative effects are generated by biomass production business, but they are not focused on the contribution to the local economy.
- Well being is much more elaborated in 5 sub points,
  - o Aspects on working conditions,
  - o Human rights,
  - o Property rights,
  - o Social effects of the biomass cultivation,
  - o Integrity is countering bribery.

The environment points relate to the inputs (integrated crop management) appropriate use of fertilizers, soil conservation and conservation of water (ground and surface water).

So the Cramer commission criteria are applicable to large scale cropping systems, but not on the processing, and not on the effects of market changes or applications due to such large scale biomass production. These points should be included if one wants to consider a chain concept .i.e from a biomass crop to a end product with a market.

Based on the Cramer criteria a workgroup of parties in the Netherlands including Standards institutes, Power companies, Environmental and Development NGO's have produced a NTA 8080 which is a more specific elaboration of the Cramer criteria. Amazingly the document is in Dutch language. It is well defined but in some cases presumes the existence of data and institutes that are not commonly found in developing countries.  
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