

Jatropha Oil for Local Development in Mozambique

Biofuel for development and Communal Energy Self Supply



Prepared by Annie Sugrue, February 2011

Executive summary

This pilot project has achieved, in essence, all of its intended outcomes that were possible to achieve. It was an immensely ambitious project in terms of its point of delivery in a remote area of northern Mozambique without access to modern service delivery and the fact that it was dependent on working with rural poor farmers who lack education and training to any great extent. The evaluation report indicates that what was achieved over a four year period is remarkable in its extent and the fact that many important deliverables were not only delivered within the target numbers and time frames, but many of the targets were exceeded. Some deliverables were altered by the project managers in agreement with the funders as they needed to match the actual circumstances and respond to the limitations that were experienced in the field; the assessment of these changes is that they were entirely appropriate and correct and that to have proceeded with the original plan would have been irresponsible given the circumstances on the ground. This report cannot adequately reflect the excellent quality of the work undertaken, nor the dedication and commitment of the staff and project partners to their work. The efficiency of the project was reflected in the many and comprehensive reports that were produced and the efforts undertaken on many different aspects over a very short project period of 4 years. It is hoped that the report and the few pictures adequately reflect this efficiency and extremely high standard of project implementation by the project partners. .

The work undertaken here will be immensely useful to anyone wishing to use *Jatropha* as a local economic driver in poor rural areas. Given the right conditions, this crop can be grown easily and is reasonably pest free, not requiring a lot of agricultural inputs or time from farmers. Harvesting and dehusking are time consuming, but assuming that the crop gives good value, this issue can be overcome. Technical challenges mean that the oil needs quality control provisions if used in diesel engines, but not for other purposes such as soap making. As a local economic driver, *Jatropha* holds great potential.

It appears from the interviews and the evaluation that *Jatropha curcas* grows well in the project area and the small scale farmers found it easy to cultivate. However, farmers complained about the labour intensity of dehusking in particular and to a lesser extent the harvesting, while admitting they did manage to do this without compromising their other tasks. The interpretation during the evaluation is that this issue is more a question of labour versus cash gain and some farmers felt that *Jatropha* seed harvesting at the price being offered by the project was not a value proposition at present, except on a smaller scale. Generally the farmers felt that if the oil could be used by them for some purposes, to alleviate their own household budget expenses, for instance, that this would mean that it would become a value proposition. They expressed a good deal of interest in using the oil to make soap as this is an expensive household item and the surplus could generate more income than selling the unprocessed *Jatropha*. It appears that soap making would provide the greatest

economic opportunity to the farmers at present as a value added processing activity. It also appears that this activity is not particularly difficult and the market for the soap is local thus not requiring logistical inputs. However, challenges arise when the oil needs to be expelled as the most efficient way is by using a powered expeller.

Some farmers discussed using the jatropha oil to make electricity or to use in lights. Energy is an extensive need in the pilot project area and such uses would be extremely beneficial to the local people. However, technical issues of quality control would make this almost impossible without a central facility that could ensure the quality of the oil. Additionally, generators are not common in the area, and very few farmers would have access to such equipment. The project also looked at the use of the jatropha oil in oil lamps but the particular properties of the pure plant oil from jatropha make it, like many other vegetable oils, unsuitable in most conventional oil lamps.

Some of the small scale farmers have found an alternate market for the seeds, which, while good for generating income in the short term may not be a sustainable market and this new market acted in competition with the project. This new market was willing to pay more for the seeds because it wanted them for planting rather than for expelling oil. This market was prepared to pay 20-40Mt/Kg of seed as opposed to the 2010 price that BBC paid of 5Mt/Kg.

A key issue that arose during the evaluation was that the long distances between the farmers clubs growing jatropha makes collection of the seeds expensive and difficult. These logistical costs mean that the central facility, the BBC, which purchases the seeds and makes the oil, had, at the time of the field trip for the evaluation, estimated that it can sustainably pay 2.5 Mt/Kg of seed if the price of the oil is to stay at the same price as fossil diesel. These economics do change with a change in oil price or if the oil is used for another purpose such as soap making. For instance, since the field trip the project partners calculate that given a change in the oil price that an amount of 4Mt/Kg is viable and it is likely that prices will further rise over time.

All farmers indicated that they would continue to plant more jatropha as it is was easy to cultivate. Visits to the fields confirmed that farmers are actively planting more Jatropha on their own initiative. However, many indicated that they were unhappy with the price of 5Mt/Kg and they expressly wanted to be able to use the oil themselves to make soap and sell it.

It was difficult during this short evaluation to determine the reason for why the farmers sold less seeds to the central facility than was expected and this report tried to delve into some of these possible reasons.

The farmers expressed general satisfaction with jatropha as a hedge, most saying they enjoyed the way it allowed them to know which machamba (local

word for cultivation field) belonged to whom. They all indicated they would continue to grow jatropha in the hope the price increased over time and they would look at opportunities for adding value to the crop for themselves.

Partnering with ADPP as the local counterpart was a good decision; the farmers expressed how grateful they were for help in improving their overall cultivation technique for their subsistence crops (through the ADPP food security programme) and how useful the rope pumps had been. However, all groups complained about not having enough water, and they felt that if they could get water during the dry season they could grow vegetables which they indicated gave them an excellent return on labour and investment.

The pilot project did extensive research into the cultivation, harvesting, processing and marketing of jatropha. The work is a significant contribution to the body of knowledge on jatropha and will be extremely useful to others working in this field. Annexe 3 contains a summary of this work, but the reader is recommended to read the reports on the project web site for more detail ¹.

1 Introduction

1.1 The project and project area

The project evaluation described herein is for an agricultural project that involves both cultivation for food and cultivation of an oil bearing shrub called *Jatropha curcas*. A project web site has been established where most reports can be found¹ and the FACT Foundation also has a web site with information². The project area is based in the Quirimbas National (conservation) Park, located in the Cabo Delgado province of Northern Mozambique. The park is close to the border of Tanzania and the main road to the project is the main Mozambique-Tanzania border which cuts through the Quirimbas National Park. The project office is based at the ADPP Mozambique Center in Bilibiza which houses the ADPP Bilibiza agricultural college and ADPP Teachers Training College in Bilibiza. Both are ADPP institutions that ADPP is managing, recognized and supported by the government.

The Quirimbas National Park was declared in 2002 but the area was not cleared of people: it is designed as a park where people and nature live side by side. Increasing population pressure has meant that this creates some conflicts, in particular with dangerous animals like lions, and leopards and with large animals that need a large grazing territory such as elephants. The project area is

¹ <https://sites.google.com/site/mozambiquejatropha>

² www.fact-foundation.com

estimated to have a population of 316,000 people, more than 90% of whom have no access to electricity³.

The local communities largely practise slash and burn traditional agricultural practice for subsistence livelihood support. They grow a variety of crops such as maize, beans and cassava, but they also grow some cash crops like sesame, cashew and ground nuts. They also grow vegetables on a small scale but in the dry season they frequently do not have enough water, as even the borehole water is saline, and this is a challenge for cultivation. The soil is light but is not loamy and the local people lack capital to invest each year in fertilisers. Rainfall is good in the area; around Bilibiza, the project centre, rainfall is 800-1000 mm per year. As a result of the traditional practices, large parts of the park are now devoid of its natural vegetation and it appears that the greatest conservation activities take place closer to the marine nature reserve of the park, along the shore, which houses elite and expensive lodges for tourists. A system for revenue sharing with the population inside the park is in place but for the foreseeable future this will not provide significant income due to the limited number of tourists. It is unclear what will be the future way forward with the park, but there is considerable pressure from the animals in the park, in particular elephants, to secure enough food.

Jatropha curcas is a new crop to the local people, even though there was evidence of a few shrubs in the local area when the project started; they were mostly used for traditional medicine. The initial idea was to grow the shrub in plantations, but once the project started and after the coordinators spoke with the community, it was decided to grow the shrub to act as a fence for the machambas (fields), with the hope that its poisonous nature may keep out grazing animals which create a problem for the subsistence farmers. However, while it does keep out some grazing animals it does not keep out elephants, but the farmers, during interviews, all felt the shrub plays an important role in defining their plots of land. The seeds from the cultivated shrubs are sold by the farmers to the project to generate additional cash income for the farmers. All of the farmers clubs involved in the project have also received rope pumps for drawing water and most of these are located close to the Machambas. These rope pumps were funded through this project but are a key component for ensuring food security and can be found in many of the other ADPP funded food security programmes.

1.2 Description of project staff and project partners

The project partners are Ajuda de Desenvolvimento de Povo Para Povo (ADPP) Mozambique and FACT Foundation; IIAM (Mozambique), GAIA-Movement (Switzerland), Foundation DOEN, Solidaridad, and Hivos. FACT and sub-contracted technical advisors provided, and gave advice and guidance, during

³ Draft: End Report for the FACT pilot project “jatropha oil for local development in Mozambique 2007-2010”. Prepared by FACT FOUNDATION.

technical assistance missions and site visits. There was additional funding for various aspects during the life of the project from the EU and from USDA; both of these have come to an end. The project funding from Hivos, DOEN, and Solidaridad came to an end at the end of December 2010. However, the project secured funding to continue some aspects, in particular support to the farmers clubs for continued cultivation and purchasing jatropha seeds and for the food security work. This is from the Lombardia in Italy, and AECID (Agencia Espanhola de Cooperacao Internacional ao Desenvolvimento) from Spain. The project has also secured funding to participate in research and good practice information dissemination from WWF for a period of three years starting from 2010 to 2012.

The project staff who have been in charge of management for the past four years has consisted of a support manager located in head office in Maputo, a project manager located in Bilibiza, a HR and an extension services manager and towards the end of the project a manager of the Bilibiza Biofuels Centre (BBC) was employed. The project had a no cost extension from three to four years due to delays during the project.

In addition there are 5 extension offices servicing the 36 farmers clubs and an additional 3 staff over and above the manager working in the Bilibiza Biofuels Centre (BBC) on technical issues.

From January 2011, the extension officers remain on in the project as well as the HR and extension services manager, who will take on additional project management roles. The BBC will become a separate and profit making entity managed in a similar way to the way it was during the pilot project. It has developed its own business plan for its future activities which can be found on the project web site.

1.3 The Bilibiza Biofuels Centre (BBC)

The BBC oil processing unit was established by the project to produce pure plant oil (PPO) from the collected Jatropha seeds as well as to produce rope pumps. It consists of a large warehouse that houses the equipment and where training can take place. It also houses the converted diesel generator which powers up the Bilibiza project centre and BBC processing unit. Located next to the BBC is the small training nursery where lead farmers are taken for training on sustainable agricultural practices; a small testing nursery for Jatropha is also located there as well as a demonstration rope pump.



The BBC centre

2 Methodology

The evaluation was carried out by doing a series of interviews both on-site and off-site, as well as through desk top analysis and report writing. Project managers involved in all aspects were interviewed separately and together. A questionnaire (annex 1) was developed and used for interviewing farmers clubs. A summary of some of the results of the interviews are also contained within annexe 1. The external evaluator also attended an ADPP/FACT seminar held in Maputo on 25th November where results of the pilot project were presented.



Meeting a group of farmers from a Farmers Club

3 Evaluation Report

3.1 Achievement of deliverables and targets

A full summary of the expected deliverables, assessed against actual achievements of this project are to be found in annexe 2.

The **objective** of the pilot project is:

To build an infrastructure and capacity to enable the autonomous upscaling of the activities after termination of the project. The project will initiate the local production of Jatropha seeds and develop a local market of end-users of the oil. The creation of capacity among the local small farmers and technicians is an important component of the project.

The overall assessment of the project is that many aspects of this objective have been met for the following reasons, measured by progress in the project, all of which will be detailed further on in the report:

- 1800 of farmers have planted over 600,000 *jatropha curcas* trees.

- A centralized facility has been built in Bilibiza which has oil presses and equipment that can extract and purify jatropha oil for application such as motor vehicles, diesel engines and to make soap; the centre has adapted its diesel engines and project vehicle to use pure plant oil.
- Local farmers have received skills and knowledge on growing jatropha curcas along side their own crops both on farm and at the Bilibiza training centre, while also receiving capacity building to improve their general farming techniques. Leaders from the farmers clubs were also taught how to make soap

However, in relation to the development of a local market of end users of the oil the following can be said:

It is likely that all pure plant oil produced by the BBC will be used by project partners, at least initially. So far, only small amounts of pure plant oil have been used to run the generators at the BBC and the ADPP Mozambique Centre in Bilibiza; currently the centre uses fossil diesel to run its generators, but the Feidong Genset generator has been modified to accept pure plant oil, and one of the vehicles (the Nissan) at the centre has been modified to run on pure plant oil. It was estimated during the project ³ that the ADPP Mozambique centre and the converted Nissan vehicle alone requires 20,000 litres diesel per year and the maize mills in the project area use a further 20,000 litres of diesel. Replacement of this fossil diesel with pure plant oil is already a large market. Thus, the market for significant amounts of jatropha pure plant oil is secured given this need. It is too early on in the project development cycle to say if additional markets will develop if the existing market is saturated, but given the global need for oil, it is very likely that a market will not be difficult to secure. If a new source of fuel were made available that was cheaper than the fossil fuel or even more readily available, there is no reason why local people would not shift to using it. Quality issues become paramount to ensure sustainability of this market.

3.2 Expected results:

The following were the expected results of the pilot project:

3.2.1 Production and cultivation

- 1 Create between 250- 500 Has of land cultivated with jatropha within three years

Result:

Jatropha was grown as hedges not plantations, but approximately 600 ha equivalent of land has been planted with over 600,000 *Jatropha Curcas* trees over the four year period, which is more than the original target deliverable which was a maximum of 500 ha (this figure is based on 1000 plants/ha). The plants

were planted in hedges to help define the machambas (cultivation fields). Planting varied according to the farmers need and desires. Some planted at a 1 m interval to create a dense hedge, others planted at a 3 m interval to allow for maximum growth of the shrub and hence better yields of seeds from the *jatropha* trees. Farmers looking to increase yields of seeds practiced pruning methods. Farmers initially used seedlings to plant, but once they have full grown trees they used both seeds and cuttings for their new plantings. The *jatropha curcas* was growing well in nearly all fields. Some fields had trouble with termites which destroyed the plants. Others were completely pest and disease free. The plants all seemed to grow well in the soil in the area; none of the farmers indicated that they irrigated or fertilized. Farmers were not able to tell much about yields from individual trees, only overall yields when they sold the seeds. They did indicate great variability in the yield of seeds from different trees.

To support the cultivation activity, 5 extension officers are employed in the project; they are all from the local area and are fluent in the local languages as well as being literate. They were issued with motorbikes in order to be able to service the farmers clubs where they were allocated. Each extension officer serviced between 6-7 farmers clubs.

During the evaluation it was clear that the members of the farmers clubs that were interviewed were a) very familiar with the project and its intended outcomes; b) knew the project coordinators and extension officers well and c) had been visited frequently. A summary of the interviews can be found in annex 1 along with the questionnaire.



Weighing *jatropha* seeds for sale to the BBC

- 2 The production of *Jatropha Curcas* will be done through the use of 25 farmers clubs established by ADPP/ FACT

Result

The number of farmers clubs finally reached was 36, which is almost a 50% increase on the deliverable target number. Each farmers club has an average of 50 members which means that 1800 farmers are involved in the project. Some lose members but then new ones join; they have strict rules of membership to avoid freeloaders. Estimating a household number of 5-6, this translates into 9000 – 10,800 direct beneficiaries of the project. During the evaluation the team visited 4 farmers clubs, from very distinct areas of the project to ensure adequate distribution across the projects. The farmers clubs involved in this project were all part of the ADPP food security programme. It should be noted that the distances between farmers clubs was large, and for the evaluator to visit the 4 clubs, required long hours of driving and huge distances. This would have had an impact on the success of the project in some way; it was certainly noted as being an important factor when pricing was done. The BBC estimated at the time of the evaluation that it could not pay more than 2.5Mt/KG for jatropha seeds to ensure that pure plant oil can compete with the price of diesel. This will change with oil price increases.



The board of one the Farmers Clubs

- 3 The sites will be located in 5 different areas spread over Mozambique (from north to south) in which the local counterpart, ADPP has a presence. (This deliverable was changed - see motivation for change below).

Result

While it was initially thought that the project could support 5 different areas spread out over Mozambique from north to south where ADPP has a presence, this proved not be possible. Logistics and costs of such a widespread distribution would make it impractical to carry out the project; the farmers clubs need to be within, at the most, a few hours driving distance of each other and the Bilibiza

centre. However, initially the project was undertaken in four additional areas beyond the Quirimbas. These included: Sofala Province, near Gorongosa; Chimoio - where jatropha was grown but it was overwhelmed by pests; Itoculu - where all the plants died and this area was abandoned as a pilot site; Macuse - where 4,000 plants are growing successfully but the farmers clubs are not working as well and this the project area was not suitable to fit in with the pilot project model. As a result of the many difficulties, the target deliverable was changed to concentrate on one province and 5 districts within that province, both to increase efficiency by reducing the project area to working within the Cabo Delgado province and to choose the best growing area for jatropha. Keeping all farmers clubs within one area made it easier to transport the seeds to the centralised facility based in the ADPP agricultural college in Bilibiza. Additionally *Jatropha Curcas* appeared to grow well in the Cabo Delgado province with limited inputs and it was not heavily attacked by pests. In the final evaluation, the farmers clubs were spread over an area of some 75 X 100 Km within the Cabo Delgado Province, and 5 districts. An analysis of the area covered by the project and the distances is given in the section called "Analysis and Recommendations"

- 4 Research and development would be carried out on the growing of jatropha in the areas chosen

Result

The national research institute IIAM carried out on-farm research to investigate different varieties, pests, diseases and the use of biological pesticides, led by Flemming Nielsen who was a staff member of IIAM until 2008, when he moved to Netherlands. IIAM after that did not perform as requested and services were taken over by Flemming. Technical and administrative support was provided by the international coordinator of the FACT Foundation team. On-farm research nurseries were developed as well as a research area within the nursery planted at Bilibiza. Much data was gathered from these research facilities that have been presented at many international and national, meetings, conferences and seminars. The work is invaluable to the further understanding of *jatropha curcas*. It has helped establish issues such as that importance of the planting date to the incidence of disease prevalence in the plants over its lifetime; determine which pests are the most risky for the area; identification of organic pesticides to control major pests; optimal seed pre-treatment; the importance of different soil nutrients for the development of Jatropha plants; and the energy and carbon balance of the Jatropha production. Trials with Jatropha varieties from other continents have been established as well as trials with different plant spacing and planting material. Yields have been monitored both on-farm and in well managed demonstration fields. Much of this information is not yet available from other projects. A key finding of the research, using other data available is that it takes far longer for jatropha to produce its maximum yields than initially anticipated, and that 7-10 years is shown as the time period when these maximums can be expected. As expected, trees grown from cuttings give higher yields faster, but

the life span is shorter for the higher yields and they are more vulnerable to drought and strong wind.

This research also involved looking at the economic benefits of growing jatropha. It found that most labour was used in harvesting and dehusking. Farmers can harvest 1-3 Kg/hour which include dehusking. This will give a “wage equivalent” of between 40 - 120Mt for a days work. The minimum wage for an agricultural worker is approximately 70Mt/day (assuming they work 24 days a month for approximately 1700Mt per month). This means that if a farmer works efficiently to harvest her jatropha, she can expect a better than, or equivalent, wage than the government stipulated minimum wage.

The research was undertaken in collaboration with research institutions in Mozambique and abroad. Several students have received their degrees from this work and the project has in this way contributed to broaden the knowledge base and research capacity.

The work done on research was extensive and it was not possible during this evaluation to evaluate the full extent of this work. In annex 3, a short summary of the research finding is reproduced from the FACT Foundation End Report but the project web site contains more information ^{1, 3}

3.2.2 Marketing

- 1 Develop a local market for the oil through adapting local generators at schools and at corn mills to use the oil – expected to have adapted 25 diesel engines in 25 villages and /or schools and 10 presses at local sites suitable for use by local people.

Result and motivation for change to result

Initially, it was proposed to convert existing diesel engines located at schools in the area and at maize mills so that they can run on pure plant oil. However, early on in the project, it was realized that using pure plant oil was not as technically easy as was originally thought. For instance, if the seeds are harvested at the wrong time, or stored incorrectly, or if the oil is pressed under extreme heat, the oil may end up being too acidic for the engine to tolerate. As a result a good deal more technical research was required into the process. FACT/ADPP used the established processing centre at the ADPP EPF college to do technical research as well with other parties in the Netherlands and in Chimoio. Three different presses were purchased and placed at the centre. One was a hand press, the other was a Sayari press from Tanzania and the third was a Double Elephant press (from China via a dealer in Maputo). The hand press was very difficult to use and very little oil was produced from the seeds. The Sayari press and the Double Elephant press are electrically driven by a separate diesel generator set, of which the diesel has been modified to run on plant oil. The electricity of the project centre is provided from this system. The Double Elephant press is of

better industrial quality than the Sayari press. The centre has recently succeeded in producing oil with an acceptable acidity level that is suitable for use in the converted diesel engines with slight chemical modifications. In order to complete the endurance test of the diesels, cooking oil has been bought to run the engines on. As demonstration to the public that a car can drive on pure plant oil, the converted project vehicle (converted by Niels Ansø) was driven from Bilibiza to Maputo using only pure plant oil from Sunflower.

A market is most certainly available for the oil, however, availability and price is the issue. The FACT Project partner in collaboration with its many partners has developed a business plan for the production and sale of jatropha oil, and other products, and it can be found on the project web site referenced in the first section. It indicates that under the current conditions, with the extensive driving and collection required by the project to bring the seed to the centralized facility, that a figure of 2.5 Mt/Kg of seeds makes this a workable business (this figure will change if the price of oil increases). At the point of evaluation of the project, farmers were being paid 5Mt/kg of seeds and they were complaining that this price was too low. This will be discussed in the “analysis and recommendations” section.

2 Train local technicians to convert engines and maintain them

Result

The project held training courses for members of the farmers clubs in many aspects. A number of mechanically skilled people from the area were trained over 3 training courses, on how to convert engines and maintain them if they use pure plant oil. (dates of course: September 2009, July 2010, October. 2010)

3 Look for alternative markets for the oil such as oil lamps and soap

Result

During the evaluation, some farmers indicated that they had been shown how to make soap from the jatropha oil. They also indicated that they had used the seeds for lighting, but one seed only lasted a few minutes and thus was not much use. The project coordinators explained that they had tried to develop lamps for use by the local people, but the lamps required copper which was too expensive. A study was completed on the potential market for lamp oil which can be found on the project web site.

The farmers got very excited when they talked during evaluation interviews about making soap with the oil. They indicated that cheap poor quality soap costs 20Mt per small bar of soap and that if they could make their own soap and sell it, this

would make jatropha oil more lucrative to them. This will be discussed later in the section “analysis and recommendations section”.

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4 Analysis and Recommendations

It is important to note that the evaluation took place over only a very few days and not all groups were visited; only 4 farmers clubs were visited due to the long distances between clubs and time required to even get to the site. While certain conclusions have been reached, care must be taken when assessing the options. Certain assumptions have been made based on farmers responses, but in a very short evaluation, other agendas may be at play that distorts the evaluation. A comprehensive analysis is required whereby all of the farmers clubs are visited and interviews are done on an individual basis to determine more accurately any agendas taking place in the area that may be having an impact on the pilot project.

4.1 Farmer’s willingness to grow jatropha

During the evaluation the following was noted:

- a) Farmers have all been involved in growing jatropha in their machambas as hedges, a few planted in plantation style
- b) Farmers indicated that jatropha was very easy to grow in this area, they did not need to fertilise or water the plants, some pruned, and others did not. Generally those who wanted seeds did more pruning and planted at greater distances (3M apart), while those farmers who saw the greatest value as hedges did not prune as much and planted at 1m or less apart.
- c) Farmers were successfully able to use jatropha cuttings to get new plants in a very efficient way but they also realise that plants grown from cuttings are not as sturdy as plants grown from seeds.
- d) The farmers complained that 5Mt/Kg for the dehusked seeds was too little and they wanted a better price. They were aware that were discussions to reduce the price further to 2.5Mt/Kg and this made them feel demotivated to harvest jatropha seeds into the future until the price improved.
- e) Some farmers noted that another group, which appeared to come from Tanzania, were offering between 30- 40Mt/Kg for the seeds.
- f) Most indicated that they were able to harvest the jatropha at the same time as working other crops, and that they did the dehusking around the fire at night, although dehusking was hard; thus jatropha was not too much of an extra burden on their subsistence activities
- g) While the overall amount of seeds sold to the project/BBC was higher in 2010 than in 2009, given the expectations of older and more fruit bearing trees, the number of seeds collected was smaller than anticipated. This may be a combination of the farmers harvesting less

seeds due to the low price paid by the project/BBC and the new market creating competition. But some farmers indicated they did not even harvest, as they felt the value was not there.

- h) The farmers indicated that they found the additional support for their food security activities (training, rope pumps, watering cans, extension support) offered by the pilot project was very useful and they had enjoyed being a part of this group
- i) Many farmers' clubs complained about not having enough water. They all indicated that growing vegetables was lucrative but without water they would not be able to do this.

This summary indicates that farmers are willing to grow jatropha as it is not difficult to cultivate. We also saw in the field that farmers continue to plant Jatropha. However, the harvesting and dehusking is additional work. There was a general feeling among many of the farmers that they will only continue harvesting when the price increases, while some say they will continue in any case; in the meantime they will continue to use jatropha to mark out their machambas.

4.2 Additional uses for the oil from jatropha seeds

- a) The farmers cannot easily access the jatropha oil to use for cooking or lighting as the existing technologies are expensive and thus inaccessible. The same farmers do not have diesel motors or vehicles into which they can put the pure plant oil. However, some mentioned that they would like to be able to use the oil for electricity production, if they had the means to do it. They also agreed that it would be good if the BBC pressed the seeds and brought the oil back to them to use themselves (the farmers talked about making soap with the oil primarily but the possibility of expanding the use to household energy sources is a possibility into the future if oil lamps can be improved and made more affordable for instance).
- b) The farmers clearly stated that they wished to be able to use the oil themselves, in particular for soap making. It appeared that the normal pattern of cultivation on the area was that farmers grow food and crops for their own purposes and sell the surplus, in this way they protect their livelihoods as if the crop is little, they can still utilise it, whereas with jatropha seeds they currently have no added benefit from its use in the home. They indicated the more added value given the more interesting a crop is to them

A good example of how something can temporarily impact on a situation is the fact that another market for the jatropha seeds appeared this year. Farmers, who reportedly were happy with 5Mt/kg were no longer happy. This may be because the new market was prepared to pay 20- 30Mt/kg and thus the farmers suddenly

felt that the BBC market was unfair. Farmers are likely to take the best farm gate price, even if the market is not sustainable into the future, unless they are in some way bound into a market through profit sharing or a long term vision. Farmers complained about other crops farm gate prices also, such as maize, which they were forced to sell for 1.5Mt/Kg because they don't have access to the regulated market. Small scale rural farmers are nearly always exploited by middle men as they are unable to access the market directly.

The economics and practicalities of using jatropha oil for soap making

4.5 Kg of seeds produces 1 litre of oil (cost in market of seeds 5Mt/Kg = 22.5 Mt

1 litre of oil is enough to produce 1 big bar of soap which can in turn make approximately 15 smaller soap bars

A big bar of soap fetches approximately 100 Mt

You have to add water, caustic soda and another aromatic oil like lemon grass or coconut to make the oil smell nice, the price of these items is unknown but they are not expensive

The market is local, everyone buys soap, so transport is not an issue as the market can be the village. The FACT (draft) end report noted that a family spends about 20Mt a week on soap, so this is a large market given the local population³.

Pressing the oil from the seeds is an issue, hand presses are not efficient at getting the maximum oil out, and other presses require a mechanical engine driven by a fuel.

If the farmers make soap this will be far more lucrative than if they sell the seeds to the central processing facility for use as pure plant oil for engines as the processing facility can only pay between 2.5- 5 Mt/Kg of seed at the current fossil oil price.

The farmers were excited about soap making possibilities. It was clear from the interviews that they wanted the oil to be able to add value. Some indicated that they were willing to use the hand presses, while the project managers said they were inefficient at pressing oil and very hard work. Indications were that they would use the oil as an alternative energy source if they had the right equipment. It appeared that a partnership could be developed between the BBC and the farmers where the farmers can give their seeds to BBC to press and receive the oil back to make soap. BBC could charge a small fee which could be paid for in pure plant oil as a barter/exchange. The same model has been successfully used in corn milling for many years in parts of Africa.

4.2 Summary of the cultivation and marketing of jatropha curcas

It was clear from the interviews that the farmers found growing jatropha in Cabo Del Gado easy. Farmers indicated that weeding was not a big issue as they were doing this already for their crops and jatropha was in the same machambas acting as hedges. They understand the uses of the jatropha oil and some farmers reported that they had been trained in how to convert engines to run on pure plant oil, had experienced at the workshops using the hand presses to expel oil and that they were shown how to make soap when at workshops in the Bilibiza

training centre (BBC). The farmers indicated that the extra work for the cultivation of jatropha plants was not excessive nor did it interfere with other work. They did complain that the dehusking was hard work and some felt harvesting was time consuming, but many harvested as they worked the fields. Nearly all farmers said that they would continue to grow jatropha but that they may not harvest the seeds more than they were at present until the market price improved. They noted that it was little effort to plant, in many cases the plants grew where the seeds fell. Many will use the seeds to plant rather than to sell. Most indicated that harvesting their 350-500 or so trees, and deshushing took 7 days work in total; they did not include cultivation as they felt this was not time consuming and was part of the overall activities on their machambas..

In many instances it was only a few of the farmers that were actually harvesting. One example is that of the farmers club called Xinavani with 50 farmers. 10 bags of seeds were sold to the project (each bag = 50Kg= 300 Mt), but these came from only three farmers. Yet all of the farmers in the club each had about 350 jatropha shrubs each. Another group said that 1 bag represented about two days work (5 am to 12 noon) for harvesting and dehusking

However, when the farmers were specifically questioned as to whether they felt it was worth their while to grow, harvest and dehusk jatropha for sale, many said that it was not. When further questioned on this, the farmers said that when they grow maize, they know that even if they cannot sell or, if the harvest is poor or the farm gate price low, they can still eat it as they only sell the surplus; in other words, selling was not a key purpose in their growing of maize. This appeared to be the same for other crops as well. Sesame was noted as being an exception as they only grew it for sale, but the price was good at about 35Mt/Kg. Furthermore all of the farmers were asking for more assistance in growing vegetables, especially in the dry season, where the price was high. It therefore appears that the farmers discriminate effort for subsistence versus cash crops, and are fully aware that the effort spent on growing vegetables is better rewarded; jatropha was not seen, at the current prices, as being a high value crop. However, they did indicate that if they can get greater value, such as through making soap this would completely alter their attitude to jatropha.

It was difficult to determine if this attitude was a result of the higher prices offered by the new Tanzanian seed market that opened up this year or not. In the example above, the farmers club Xinavani, a Tanzanian group had offered them 30Mt/kg and the farmers collected seeds (15 bags) to sell to them. However, these were seeds that were initially meant for sale to the BBC facility (only 10 bags were sold to the BBC of the 25 produced). The farmers reported that the Tanzanian group, in the end, came late to pick up the seeds and the seeds had spoiled. The farmers said that this demoralised them a lot.

However, there was one farmers club called Nanlia, closer to Pemba that indicated that the Tanzanian group had not approached them to sell seeds and

that they knew nothing about this new market. This interview also picked up a lack of interest in harvesting jatropha. They had a 400 m² plantation which was where they picked most of the seeds from and they harvested 48Kg (less than 1 bag). This translated to 240Mt, which did not seem worth it to them as they had many farmers to split the money up with. However, they indicated they will continue as the price may increase over time. The farmers indicated that they made 5,800 Mt when growing and selling all other crops, like maize. They sell the maize at 1.5Mt/Kg (government floating price is 5Mt/Kg); they are unhappy with this price too, but as they cannot transport the crop to the market they are forced to sell to whoever comes to the farm gate. They were clearly interested in high value crops. They were however, extremely interested in pressing oil from jatropha to make soap.



A rope pump distributed in the project

4.3 Technical issue relating to processing of jatropha seeds

When speaking with the project coordinators, it was clear that dealing with jatropha oil is not that easy and there are issues that need to be taken into consideration. For instance, if harvested when unripe, or stored in wet conditions, the seeds produce oil that is too acidic with high levels of F, Ca and Mg which are not suitable for diesel engines, even if the engine ash been converted to work on pure plant oil. Pressing also has an impact on acidity: cold pressing produces less acidic oil for instance. The project coordinators had gone some way in explaining this to the farmers and the most recent batch of oil pressed from seeds from the farmers was less acidic and had lower levels of F, Ca and Mg than the previous batch. However the project co-coordinators felt that care would need to be taken if communities were to press the oil themselves and use it in diesel engines without some sort of quality control; the acidity levels do not matter as much when making soap. This kind of quality control is reasonably difficult in the more remote rural areas.

These technical issues were the reason that the project partners decided to create a central facility and bring the seeds in to test. In this way they could report more accurately on quality and figure out ways to be able to improve it. For this reason, it was not possible to convert the diesel engines of the maize mills or schools for instance, as the poor quality oil would have impacted negatively on the engine, possibly even destroying it. Now that more is known about quality issues, these concerns were completely valid and remain an obstacle to the original idea of converting engines within the community. A facility like the BBC is essential to ensure quality control, but the project has also shown that logistical costs with low fossil oil prices would not be sustainable into the future, this will all change if and when the oil price increases, given that the agricultural inputs for jatropha in this province are not high or linked to the cost of oil (it is rain fed, unfertilized and labour intensive). The challenge is to find a way in which the farmers can get added value from the oil whilst being supported to press the oil from the seeds and in ways in which the logistical costs are lowered.

4.4 Recommendations

The following recommendations are proposed for the way forward:

- 1 Find ways to help the farmers get added value from their jatropha seeds and oil

It is clear that the successful pilot project completed by ADPP and FACT foundation needs to be further extended to ensure that the excellent work is not lost. Four years is too short a time to derive real and meaningful benefits from any local economic development project, but this is more so in a remote rural part of a country like Mozambique, and when dealing with a fairly unknown crop and its commodity. That the project achieved as much as it has is remarkable; it would be a travesty to simply set aside this good work and not continue with further development. The research generated by this project will be immensely valuable to other jatropha projects.

To assist farmers to make more use of the jatropha oil is not a simple task, as noted during the evaluation. Suggestions can be made herein but these also need to be tested in the field to ensure that they do, in fact, make sense. There are a few ways that added value can be created but there are challenges, for instance if the farmers clubs are issued with pure plant oil driven diesel engines they have to be able to ensure the quality of the oil or it will destroy the engine in a short space of time. According to many sources, ensuring quality control by small scale farmers is not realistic and most companies involved in working with jatropha and its oil employ people experienced in chemistry, such as chemical engineers. The farmers can certainly be involved in improving quality, by improving storage and picking times, but testing the oil and assessing its quality

for use in an engine is a bit trickier and requires chemicals and equipment. However, it may be possible for the BBC to continue providing various services, such as collecting the seeds, pressing the oil and then bringing it back to the farmers. In this instance, the BBC could take a portion of the oil as payment and the BBC could supply farmers with inputs for making soap such as the essences and caustic soda. The BBC may consider looking at a mobile unit that could go from area to area, perhaps working closely with the maize mills as an energy source, only bringing the presses on the mobile unit.

Another alternative, building on the ideas proposed above, which would reduce the logistical costs, could be to work more directly with the maize mills, building the capacity of the local suppliers to work with pure plant oil. The millers could be provided with an oil press that can be powered by the diesel engines used to grind corn, and thus the maize mills are providing an additional service for jatropha farmers to press the seeds. The BBC could come and collect the surplus oil the farmers don't use for making soap and take it to their facility to test its quality and determine which use it could be put to, or do chemical modifications to make it suitable for use in engines. While collecting oil they can also deliver good quality oil to the mills to use in their diesel engines. As the oil is lighter than seeds, the logistical costs would be less than merely collecting seeds, with the added benefit of the seed cake remaining in the local area for use as a fertiliser or pesticide. Price differentials can be used as incentives to improve the quality of the oil coming from farmers. In this way the local community is further empowered through additional activities and more involvement of service providers. However, the details would need to be looked at carefully.

It was suggested by project managers that the jatropha biomass could be used to make biogas at the Bilibiza centre and this seems to be a perfectly reasonable suggestion to enhance the value of the crop.

Since dehusking consumes a major part of labour required in the harvesting of Jatropha simple hand driven dehuskers should be considered. The BBC has facilities to produce simple dehuskers.

The BBC will be a key partner in all of these efforts as it has the expertise and business approach to make this a sustainable practice. The BBC should be further supported in its entrepreneurial activities to ensure its own sustainability. It is difficult to see how this project can grow and develop if the BBC were to flounder.

2 Research and development

Important work has been done during this pilot project on researching jatropha in the field. As the trees grow to maximum potential, it would be a shame not to continue with this work. All jatropha farmers all over the world and jatropha

breeders could gain immense value from the research data that could be collected over the next few years.

During the visit it was not possible to assess and evaluate all of the research developments made during this project. This aspect of the work done by the pilot project represents a large contribution to the body of knowledge on jatropha and its importance cannot be underestimated considering the lack of knowledge of this crop in the field. Annexe 3 contains the relevant section of the document called the “End Report” written by the project proponents on what was done and achieved in this part of the project work. While in- field evaluation, there was evidence of trials and nurseries with different varieties which were also observed at many of the project sites, and interviews with the project partners indicated significant scientific knowledge, the scientific basis of this data would need peer review. It was reported by the technical consultant, Flemming Nielsen that the data has been presented at various scientific seminars and conferences with much interest and acclaim.

3 Continued support to the farmers

During the evaluation it was noted that there are additional partners coming on board to work with the farmers. This is good news, as the farmers wish to continue growing jatropha in the hope that a) they can use the oil for their own purposes, b) they can find added value activities for the oil which can make them extra cash and c) the price of oil may increase and thus their oil seeds will become far more valuable. These are all good signs, but the farmers need continued and additional help to make sure that they can capture these opportunities when they present themselves.

Additionally, this is a very poor area of Mozambique. Yields of crops are poor and could be hugely increased with additional support as this project has shown already. These activities alleviate the food insecurity issues present in the area in general and help the farmers to generate more income. Continued support for this work is essential.

The farmers need more infrastructure for water supply. They irrigate using watering cans and buckets which is back breaking. The farmers will be able to produce much higher yields if they have access to more water in the dry seasons. This should be a priority for the future. According to the main project leader at FACT Foundation (Jan de Jongh), water is a serious issue in the project area. He reported that a water study was completed during the project and that deforestation, the fact that the land slopes to the sea and the lack of water collection infrastructure like dams, has meant that the area is under extreme stress. Government has regulated the drilling of boreholes, largely preventing this due to the salinity of the water. It is clear that major interventions are needed or the economic opportunities of the area will not be fully realised.

The farmers are not finding it easy to work in a national park. They leave their homes for three months of the year to sit in their machambas and protect their crops from elephants and monkeys and other grazers. The FACT Foundation is working with other partners like the WWF to explore the idea of helping the farmers erect elephant electric fences around the machambas and this effort should be supported. The intention is to use *Jatropha* powered diesel generators to provide light for the villages and electricity for the fences.

5 Conclusion

The FACT/ADPP pilot project has been implemented in line with its original objectives. Many of the deliverables were overachieved, i.e. more plants were grown, more farmers were involved and more land was planted than the original targets. It is remarkable what has been achieved by this project in such a remote area working with many illiterate farmers and extremely poor infrastructure.

The use of the oil from *jatropha curcas* for stimulating development amongst rural poor farmers and communities has been piloted and tested in the area surrounding the Quirimbas National Park in the Cabo Del Gado province. The pilot test indicates that in this area the agricultural inputs for cultivating *jatropha* is minimal, the rainfall and land is suitable and pests are relatively inconsequential; thus this area holds great promise for the continued growth of *jatropha*. Given that the price of oil is expected to increase over time, yet the cost of production of *jatropha* should not increase due to its low inputs, this crop may yet prove to be a high value cash crop for the local people. In the interim it has great potential for use in soap making which is of great interest to the farmers and which will not only generate cash for them, but also give benefit to the local people through access to better quality soap.

Some outcomes were changed during the project for appropriate and good reasons. While the original intent to convert engines to using *jatropha* pure plant oil was a good concept, the pilot project revealed technological challenges to using the oil without a supportive quality control system. Future plans in this regard will need to be carefully considered, as a central facility where the quality is controlled is essential if the oil is to be used in diesel engines. However, the oil can be used for making soap even if the quality is lower, and this activity has presented itself as a good opportunity for the farmers to increase their cash income from the crop.

A key target was the creation of a local market of the pure plant oil. During the pilot project it was proven that if good quality oil is available at a reasonable price (the same as fossil diesel) that local people will purchase it for their diesel engines. The ADPP Mozambique centre and the BBC's vehicle require 20,000 litres of diesel alone and local maize mills require a further 20,000 litres meaning that there is a market for at least 40,000 litres in the locality of the BBC alone.

It is the opinion of the evaluator that the pilot project has given strong indications that jatropha oil has significant potential as a driver for local economic development within the pilot test area. Many aspects of the work have proven jatropha's ease of cultivation by farmers in the area, its applicability within a rural setting as an oil and its usefulness as an added value product (for instance for soap making).

The research component of the project was significant. However, it was not possible in the short space of time to evaluate this in the field. Peer review from conference proceedings and papers has indicated the usefulness of this work to others. It is an aspect of the work that should be maintained as the best results of the trials and the tests on growth potential and pest resistance will only be seen in the future as the crop grows to its full potential.

The centralised facility at Bilibiza is likely to grow and develop in its own right, as a small entrepreneurial business. While it will use jatropha oil for many purposes, it is likely that oil extraction will continue to develop from other crops like peanuts into the future. The BBC is an important part of any future development of this crop in this area and should be nurtured and supported.

The work in this project is a significant contribution to the understanding and knowledge of using jatropha as a crop for driving local economic development in rural poor area. However, the four years allocated to its research are not enough; more time must be given to develop the work further and allow it to reach its full potential. It is recommended that further investment is made into the project, to ensure that the full value of its work is not lost.

<p>Do you know that the seeds must be dry before you put them in bags? If yes, how do you dry the seeds? How long does it take to harvest one tree? How much time do you spend harvesting per day during jatropha harvest season And for how many days per year/season? How much time do you spend dehulling the seeds? Is there any additional time related to jatropha that is spent by you? So the total time spent by you (or family) on jatropha is.....</p>
<p>On average, do you think growing jatropha is worth the time, effort and cost for you? Yes no Explain</p>
<p>What crops give you the best return for time, effort and cost?</p>
<p>Does growing jatropha interfere, interrupt, impact or affect your other farming Yes no Explain Do you harvest jatropha after the main crops have been harvested or before, - how does it work?</p>
<p>Question must be aimed particularly at women (as well as men) Does growing jatropha impact (positive or negative) on your or your wife's, children's ability to complete household level activities (collecting wood, water, cooking, washing etc)</p>
<p>Do you think that in the future growing jatropha can improve the household income more than it does now? Explain</p>
<p>Do you think that in the future jatropha or its by products will improve your living conditions in some way (providing energy, or bi-products like soap or biomass/fertiliser) Yes no Explain</p>
<p>Do you want to continue growing jatropha Yes No Explain</p>
<p>Would you like to increase your jatropha plantations? Yes no Explain (by how much, for what purpose or if not, why not)</p>
<p>Was anyone removed from the land where they are living so that any of your farmers can grow jatropha?</p>
<p>What was generally growing on the land before your farmers planted jatropha? Has growing jatropha changed your traditional practise of cultivation like slash and burn? Does jatropha help stop animals come onto your fields where you are growing other crops? What farming practise do you use? Explain Did you always do your farming like this?</p>
<p>If you are not already, would you like to be more involved in the processing and other value added activities of jatropha?</p>

Result of the questionnaires

Name of club	1 st May	Xinavani – district Mwangide	Nandia	Koko
No of farmers	50 farmers 18 women	50 farmers 14 women	29 farmers 10 women Farmers expelled	45 30 women
Area planted		About 80Ha	35HA 2 X 2 spacing, plantation style	70Ha
No of trees		350 trees/farmer total 1220 as only 3 farmers involved		Thousands, don't know how many
Jatropha seed production	Sold 50 bags of 50Kg each total 1000Kg	Sold 10 bags of seeds to BBC 15 bags waste as kept for another buyer who never came	Sold only to BBC 48 Kg (1 bag) = 240Mt	
Price	Thinks 5mt to low a price	Unhappy with price of 5Mt/Kg	Unhappy with price of 5Mt/Kg	Unhappy with 5Mt/Kg, felt that 10Mt/Kg was a better price
Cultivation	Does not affect other crops unless it causes shade. No fertiliser	Find growing jatropha easy & no competition with other crops	Easy to grow	Easy to grow
Pests and weed control	Termites in some fields	No pests, weeding done with other weeding Mostly prune	Challenge with termites	Small termite problem,
Harvesting, pruning, dehusking	Find cultivation easy, harvesting – collect 4Kg per hour. Estimate each farmer takes 1 week in total for all work related to jatropha	Harvest and dehusk at same time as other crops	Find dehusking time consuming but not cultivating or harvesting	Say it takes 2 days work to prepare one large bag. Now they just leaving the seeds to fall on the ground and they are not collecting
Future plans	Would like to be able to use the oil	Will keep growing in case price improves and	Will keep growing in case price	Will keep growing jatropha

Final Evaluation report of the FACT/ADPP project February 2011

	themselves, 1 person mentioned generating electricity or for lamps – other mentioned making soap. Will start growing jatropha in plantations	they like it as a hedge	improves	
		Would like to make soap, it would empower them	Would like to make soap, it will earn them good money	
Other vegetables	Grow sesame, ground nuts, beans, maize, pigeon peas	Grow cassava, okra, rice, maize, beans, peanuts, sorghum, sesame, tomatoes, cabbage, rape, carrots, lettuce, sweet potatoes, pigeon tea	Grow tomatoes, maize, beans, cassava, cabbage	
Water		Cereals rainfed, vegetables irrigated	Cereals, beans and cassava is rain fed	
Profits		FC made 2650Mt from surplus crops and 800Mt from jatropha, but still feel its not worth it	FC made 5800Mt from surplus vegetables, produced 15 tonnes maize (sold 5 tonnes) and got 8,000 Mt @ 1.5 Mt/Kg and they all sold their beans individually.	Made 60Mt from the demo plot
Challenges or desires		Want more water, spray machines for pesticides		Small termite problem
comments	Don't feel jatropha a waste of their time, but want a slightly better			Don't feel jatropha waste, will keep growing in case the

	price.			price improves
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Annexe 2 – Deliverables measured against the target

Objective

FACT's long-term goal is to make a tangible contribution to the development of biofuels in developing countries, enabling local communities to benefit from this renewable energy source also when supplying the world market on the medium term.

The **objective** of this pilot project is”

To build an infrastructure and capacity to enable the autonomous upscaling of the activities after termination of the project. The project will initiate the local production of Jatropha seeds and develop a local market of end-users of the oil. The creation of capacity among the local small farmers and technicians is an important component of the project.

Project elements and expected results

As a first element, the project will create between **250 and 500 ha** of land cultivated with Jatropha after 3 years. The sites will be located in **5 different**

areas spread over Mozambique (from north to south), in which the local counterpart ADPP has had a long-lasting presence. The production of Jatropha will be done by small **farmers who are united in 25 farmer organisations** (the so-called “farmers clubs”), which are supported by ADPP and will be coordinated by FACT.

People in various projects have come up and were trained.

The national research institute IIAM , in cooperation with the project staff ,**will carry out “on farm research”** to investigate different varieties, pests, diseases, and the use of biological pesticides with the aim to achieve a balanced production of the Jatropha crop.

First study of insects – collaboration with IIAM
 Pretreatment of seeds to increase germination rate.
 Other research results here

The second essential element of the project is the **development of a local market** for the oil, which can be used **to operate diesel generators** for schools, to run corn mills and as a fuel for (a few) vehicles equipped with a diesel engine. **Local technicians will receive training** on how to convert diesel systems for plant oil operation, which involves the assistance of experts from abroad. **The oil will be pressed at 10 different sites (within 5 schools and 5 small enterprises)** to create a guaranteed initial market for the farmers to sell the seeds and the oil. Another option is the use as lamp oil for lighting in the villages and as a prime material for soap production. It is expected that at the end of the project **a market will have been created for 25 diesel engines distributed over 25 villages**. The **knowledge** acquired from this project will be **disseminated** and the experiences and local revenues will generate new, comparable projects.

Lamp oil – still being worked on but there are logistical issues which include small pieces of copper pipe that holds the wick,
 Community members talk about using the seeds but they don't light for long
 Market survey was done to determine market size for lamp oil

Project activities

1	Development of an agricultural infrastructure for Jatropha:
1.1	Recruitment and selection of 25 farmer organisations (out of a potential group of 180);
	36 farmers clubs selected and recruited
1.2	Training of farmers and extension workers on the production of Jatropha;
	Completed for all 1800 farmers associated with the 36 farmers clubs
1.3	Base line measurement among 250 households to determine the

	penetration of Jatropha oil after two years;
	Assessment of need completed, report available on web site
1.4	Installation of 50 irrigation systems (wells plus water pumps);
	Completed and watering cans distributed also
1.5	To make available and to plant Jatropha, initially on 25 outgrower research plots and, at a later stage, in an area of 10-20 ha per farmer organisation (25);
	36 farmers clubs, over 600 Ha planted
1.6	To harvest the Jatropha seeds;
	Farmers harvest seeds and sold to the BBC
1.7	Monitoring, field visits and meetings by / for the project participants.
	Detailed monitoring system in place, fixed schedule that is checked and assessed
2	To bring Jatropha oil on the local market and enable its use for self-supply:
2.1	Selection and training of 20 small entrepreneurs and 30 technicians for processing biodiesel and for maintaining diesel engines (generators);
	Although biodiesel was mentioned in the summary proposal, right from the beginning the aim was to produce PPO, due to economical (cheaper) and technical issues. Three training courses for the conversion of engines to run on PPO were carried out. Courses were run where members of the FC were shown how to make soap making, and explaining how the process works and the objectives of the project
2.2	The installation and adaptation of 10 diesel generators and 2 cars to run on biodiesel;
	2 engines converted and converted one vehicle – plus 2 diesel engines for endurance testing
2.3	The procurement and installation of 5 oil presses
	3 presses were purchased and tested. The hand press is not being used as it is very inefficient. The two motorized presses are both operational
2.4	The development of a transport and local trade network for biodiesel;
	BBC have a network within the project
2.5	To monitor performance of the technology, maintenance and stock of spare parts.
	All completed within BBC
3	Project upscaling based on the created infrastructure:
3.1	To create stocks of seed samples covering 5-15 varieties of Jatropha, including the execution of tests;
	Have tested Guatemala, Zimbabwe, Gorongoza, Malawi, bilibiza, Honduras plus a few more , Research plantations and nurseries Various studies completed, results to be found in annex 3
3.2	The economic analysis of the preliminary results, including determination of the price conditions for further upscaling within subsequent projects;
	Completed business plan
3.3	The exchange of experiences with Jatropha production in Mozambique

	with other countries, such as Zimbabwe and Zambia;
	Done through workshops (4 of them). Participated in other workshops organized by various universities (list available)
3.4	The development, coordination and monitoring of a research programme targeted at upscaling.
	Completed see annexe 3
4	Promotion and dissemination of results:
4.1	Development and distribution of training material (covering radio broadcasting, video movies, books and leaflets) on the cultivation of Jatropha and the adaptation of diesel engines;
4.2	The dissemination of “best practices” using newspaper articles and a website;
4.3	To execute 2 seminars and training courses for several target audiences
	All of the above were done successfully with extensive communication and marketing

Annexe 3 – Summary of research and development work

This data was taken from a draft FACT report and details the research and development components of the project.

Research on the plant *Jatropha*

- A trial of pre-treatment of *Jatropha curcas* seeds showed that untreated seeds had as high germination rate as any of the tested treatments. Pre-treatment of seeds is therefore not recommended under Mozambican conditions.
- Preliminary identification of pests was undertaken and samples that could not be identified were submitted to the Plant Protection Research Institute in Pretoria, South Africa which in turn has enlisted assistance from Prof. Maurizio Biondi, Italy, who is a specialist on southern African *Alticinae* spp. which turned out to be the major pest in *Jatropha* in the region.
- A thorough survey with almost national coverage of insects in *Jatropha* was undertaken with Eduardo Mondlane University. It confirmed that the project area has few pest problems compared to other areas in the country.
- The survey also showed that the planting time has significant effect on the pest pressure years after the planting took place.
- Organic pesticides were tested for their efficacy in controlling the flea beetles.
- A model for yield forecasting was developed based on the few reliable data series that exist on *Jatropha* yield and adjusted for the local agro-climatic conditions.
- *Jatropha* varieties from different countries were compared in trials that are still too young to provide conclusive evidence. This work should be continued as yield data are essential and virtually missing.
- Trials with improved hedges were established with the goal of maximizing the yield from farmer's hedges.
- Monthly yield measurements in both fields and in well managed demonstration plots was undertaken. Because the plants are only half way to maturity conclusions can only be reached if measurements continue.
- A study of the carbon and energy balance was undertaken in collaboration with University of Copenhagen. It showed that *Jatropha* production in the area has a positive carbon and energy balance if undertaken on fallow land or in maize fields but not if primary forest is cleared in order to plant *Jatropha*.
- A study of the effect of soil nutrients on plant development was undertaken in collaboration with Wageningen University. It was found that macro nutrient availability has low explanatory power and the effect of water, and management therefore warrant more research.
- A GIS was developed to support various analysis including transport requirements.

- Observations and measurement of labour requirement and productivity were undertaken. The results have been summarised elsewhere in this report and on the project web site.
- Simple methods for selecting seeds according to size were tested but found in inefficient.

From systematic observations and monitoring it appears that:

- The risk of direct seeding is low compared to the savings in working hours. Direct seeding is preferable to cuttings because they develop a tap root which ensures longevity, the ability to utilise water and nutrients from deep soil layers and provides stability during storms.
- *Jatropha curcas* performs almost as well in unshaded nurseries as in shaded ones provided they are watered sufficiently.
- Researchers assessed the effect of pruning at different times. In only one case was it observed that many plants had died after pruning. It is likely a fungal attack caused by pruning during the rainy season. Until further information is available it is recommended only to prune during the dry season.
- In an observation trial manure was applied to some *Jatropha* plants. A very strong positive response to manure was observed.