Conference report: Jatropha Expert Meeting

Perspectives of Jatropha Production and Processing for Small-scale Producers

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Over the last few years, Hivos has engaged in various pilot biofuel programmes, mostly involving *Jatropha curcas*. These programmes have the intention to provide additional cash income for the farmers who grow the crops and may have additional features, such as adapting engines, converting the pure plant oil into bio-diesel, or even wider goals such as providing the community with renewable energy or dynamising the local economy.

Biofuels have been widely criticised for several reasons, such as displacing food crops and thus reducing food security and possibly food sovereignty, land grabbing, causing large-scale deforestation or clearing of natural vegetation, pushing small-scale farmers into exploitative labour relations or contract farming with large companies, etcetera. Being aware of these criticisms, Hivos established criteria to be fulfilled before engaging in biofuel projects. It also decided that no new pilots would be started before having more insights in the outcome of these pilots. In order to assess its first experiences with biofuels, Hivos conducted a meta-evaluation of all its six biofuel programmes. This study examined if the introduction and processing of biofuel crops have brought the farmers the expected additional income and contributed to the local economy, or that – on the other hand – the introduction of these crops has resulted in negative unintended consequences whereby communities are actually worse off than before.

The meta-evaluation brought many insights, but also evoked many questions. For example, if small-scale biodiesel production is not financially feasible now, at what international oil price would it become so? If Jatropha production yields are low now, can we expect them still to rise and what would have to be done to achieve that? Or would we have to opt for a more divers approach including other (food) crops? Would farmers be more interested in the crop if returns to labour where better, e.g. if shelling machines were available? It was decided to further research some of the most crucial of these questions and bring the outcomes together with those from the evaluation in a publication focusing on the benefits for small-scale Jatropha producers and processors, and elaborating the prerequisites and strategies for maximising these benefits.

On Wednesday 3 October, Hivos organised an expert meeting to present the findings of the meta-evaluation of the Hivos projects, to discuss the preliminary conclusions of the publication and to stimulate exchange and discussion between all types of public and private actors involved in the Jatropha and/or biofuel sector. It brought together development workers, NGOs, academics, business, politicians and consultants working and interested in this field, and aimed to generate a substantiated perspective on the way forward. Does Jatropha production by small-scale farmers have sufficient potential for benefits to justify its promotion? If yes, how can we make that happen and in which way can we maximise the benefits for small-scale farmers?

Lessons learned & ongoing questions

Some years ago, Jatropha was presented as wonder crop: a crop that would grow anywhere, require nothing, produce anyhow. However, the results in practice in amongst others the Hivos pilot projects have been rather disappointing with regard to both outputs and inputs.

During the meeting, various speakers presented their studies and experiences concerning Jatropha production and processing, and the involvement of and benefits for small-scale farmers. The variety and depth of insights did not only result in knowledge integration, but sometimes also in discussion, contrasting observations, and new questions. Below, an overview is given of the main learning, issues of debate, uncertainties and recommendations that have been identified.

Jatropha production

Jatropha has been depicted as a crop that requires little attention and can thrive on degraded and dry soils; it would just be a matter of plant it and let it grow. Although Jatropha production indeed requires relatively few inputs in comparison to many other crops, various limitations have been identified with regard to its production. Firstly, the average yield generated in the Hivos pilot projects was just about 0.2-2 ton/hectare after 3-7 years, rather than the envisioned 2-7 ton/hectare after 3 years. Moreover, the oil content of the seeds was considerably lower than expected (20-28 per cent rather than the suggested 33 per cent). Earlier reported high yields have been made in demonstration plots under strict and special conditions, and cannot be replicated in most settings. Furthermore, many sites do not have the right agro-climatic conditions for Jatropha. It is estimated that more than 80% of all Jatropha is planted at sites unsuitable for Jatropha.

Practice has in addition showed that Jatropha production requires considerable effort just like any other crop and that Jatropha does not produce sufficiently under poor conditions: Without sufficient care, water and nutrients Jatropha will survive at most locations but the yield is insignificant. Last but not least, Jatropha trees only start to generate a substantial yield after a couple of years. Research suggests that after five years of production, we can only expect about 25 per cent of the yield at full maturity. Yields only stabilise after 8 to 9 years.

Various factors can be identified which are conducive to Jatropha production. Apart from good soil and climatic conditions, these are improved accessions, land preparation, adequate planting distance, intercropping of crops with nitrogen-fixing properties, fertilizer, possibly irrigation, weeding, and integrated pest management. Pruning was also considered important, with studies suggesting that pruning would result in a higher yield. However, this observation was countered by a representative of a company involved in Jatropha, who argued the opposite and suggested that you should not prune in order to get the best yield. So here additional research is required.

Technical assistance is perceived vital to successful production, and should involve improved input packages, as well as and planting, growing and pruning instructions. There is a need for seeds (accessions) with improved characteristics, such as disease resistance, larger seed size, higher oil content, easier to shell and a harvest cycle that does not coincide with that of other crops. Nevertheless, experience with introducing for instance high yielding hybrid seeds of maize into low-input farming systems have shown that their impact is limited because other factors keep production down. The impact of high yielding Jatropha may therefore also be limited in low-input farming systems. Also, Jatropha appears to respond less strongly to extra inputs than crops such as maize. This implies that adopting a more commercial approach with high inputs will not easily result in a manifold higher production. Until better planting material is available Jatropha is therefore best suited for low-input agriculture. Little experience exists at this point with regard to high-yielding Jatropha varieties and hybrids will only become available on the market in the next few years.

The working group on production formulated the following points of attention recommendations with regard to Jatropha production:

- Make a long-term plan
- Do not plant in monocultures
- Reduce the risk for farmers (investment, guarantees that seeds will be bought from farmers (see also under farmer organisation)
- Demonstration fields (test possibilities first in a realistic setting)
- Choose the right locations (start on better fields, show example)
- Clarify it is for local development (farmer is the beneficiary and what can be expected; farmers should take ownership of problems. Question whether there is an energy or an income need.)
- Connect with local / national policy (legislation; advisory systems) and rural electrification (with national governments)
- What you plant should be good (good varieties to start with)
- Work has to be done to make improved accessions available, improved input packages and planting/growing/pruning instructions

Jatropha processing

The processing and application of Jatropha seeds turned out to be characterised by various bottlenecks as well. Both the harvest and shelling of Jatropha seeds is time consuming. While there are no devices (yet) to speed up the harvesting, shelling can be done more efficiently with a manual or motorised shelling machine. However, overall motorised shelling devices are far too expensive for smallholders.

Pre-treatment and storage of Jatropha also need attention. The seeds need to be well dried (resulting in a humidity level of under 20 per cent) and stored in a dry environment in order to prevent the seeds from deteriorating which result in oil which is too acid. On the other hand, Jatropha has the advantage that its seeds and press cake can be kept for a prolonged period of time under good conditions, and faces less deterioration problems than for example cassava. This may result in lower transport costs.

When it comes to oil extraction, various points of attention can be discerned. Firstly, manual presses are very inefficient and tiring, and therefore only feasible for small volumes such as with artisanal soap production. Solvent extraction is more efficient than expelling oil, but is not feasible at a small-scale operation level for several reasons: the minimum investment is 0.5 million Euro, the process is very complex and requires strict safety measures because of possible residues, testing capacity see if your product is free from solvent is lacking, spare parts are often not available, and solvent needed for the process may have to be imported.

This leaves mechanised extraction as the most efficient and feasible method for oil extraction for small-scale farmers. However, this type of extraction is only feasible at cooperative level, with production volumes of 100 litres/hour or (much) more. The technology is still in full development and a lot can be improved. In order to avoid acidification, Jatropha seeds should not be pressed too hard or exposed to high temperatures. Subsequently, the oil needs to be stored in correctly to prevent polymerisation.

As both solvent extraction and biodiesel production are relatively complicated and expensive, and biofuel prices cannot compete with fossil fuel prices now (see next section), processing of Jatropha seeds for biofuel use is not very feasible or attractive for many small farmers. It has therefore been suggested that you should focus on minimum processing, and use PPO instead of biodiesel. However, also with PPO impediments exist. Engine adaptations are necessary in cars to make them suitable for PPO. Although this is feasible at low cost (200 US$), it is very hard to convince car owners that it will not harm the engine. Stationary engines with indirect injection are the easiest and cheapest to convert. Such engines are typically used for agricultural machinery like water pumps, mills and generators. In many settings it is possible to sell the oil to those who have large diesel generators. In any case it is important to ensure the quality of the oil to avoid reduced longevity. When machinery for expelling and processing Jatropha oil is available, profitability may be increased by processing oil seeds from other plants found in the area. For instance Hugo Verkuijl noted that the majority of the profit from his company now does not come from Jatropha oil but from other high value oils with special use in for instance the cosmetic industry. Various alternative value-added products based on Jatropha oil (PPO) have been tested, including different soaps, baby oil, lamp oil, floor polish, and bio-pesticide. Although these applications have been proven profitable, the experience on which this statement is based is limited and perhaps not valid for all contexts. The wood of Jatropha is light and of low value. Prunings are usually left in the field as mulch.

Researcher Marieke Bruins suggested that Jatropha oil in itself will never generate much profit. When you look at soybeans for example, almost half of the profit made from it is derived from the meal. The challenge is to get more out of the Jatropha seeds than oil alone, and to valorise the press cake (residue valorisation) by making food or feed out of it. The fibre, lignin and especially protein in the press cake

can offer added value and attempts are made to generate animal feed from the press cake. However, also production of animal feed is not cost-effective for the moment, which is related to the fact that the press cake needs to be detoxified in order to become edible for livestock. Treating Jatropha for feed use is more complicated than with soy, and will probably not be feasible at a small scale. For now, it is unclear whether Jatropha press cake will be able to compete with non-toxic oil seed press cakes and to generate interest from the animal feed industry. Doubts have also been expressed with regard to the acceptance of (detoxified) seed cake by livestock; a participant suggested that animals will not eat it if they find a trace of the solvent. The seed cake can be digested very well in a biodigester, also in combination with other feed stocks with a high C and low N content. Moreover, it has been argued that valorisation requires large scale for logistic and efficiency reasons. Another option is to use non-toxic varieties of Jatropha. Such varieties exist in Mexico but have generally been disappointing when tested elsewhere. One company claims to have improved the performance of non-toxic Jatropha significantly but has not yet released the improved material. For small farmers Jatropha is attractive because it is poisonous and therefore does not require any protection. It is therefore not clear that non-toxic varieties will be of particular interest to them.

Another suggested application of the seed cake is for briquettes and charcoal, which can be made more or less profitably. Opinions about its suitability as a cooking fuel as briquettes or pellets are mixed. In some (mainly urban) settings it was successful, while it failed in others. There are studies that indicate that the smoke can be harmful for health.

The considerations above imply that processing for local use is preferred as long as the prices for PPO, biodiesel and animal feed are not attractive. This represents a different perspective from that of commercial export-oriented application, but does not mean that Jatropha has no use for local economic development. There are various potential applications of Jatropha that have a low market value, but can serve the local community well and substitute products that were otherwise bought from outside. Moreover, the local use of these products result in closed nutrient loops, and hence contributes to sustainability whereas most cash crops result in a constant nutrient export. For instance, branches and leaves can be used as compost or medicine, fruit waste and hulls can be also be used as compost, seed cake can be used as fertilizer (it still contains most of the nutrients after pressing and requires no treatment for this purpose) or as a source of biogas, and straight Jatropha oil can be used for cooking (stoves) and lighting (lamps). These forms of closed nutrient cycling can render Jatropha both economically and environmentally sustainable.

The working group on processing formulated the following points of attention recommendations with regard to Jatropha processing:

- So far the very large-scale processing of Jatropha has been successful only in few cases, while the community level is the other infeasible extreme. The level of the cooperative or even of groups of cooperatives, like organisations, looks promising.
- However, while growing Jatropha is relatively easy to learn for small-scale farmers, its processing is a whole different ball game and is far from common knowledge. Education is key, and should include training on the necessary technology.
- Mechanised extraction now seems the most efficient and feasible method for oil extraction for small-scale farmers. For mechanised extraction there are many models, brands, qualities and prices. Indian and Chinese models have proven efficient and spare parts are locally available. In some countries like Tanzania there is a local production of presses for Jatropha. *Nevertheless*, experience has found that in particular German made presses have performed well and are very efficient, albeit also rather expensive.
- Centralisation of logistics and administration is unavoidable both for pure plant oil production and for biodiesel production, not only for efficiency reasons, but also for oil parameter standardisation.
- The technological set-up for Jatropha processing is not yet fully developed and progress may be made in terms of mechanisation and processing technology

Economic viability

The economic viability of Jatropha production depends on various factors. When looking at the most appropriate locations to grow Jatropha, various issues should be taken into account. Firstly, you should look at the climatic and geographical zones in which production would be feasible. In practice, these are located in Africa, Asia and Latin America. However, production is not as viable or attractive in all of these regions. The level of wages is crucial; Jatropha production at small-scale producer level is only lucrative in low-income countries, which mostly excludes Latin America as a suitable production region because the minimum wage is 2 or 3 times as high as in Africa and some Asian countries. Collaborative research by Copernicus Institute, Wageningen University and Research Centre, and Technical University Eindhoven suggest that Jatropha can become profitable if the wage is no more than 4 USD per day, which is relatively high for Africa, but low for Latin America. Last but not least, Jatropha production is more competitive where fossil fuel prices are high. Africa, is therefore more attractive as production region than Asia. Moreover, African countries rank lowest in terms of the Human Development Index (HDI), which implies that investment in local production and energy generation is most warranted there.

Within these regions, some areas are preferable over others. Overall, excess land should be available, or Jatropha production should be more profitable than alternative non-food crops. Some areas can better be avoided because of pest problems or low water availability, while remote areas with high fuel prices are more attractive as biofuel generated from Jatropha is most likely to be competitive. At this point in time, the price of fossil fuel needs to increase 10-15 % (up to approximately USD 115) in order for Jatropha to become competitive for biofuel production in most locations (although many assumptions

are implicated in this expectation). For biofuel production, the price of Jatropha seeds in many regions too low for adequate returns on labour and too high for biodiesel production.

Research suggests that Jatropha production in plantations, with high overhead costs, is not economically attractive at current fossil fuel prices. For that to change higher yields have to be achieved. As the production of biodiesel and PPO for biofuel is complex, involves considerable costs, requires scale, and is risky with current volatile oil prices, it is also not very feasible at the small-scale level. However, this does not imply that Jatropha oil production has no use today. It does not cost a lot; the oil can be used directly in modified engines as explained earlier and there are various potential processing options of Jatropha that may generate income and benefits for the local community, making production at small-scale level attractive.

Various local applications have been tested, including compost/fertilizer, medicine, and fuel for cooking or lighting. Furthermore, cases suggest that Jatropha oil can be successfully processed into various kinds of alternative (marketable) products, including soap, baby oil, floor polish, and bio-pesticide(see previous section). For example, in pilots projects by Hivos in Zimbabwe and Mozambique, soap production generated an income that was 8 to 14 times higher than that of PPO production, while in Peru, Honduras and Brazil bio-pesticide production provided an income that was significantly higher than PPO production. Moreover, income can be increased by the sale of carbon credits generated by the planting of Jatropha trees. Only a few projects have done this so far but several projects are in the process of being certified for carbon credits. Nevertheless, more research is needed and the financial viability of the production of these goods will have to be evaluated for every specific setting and market.

Jatropha can become an additional cash crop that offers a continuous additional income if at least some basic conditions are fulfilled. First of all, as mentioned earlier, water availability should not be a problem, and excess land should be available, or Jatropha production should be more profitable than other cash crops. Secondly, mechanised dehulling is needed and competition for labour needs to be resolved. Without the availability of a shelling machine, it will be unattractive for farmers to opt for Jatropha except where wage levels are very low. Labour is often the limiting factor for the economic viability of Jatropha, and the returns on labour are more important than the returns on hectare. In many settings, Jatropha production for selling as oil can only be profitable when unpaid family labour is used when no shelling machines are involved.

Whether Jatropha production can be more lucrative than other cash crops partly depends on the efficiency and effectiveness of production and processing that can be achieved, which varies from region to region. As mentioned in the first section, multiple factors impact on the productivity of Jatropha, including the type of variety and the nature of the technical assistance provided. The income generated from Jatropha also depends on the set up of the production system. Although monocultures produce the highest yield per hectare, the first years no or little income will be derived from Jatropha trees. When the trees are planted at larger distances, with other crops in between, the overall income from the multicrop system will be better. With the right crops positive interaction can occur to the benefit of both Jatropha and the intercrop: Jatropha has a deep taproot that brings nutrients to the surface where

crops benefit from them. Jatropha can benefit from nitrogen fixing crops. In some regions Jatropha is traditionally used to support climbing crops like vanilla.

Processing efficiency can be influenced in various ways as well. In case of production of biodiesel and PPO for biofuel, economies of scale are required to make investments in expellers and biodiesel equipment feasible. For example, mechanised extraction requires considerable scale and hence operation at cooperative level, with production volumes of at least 100 litres/hour. Small-scale PPO production and the production of other products like soap and bio-pesticide can be commercially viable at a smaller scale. The way farmers are organised is central to the efficiency levels realised and the effectiveness of the business model (see the following section). The relative efficiency of processing compared to other crops also varies from region to region. For example, cassava needs to be transported to the market in a short period of time to prevent deterioration, which implies that Jatropha production may be more attractive in (remote) regions with poor infrastructure.

Moreover, a lot of motivation and education is required to make Jatropha production work. Subsistence farmers will not easily take the risk of growing an alternative crop rather than their conventional food crops, and risk reduction mechanisms are needed to support them in cultivating Jatropha. This not only involves offering farmers a guarantee that the Jatropha seeds will be bought at a reasonable price, but also an integral approach to the farmer's production system. Jatropha production is feasible in a small scale set-up, but will take a couple of years (8-9) before it really becomes interesting. Applying intercropping is recommendable to generate income while the Jatropha production is still incipient. Where possible it is recommendable to work on upgrading the whole agricultural system beyond Jatropha production itself. This will help farmers to increase their overall productivity and income, and to reduce their risks. However, the exact benefits of intercropping are unclear and subject to debate, as discussed in the last section.

Overall can be concluded that Jatropha production is technically viable and socially and environmentally acceptable at many locations, but often not competitive. Economic viable Jatropha production by smallholders requires cultivation of Jatropha as an additional crop for which a stable market exists, and opportunity costs are not high. Options are available for stimulating these conditions. Apart from optimising current approaches, it has been suggested to look for a biorefinery approach (not just PPO) and to combine different options to create more value and reach more markets. We should not just follow the initial Jatropha hype, but critically reflect on current market conditions and needs. What does the market look like, what are the competitors on the market (for instance mineral oil, other plant)? It is important to look carefully at opportunities to add value, while taking into account the alternatives that

exist for Jatropha. In the move towards a more bio-based society, Jatropha may play a valuable role. The extent to which it can fulfil this role also depends on the governance structures and incentives put in place, such as biodiesel legislation, quality standards, tax exemptions, etc.

Farmer organisation

The extent to which Jatropha production and processing can offer benefits to small-scale farmers and be economically viable depends considerably on the way farmers are organised; farmer organisation is an essential element of a successful and equitable business model. As mentioned above, scale is important to make especially biofuel applications feasible. Moreover, risk reduction mechanisms are required to make Jatropha production interesting for small-scale farmers. Both dimensions are best addressed if farmers are effectively organised, as organisation can increase scale while reducing risks. Furthermore, effective farmer organisation is required to achieve an inclusive business model with equitable benefit sharing. Equitable distribution of risks and benefits asks for an appropriate governance structure and transparent leadership of farmer organisations. Although relatively little experience has been gained so far on appropriate modes of organisation, several cases have provided interesting insights.

The Hivos pilot project in Zimbabwe indicates that the outgrower model was not attractive there as farmers received low payments, and suggests that a cooperative or associative approach would give better perspectives. However, the appropriateness of a model may vary from region to region, and in some locations for instance outgrower schemes and cooperatives may function better than in others. Overall it appears that successful organisation particularly depends on the extent to which existing structures for crop production and processing can be effectively used; i.e. making use of already present infrastructure and organisation modes that have been developed for other crops. Intermediaries between farmers and companies, such as cooperatives, may facilitate organisation and promote fair benefit sharing.

The private company Mali Biocarburant SA (MBSA) works with smallholders in Mali and Burkina Faso in an innovative way. It has established daughter companies, of which the smallholders are shareholders. The farmers sell their seeds to the daughter companies, which process the seeds into oil. Being shareholders, farmers do not only directly benefit from the sale of products, but also from the increased value of the shares and foreseen dividends. Rather than being incidentally hired for harvesting, they have ownership over the business operations. As such, they have a continued interest in increasing the shares of the company and hence in effective Jatropha production.

MBSA has also set up independent foundations where farmer leaders are also represented in the board of directors and participate in decision making. The foundations train farmers for increased food and energy security using a value chain approach. In addition, they support farmers by adding value to tree planting. In Mali, KIA Motors Europe and Trees for All (TFA) finance the operational expenses of the Mali Biocarburant Foundation, while in Burkina Faso ICCO and the Fair Climate Fund work with the Faso Biocarburant Foundation to add value to carbon credits.

This income will enable the foundation to pay for extension services to farmers and investment in sustainable agricultural practices, which in turn translates in increased yields of both Jatropha and other crops. In addition, MBSA works with different actors, including microcredit providers, to help farmers intensify and diversify agricultural production systems (for example by improved varieties). Effective farmer organisation is also required to improve the bargaining position of farmers, including their ability to negotiate prices and improve their returns by shared bargaining. Moreover, it is key to improving farmers' access to markets. The Mali Biocarburant foundation for example assists farmers to negotiate credit for agricultural inputs and to access markets for food crops. These inputs are not used for Jatropha production.

While sustainability certification may offer opportunities, its advantages for small-scale farmers are also questioned. Hugo Verkuijl, CEO at MBSA, indicated that sustainability certification is not that attractive for the company, as it is very complex and costly, while not generating many benefits. He argued that carbon credit certification is much more interesting. It embraces all sustainability criteria and it generates carbon credit income for the farmers. He therefore suggested to crosslink the sustainability criteria and the carbon credit criteria so that with one system both carbon credit revenues could be generated and sustainability is ensured.

By supporting farmers in their governance, business, marketing and production activities, their risks can be reduced as their skills and income improve. For example, training directed at enhancing the productivity of the production system functions to decrease the risks for farmers to become involved in Jatropha production. Planting and maintaining Jatropha trees requires considerable labour investments, which comes with an opportunity risk of not using the labour (and land) for other purposes. Moreover, as Jatropha trees will not generate seeds in the first years, farmers need to have some incentive to invest in this 'retirement crop' (as they call it because of this long 'incubation time') in these initial years. By training the farmers in a holistic way and stimulating intercropping, both the production of Jatropha as the production of their traditional (food) crops can be promoted, which implies that even if the Jatropha production system is disappointing, their income from their other crops may be improved. Apart from increasing yields, effective farmer organisation can function to mitigate risks by improving access to inputs, credit, and insurance, by guarantee buying of seeds, and (other) risk sharing models. An additional risk mitigation strategy is endowing farmers with more legal power for in case investors pull out. However, so far there is relatively little experience with the adoption of risk reduction mechanisms and there is room for improvement here. Finally, the role of trust and information in perceiving, taking and sharing risks should not be neglected.

It is a challenge to create a business model in which profit considerations and development ambitions are effectively combined; how to link a profit orientation with a focus on local socioeconomic development? The production of the end product PPO in itself will not be enough to boost local development; a more integral approach addressing the needs of farmer communities is required. For instance, creating local access to Jatropha-based energy can generate and stimulate economic activity in remote areas, which may be more influential for local development than the sale of PPO. Moreover, multiple socioeconomic conditions need to be taken into account in order to ensure social benefits, including local policies, tenure status and land rights. In many regions, peasants use but do not own the

land, and/or women cannot inherit land. In order to be able to benefit from Jatropha and to be motivated to plant it, farmers need to have sustained land tenure security. If they are not confident whether they will be able to enjoy the fruits of their work in five to ten years time, Jatropha projects will fail. Effective community participation is essential to take these issues effectively into account.

Well elaborated public-private partnerships can be especially effective in creating an inclusive business model with equitable benefit sharing. This asks for the creation of a balanced mixture of collaborating profit and non-profit bodies, that pursue different but partly overlapping and complementary objectives. The MBSA case can be considered a successful public-private partnership, representing a mixture of for-profit and not-for-profit organisations. The shareholders in this institutional framework do not want to maximise financial profits, but make social profits. On the other hand, by creating a for-profit private entity rather than a public body / NGO, the stakeholders actually experience ownership and the likelihood of creating an organisational structure with lasting impact is believed to be bigger.

The working group on farmer organisation formulated the following points of attention and recommendations with regard to farmer organisation around Jatropha production:

- Distribution of risks and benefits (How to distribute cost and benefits between smallholders and company. Intercropping seems the best option: reduced risk for smallholder, who still has its food crops)
- Profit and/or non-profit (social enterprise, balance between profit/non-profit)
- Issues of ownership
- Cooperative as organisation structure
- Multi-crops
- Knowledge and information sharing (importance of transparency, farmers as shareholders)
- Involve women

Tensions between Jatropha and food production?

A recurrent theme during the meeting was the degree to which Jatropha is an adequate complement to food production systems. Jatropha is often promoted as suitable for intercropping with food crops such as legumes, sesame, melons, sweet potato, maize, wheat, ground nut, pigeon peas and vanilla. It would not be at the expense of food production, and, as a matter of fact, even boost the productivity of other crops. On the other hand, there has been a lot of controversy based on the perspective that Jatropha production would take over land otherwise used for food production, and hence be at the expense of (local) food security and development.

In the cases studied by Hivos, and by the collaborative research of Copernicus Institute, Wageningen University and Research Centre, and Technical University Eindhoven, no clear indications of food-fuel competition arose (i.e., Jatropha production for biofuels would not be at the cost of local food security). However, in the cases studied by Copernicus Institute, Wageningen University and Research Centre, and Technical University Eindhoven, the Jatropha trees were mostly planted in hedges which takes less space and often would have been established with other species if Jatropha had not been available.

Various participants also countered the idea that Jatropha would be in dangerous competition with food crops, as is the case with palm oil, and suggested that small-scale farmers would not let Jatropha compromise their food production.

This does not imply that there are no tensions at all between Jatropha and food production. First of all, in the Hivos projects there was a coincidence between the harvest of traditional crops grown by the communities and the harvest of Jatropha, which implies that Jatropha production brings about competition for labour. So far farmers have chosen to give priority to harvesting of food crops.

As explained earlier there can be a symbiotic relationship when Jatropha is intercropped with other crops leading to higher productivity of both crops. However, while little competition for light and nutrients exists in the first years after planting, competition increases as the trees and their canopies grow larger. Like all other agroforestry systems the overall outcome will depend on many factors and therefore be site specific. Nevertheless, it is suggested that at some locations and with the right production methods, a higher overall productivity can be achieved. This would imply that food production will not suffer, and may even benefit, from Jatropha production.

In order to keep food production at at least the same production level when you start intercropping with Jatropha, the productivity of the food crops should increase enough to compensate for the reduction in space. With financial support of NL Agency, Max Havelaar Fairtrade, Eneco, ICCO and KCU (Kagera Co-operative Union) carried out Jatropha-maize intercropping pilots in East Africa (where maize yields are generally low). Of the original food production area, 40 per cent was dedicated to Jatropha, and the remainder to maize. In most of these pilots, it proved feasible to increase the maize yield with 66% compared with the control group, which was sufficient to compensate for the decreased food area. Tropical agriculture consultant Ab van Peer, who is involved in the project, explained that this result was achieved by training farmers in better agricultural methods, by providing better seeds, and by the (indirect) benefits of the Jatropha trees themselves. The training amongst others stimulated the use of Jatropha seedcakes as local fertilizer (which according to Van Peer is more effective than organic manure). Moreover, part of the yield increase has been attributed to the fact that Jatropha trees counter erosion, reduce disease, more efficient use of nutrients (by preventing nutrients (from fertilizer) from sinking deep into the soil and becoming unavailable to food crops), and contribute to general soil improvement.

While this increase in maize productivity is impressive, it is hard to tell to what extent it exactly can be ascribed to the stimulating side effects of Jatropha production. Clear is that the yield improvements are the result of a whole-farm approach which enhances the overall capacities and practices of the farmers,

and addresses multiple points for improvement such as the quality of the maize seeds. What precisely has been the role of Jatropha production is unclear however, even as the replicability in other settings. Nevertheless, pilots like this make clear that one cannot simply conclude whether or not Jatropha competes with other crops, and that training farmers may help them to achieve income from Jatropha without the need for a trade-off in terms of reduced food production. Adding Jatropha to their production system may increase the pallet of choices farmers can choose from; even if they cannot eat it, it may improve their livelihoods by diversifying it and increasing their options.

Although the maize production clearly benefitted from the Jatropha production, the short project period did not allow for effective evaluation of the intercropping effects on Jatropha. As such, it could not be concluded that the Jatropha benefitted from intercropping as well. However, it is clear that Jatropha does benefit when intercropped with legumes. Vincent Volckaert, business director at Jatropha company Quinvita, argued that intercropping generates best Jatropha yields, as Jatropha trees automatically benefit from the attention farmers give to their food crops.

The problematic issue with these suggested synergetic effects is that farmers tend to refrain from planting Jatropha in their food production area in practice. Although the pilot project involved the support of agronomists and a guarantee to buy seeds, most farmers did not believe that intercropping would benefit them, and only dedicated poor land and little maintenance to Jatropha cultivation. Motivating them to engage in intercropping systems may require more convincing demonstrations of the value of this approach in their daily practice.

Additional benefits of Jatropha

From the previous sections, it has become clear that Jatropha production can have various benefits, including access to a local source of energy, income benefits from marketable products, improved resilience of the production system, and reduced costs for fertilizer and fuel. Several additional benefits can be discerned. One of these is the potential value of Jatropha for the tenure status of small-scale farmers: by planting Jatropha trees around their land, farmers can enhance their land security and strengthen their land ownership. By reducing risk, this may also motivate them to invest in production systems on their land. However, in a same vein, planting of trees may also incite land conflicts if it is used to claim land used or claimed by others.

Another potential advantage of Jatropha production can be found in the health benefits flowing from the use of Jatropha soap. Last but not least, the application of Jatropha oil as a local energy source may ignite the local economy and have far-stretching effects for community livelihoods. While many of the potential benefits of Jatropha production are not related to marketable products and monetary value, and Jatropha has not been very successful as a biodiesel commodity, Jatropha may have a not to be underestimated value for local development.

However, (many of) the benefits for rural development resulting from Jatropha production may also be brought about by other production systems. Jatropha is not a stand-alone solution to rural

development, and it is important to consider alternative strategies and other available oil crops and their applications to help smallholder producers and processers.

Overall conclusions

A few years ago, Jatropha has been actively promoted as biodiesel crop. After some years of experience with its production, it can be concluded that the hype has been misleading, as Jatropha's value as biodiesel commodity has not been convincingly realised (yet). It still looks promising under certain circumstances but not as a universal solution.

Biodiesel production has generally been found to be too complex, involves considerable costs, requires scale, and is still only in some settings competitive. The simpler direct use of pure Jatropha oil in slightly modified diesel engines is financially more attractive than biodiesel production but requires quality management that can be difficult in remote areas where it is most competitive. Additional applications of Jatropha are currently required to make Jatropha production interesting for most small-scale farmers. Various feasible marketable and non-marketable products and uses can be thought of, although experience with these is mostly rather limited. Currently, most potential seems to lie in local use of Jatropha in for fertilizer/compost and energy, and the marketing of PPO and sub-products such as soap and bio-pesticide. Biogas production from press cake is currently being tested at several locations. It can double the energy production from Jatropha seeds and the slurry is a good fertiliser.

Altogether can be concluded that Jatropha production by smallholders can contribute to local economic development. However, it is not a universal solution but requires the right agro-climatic and socio-economic conditions. It is now apparent that most Jatropha has been planted in areas where it cannot grow well and where it cannot compete with alternative crops. Many factors determine whether the production and processing of Jatropha is feasible and attractive in a certain setting, and uncritically promoting Jatropha without a thorough exploration of the local context and opportunities is unwarranted. Moreover, many of the applications of Jatropha are poorly explored and investigated yet, and little is documented on their value and viability. As Jatropha production for only bio-diesel or PPO is rarely viable, the challenge is to achieve value addition of co-products and to learn more about alternative applications. There is also much room for improvement when it comes to production and processing technologies.

As the contribution of Jatropha to local economic activities and livelihoods is often not specific for the Jatropha crop as such, care should be taken to avoid a restricted focus on Jatropha and to identify the best type of crop and strategy to achieve these benefits in every particular setting. Jatropha should be looked at as just one of the options in a range of options to support smallholders.

Overall it appears that Jatropha is most likely to enhance farmer livelihoods if it is cultivated in addition and in between conventional food crops, and its introduction is accompanied by a whole-farm approach that promotes the productivity and sustainability of the agroforestry systems in an integral way.

Last but not least, successful Jatropha production that truly brings social benefits for smallholder communities requires effective and sincere participation and involvement of these communities in the organisational set-up and decision-making processes. As is the case for every innovation or activity, Jatropha production will never work if there is a narrow focus on the technical features and social aspects are being neglected. The challenge is to make progress in both dimensions, and effective integration of these two may be promoted by public-private partnerships that combine profit and non-profit approaches and ensure community participation. Further work in these fields may provide us new food for thought, exchange and discussion in the coming years.