# HOW WILL SMALL SCALE FARMERS IN ZAMBIA BENEFIT FROM GROWING OF JATROPHA?

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# Norwegian University of Life Sciences

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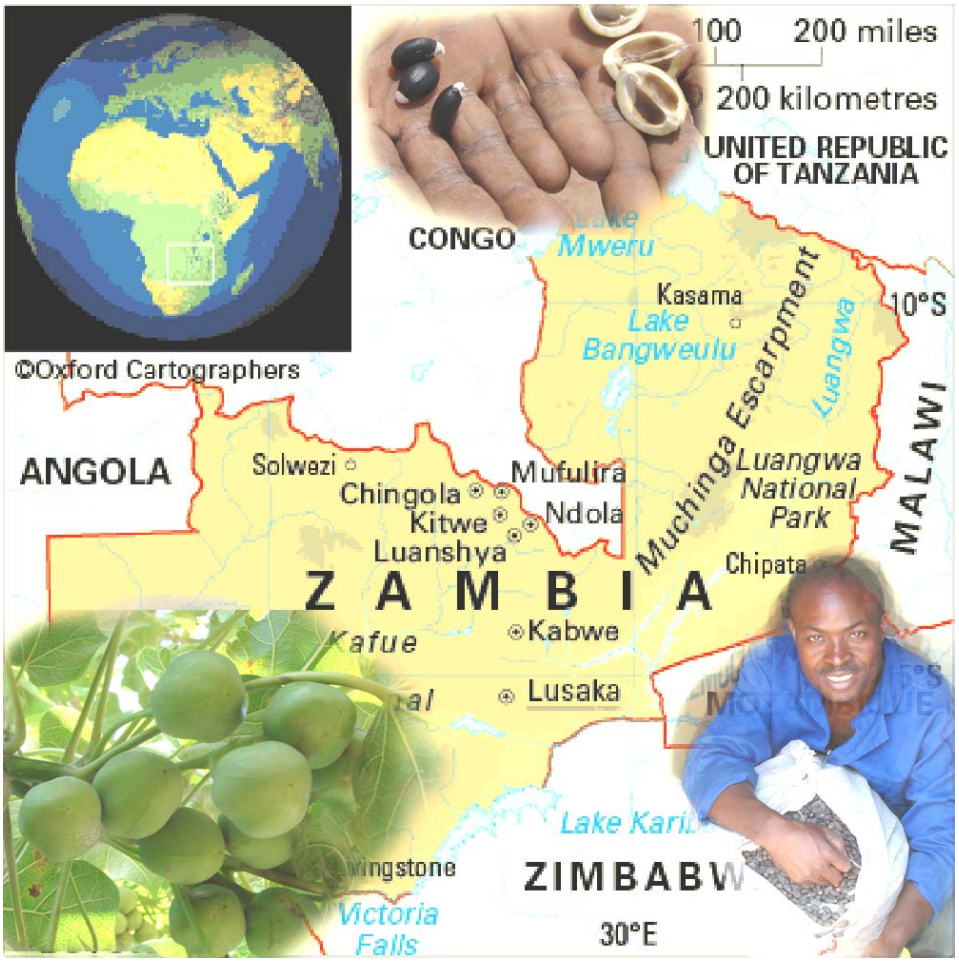


# How will small-scale farmers benefit from growing of Jatropha?


## Lars Olav Freim

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12/5/2008
Lars Olav Freim

## Declaration

I, Lars Olav Freim, declare hereby to the Senate of the Norwegian University of Life Sciences (UMB) that the present thesis is the original product of my own research. All sources of information used as references and material other than my own are duly acknowledged. The present work has not been submitted to any university other than UMB for any type of academic degree.

Råde, May 2008

Lars Olav Freim

## ABSTRACT

Environmental issues, food security and increasing prices on energy are some of the global challenges we face today. In 2000, UN introduced the Millennium goals, where one of many important targets was to reduce poverty. Several approaches have been suggested to reach the goals. One among many suggestions to give small scale farmers a more sustainable livelihood can be jatropha," the diesel tree". Zambian National Farmers Union (ZNFU) suggests to plant jatropha as hedges, fences and demarcation in the rural areas. Their main approach is planting with a purpose of fencing and to improve the local environment. Afterwards, the plant will give a surplus f seeds for sale. Several oil companies push the farmers to establish fields of jatropha. Together with ZNFU, CFU, The Royal Norwegian Embassy in Lusaka, Ministry of Agriculture and Cooperatives (MACO) and some of the oil companies in Zambia, I tried to highlight the following questions:

-*Will the growing of jatropha reduce the costs and increase the income within the household?*

-*Will the growing of jatropha have any influence on the household's food production- and security?*

-*Would engagement in jatropha production translate into better income than current activities?*

-*Is there a significant difference in livelihood between growers and non-growers of jatropha?*

A sample of 115 small scale farmers was chosen from districts known for jatropha production. The number of jatropha growers is so far, very low. Snowball sampling was chosen as sampling method. From interviews with farmers, field officers, promoters and governmental employees, the objectives were answered. An activity calendar for jatropha was developed and compared with the activity calendars for the most common crops in Zambia. Cost benefit analysis were calculated for different methods of growing jatropha. Gross margin and rentability were compared with data's for the most common crops and seemed to be very promising for jatropha. Higher wages for agricultural labour or lack of labour can be Achilles heels for jatropha since some operations are very time demanding. The operations which require most time are weeding, pruning, harvesting and peeling. In spite of this, jatropha will hardly be harmful to food production because the activity calendars show that most jatropha activities can be done in the farmer's idle time. Even in terms of land, jatropha will not be cultivated at the expenses of food production because there is plenty of dormant land in Zambia. After planting, the crop starts to give a yield after 2 years. Unless the promoters supply the farmers with seeds and implements, this will be a hindrance for jatropha growing on a bigger scale. Several promoters have invited farmers to join out grower schemes. Even though many farmers have responded positively, and now have received seeds, the promoters will face many challenges. To keep up the motivation among the farmers so they don't give up is one. To avoid side selling seeds is

another one. Calculation of the profitability has to be done over a period of 10 years or more. In a short perspective (10 years), jatropha is less profitable than cotton, tobacco and castor beans. In a longer perspective, jatropha will be more profitable than any other cash crop. In spite of the investment costs and waiting period, future income from jatropha give a very high net present value.

Weeding of jatropha seedlings in a nursery

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# 1 INTRODUCTION

## 1.1 The Jatropha plant

Jatropha curcas L. is a shrub which can reach the height of 6-7 meters. It is not a new plant in Africa. It was introduced by Portuguese traders and adventurers about 400 years ago. Oil extracted from the seeds has had medical purposes for skin diseases and stomach trouble. Soap is another of the traditional products developed from jatropha oil. Cuttings from jatropha will root easily and during a short time make a protective hedge or fill the purpose as a demar-cation. Today, jatropha is most often mentioned in the biofuel debate as a plant with energy rich seeds and very promising possibilities. It is a perennial plant with a life span from 20 to 50 years dependent on propagation. Trees from seedlings will grow older than trees propagated from cuttings. The tree will give harvest after 1 to 3 years. Cuttings will give yield earlier than planted trees. The yield will increase from approximately 1 to 9 kg per shrub during the first five years after planting. Jatropha is easy to plant and maintain. Poor and marginal soils are well suited for the plant and it needs only small amounts of water. Marginal soil should be used for biofuel production to avoid competing for land with food crops. In pure stand the spacing will normally be between 2 by 2, or 3 by 3 meters. It is possible to intercrop jatropha with food crops or other plants, but the spacing must be increased to 6 by 6 meters or more. Because of the long period between planting and harvesting, many farmers cannot afford to establish a jatropha field. Several oil companies invite farmers to join an out grower scheme where the promoter carries the costs linked to planting and nursing. The finances are given as loans with the jatropha trees as collateral. The loan is paid back in terms of a fixed amount of seeds after harvest. The surplus of seeds is sold to the promoter. Alternatively, if the farmers have access to a press, they can extract oil for their own use. Jatropha oil burns with a clear, smokeless flame and can be used in a lamp or a modified stove. A diesel engine can be run on pure plant oil after slight modifications (see figure 32). Other options are to mix jatropha oil with diesel or transform the oil to biodiesel. No modification of the engine is needed in these cases. In addition to the economic incentives, small-scale farmers can benefit from jatropha as described in the following list and figure 1.

Jatropha benefits locally:

☺ Demark boundaries: Fewer disputes caused by crop damage or unclear boundaries

☺ Living fence protecting crops and gardens against livestock

☺ Social equity; Promotes opportunities for women

☺ Fence protecting against wind erosion damage

☺ Creating jobs; reduced rural urban migration

☺ Adding fertilizer; improved soil fertility

☺ Increased livelihood diversification

☺ Rural and household incomes

☺ Insecticidal products

☺ Rainfall infiltration

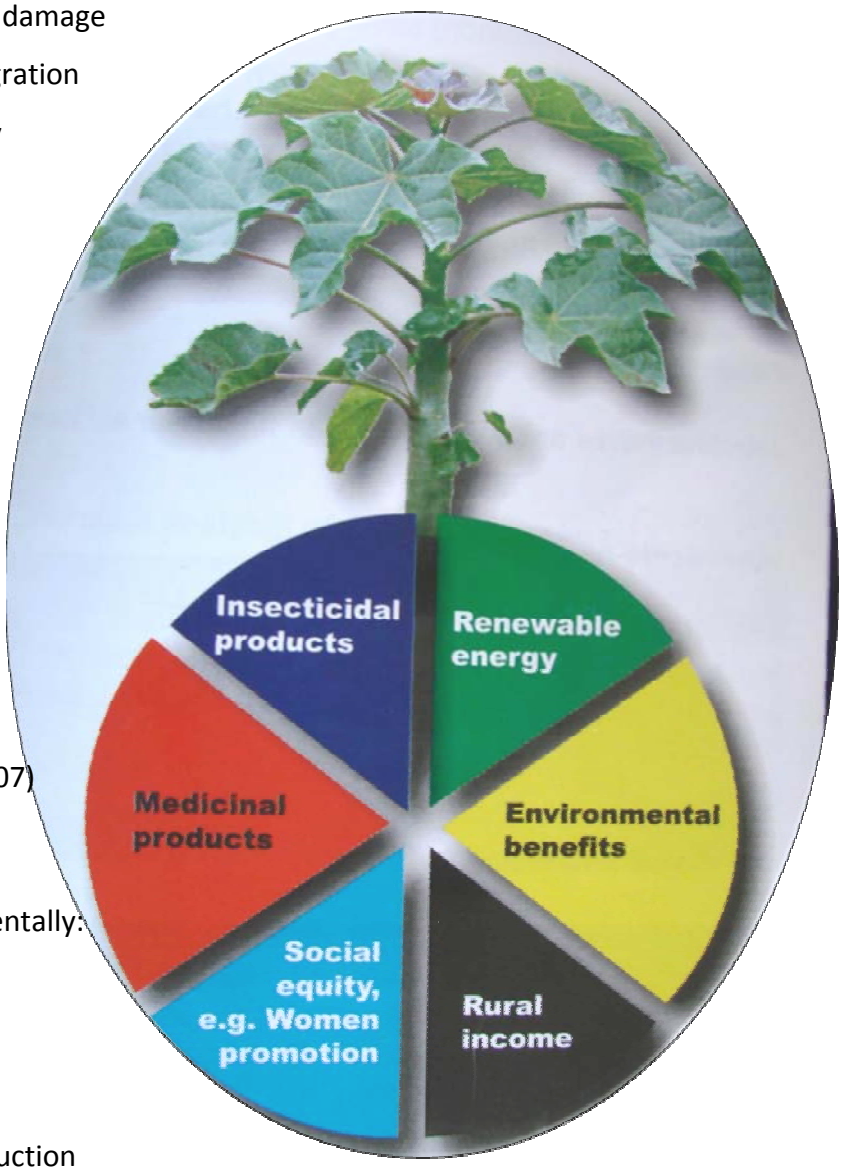


Figure 1:

The Jatropha System:

Source "*Jatropha curcas, The Untapped Potential in Eastern and Central Africa: Production and Utilization Manual*"

Nyamal, D.O and Omuodo, L.O et. al. (2007)

Jatropha benefits globally and environmentally:

☺ Renewable energy

☺ Medicinal products

☺ Reduced soil erosion

☺ The shrub binds $CO_2$ through the production

☺ Less use of firewood for cooking and lighting

☺ Can be planted in desert areas and on marginal land

Figure 2: Jatropha as a fence around a bathroom in Chipata

Figure 3: Jatropha field near Lusaka (Thomro Biofuels)

Figure 4: Cuttings taken from a shrub in Chipata on a bicycle

Figure 5: Seedbeds with jatropha near Lusaka (Thomro Biofuels)

Figure 6: Jatropha as a demarcation 6 months after planting

Figure 7: Jatropha fruit and seeds

## 1.2 Zambia

Zambia was one of the wealthiest countries south of Sahara when it became independent in 1964. Access to rich natural resources and absence of war and conflicts made the future look bright for Zambia. In spite of these promising possibilities, 45% of GDP today comes from foreign aid and financial support. In areas like life expectancy, education and standard of living the situation has not improved. UNDP's Human Development Index for Zambia has had a catastrophic decline since 1985 (Figure 1).

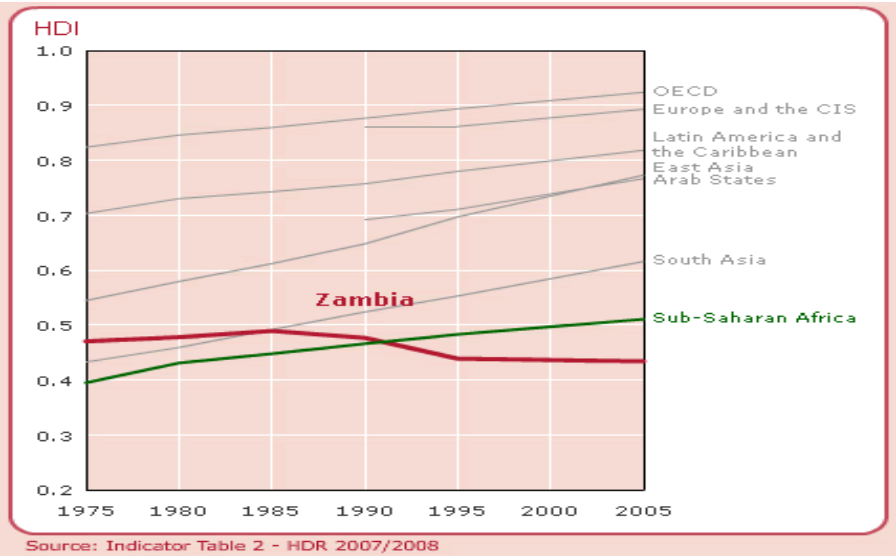


Figure 8: UNDP's Human Development Index for Zambia.

In 1991, 70% of the population lived below the national poverty line. In 2004 this was hardly reduced. This is shown in table 1.

| Residence/Provinces | 1991 | 1993 | 1996 | 1998 | 2004 |
|---|---|---|---|---|---|
| **All Zambia (%)** | **70** | **74** | **69** | **73** | **68** |
| Rural (%) | 88 | 92 | 82 | 83 | 78 |
| Urban (%) | 49 | 45 | 46 | 56 | 53 |

Table 1: Population below the poverty line in the period from 1991 to 2004
Source: The Living Conditions Monitoring Survey IV of 2004 (LCMSIV)

In the same period, the country received 12 billion US$ from international donors. Zambia suffers badly because of the HIV/AIDS epidemic. The country is ranked on the fifth position worldwide with more than 900.000 people infected (15,6% of the population). A remarkable decrease in productivity of the agricultural sector can be allocated to reduced performance of the workforce because of the impact from HIV/AIDS (Zambian Farmer Magazine-Jan. 2005).

Bie S.W. (2008) claims in Noragric report No. 42 that rural poverty is the main reason for the high rates of HIV/AIDS in Zambia. Rural poverty has to be fought by increasing the effective income in agriculture. To improve the general economic growth of the country, contribution from agriculture is important (Kabwe and Donovan 2005). The government is promoting an improved agricultural sector through their Poverty Reduction Strategy Program (PRSP) and the Agricultural Commercialization Program (ACP). Conservation farming is a part of these programs and growing of jatropha is one among many strategies to obtain progress in the agricultural sector of Zambia. The potential for income from jatropha will add another income source to the rural households and improve the livelihood diversity for them. It is also a potential for saving costs. Jatropha in a field or a hedge will increase the household's physical capital as well as the natural and the financial capital (Buyinza M, 2007).

A study on Jatropha is relevant because of the potential and multipurpose use of the tree. Even if an extended cultivation cannot transform Zambia or the world, secure the global need for energy or complete eradicate poverty, the growing of Jatropha can be an important supplement and one out of many different tools to improve food security, secure access to environmentally friendly energy and strengthen local livelihoods. Production of energy rich seeds and processing of oil can generate income and employment for farmers even in marginal locations.

## 1.3 Research Question and Objectives

Much research has been done and some experiences have been gathered in the last few years concerning production, refinement and use of jatropha oil. However, very little information is available with respect to time use linked to the different operations in nursing, cultivating and harvesting. Studies of time use are important to estimate the costs for labor and other input during the process, and finally the net profit. The net profit will be compared with data for the most common cash crops. Time use is also necessary in order to identify the bottlenecks in the

process and how to improve the efficiency in the production. Another issue is the kind of impact jatropha growing might have on food production in the terms of required land, labor and economic input. Will the food production suffer and the livelihoods be more food insecure or could the opposite happen?

Data has been collected from a sample of farmers by using interviews and observations. In addition to this, background information was collected from different actors like Ministry of Agriculture, NGO's, agricultural extension service, commercial business and other stakeholders. Central Statistical office provided background information about general living conditions and agricultural production.

The overall research question is: *How will small scale farmers in Zambia benefit from growing of jatropha?* The value chain for jatropha is diverse and gives the farmer many options whether he wants to sell or keep specific products. Benefits are primarily income, but can also be saved costs. The most significant income comes from sale of seeds, oil or soap. Substitutes for expensive kerosene, fertilizer and diesel are significant in terms of saved costs. Cash is needed in the rural households for transportation, school fees and school materials, medicine, clothes, paraffin and in many cases food during the dry season. Another aspect is health: Some households use diesel for lighting. Diesel creates smoke which smells badly, irritates and pollutes indoor air quality. Secondary benefits are oil for lighting, cooking or fuel, fertilizer, biogas or charcoal from the press cake. The wide and various value chains, give the jatropha farmer a wide range of multiple choices. It is also import to bear in mind the yield stability. Jatropha is drought resistant and natural hazards will probably cause greater losses in a yield of traditional crops than jatropha. The growing of jatropha can somehow be at the cost of food production. A jatropha field will occupy land and demand agricultural input and labor. Whether one should grow jatropha or not and the field size can be difficult to decide for a small-scale farmer. A rule should be *"to grow enough to meet your needs"* (statement from Sinkala 2007).

The objectives of the study are as follows:

-*Will the growing of jatropha reduce the costs and increase the income within the household?*

-*Will the growing of jatropha have any influence on the household's food production and food*

*security?*

*-Would engagement in jatropha production translate into better income than current activities?*

*-Is there a significant difference in livelihood between growers and non-growers of jatropha?*

## 1.4 Justification of Study

A good plant for biofuel production should be able to produce large quantities of biomass at low cost. Another desirable property is that it must be easy to handle and process. (Meijerink G. et. al. 2006) They claim that an overall cropping system should lead to:

- High water use efficiency (kg water per kg DM)
- Low input of fertilizer
- Low input of pesticide
- Low use of labour
- Low input of machinery
- Low soil requirements
- High yields per ha

It seems that the jatropha plant is able to meet those requirements. “Wonder Plant” and “Multi Purpose Tree” are some of the terms which are used about Jatropha Curcas. Many farmers use this shrub/small tree as a living fence to protect crops against grazing livestock. Its botanical characteristics are well known.

During the last few years, a lot of research has been done to determine the qualities of the jatropha tree and its oil. The results so far are promising. Most research seems to be about cultivating and oil processing. The literature is in general very poor when it comes to measuring and estimating time use in growing, farmer’s attitudes towards this tree and its potential influence on a more diversified and improved livelihood.

The approach of a global energy- and environmental (climatic) crisis has made the focus on jatropha even sharper. The seeds contain 32-35 % of oil and even on marginal land an estimated amount of 2 kg oil per tree can be the annual outcome. If 1000 trees give yield per hectare, the outcome can be about 2 tons oil annually. Large scale production of bio diesel is a

tempting enterprise for commercial business, governments, international aid- and development agencies and local farmers groups. A small scale production can give oil for cooking or lighting and a surplus of oil or seeds for sale. Pure plant oil, purified oil or a blend of diesel and oil can run local generators, tractors or hammer mills (see figure 31). The press cake is a powerful fertilizer with nitrogen content similar to that from chicken manure (Jatropha Handbook). One ton of press cake is equivalent to 200 kg of mineral fertilizer (The Jatropha Manual). The press cake can be used for charcoal or fermented to biogas as well. The leaves can be used as fodder if they are cooked.

Jatropha is easy to plant and requires very small amounts of nutrients and water. The minimum of water recommended is 300 mm annually. The optimum amount is between 600 and 1200 mm annually (Heller, J: 1996).

Production of seeds should not be at the expense of food production. Degraded and marginal lands are good locations for jatropha cultivation. Zambia has dry areas, especially in the southern and western province where the annual rainfall is below 1000 mm.

In jatropha cultivation there is a potential for cash cropping as well as protection of vulnerable soil and improvement of degraded or marginal land. Jatropha requires a tropic climate and grows in South America and Asia as well as in Africa. If the outcome of further experiences and tests are successful, extended use could be implemented in most of the developing world.

## 1.5 Description of the study area


Fig 9: Map of Zambia. (Source: The Commonwealth Secretariat/Yearbook Internal)

Zambia (former North Rhodesia) is a landlocked, independent republic which is situated in south-central Africa. Absence of harbors causes higher costs for transportation of goods which are imported and exported between Zambia and oversea trade relations. One consequence is very high prices on fuel and transportation. The country is rich on natural resources like copper, cobalt, zinc, lead, coal, emeralds, gold, silver, uranium and hydropower. Mining causes environ-mental problems. Consequences of mineral extraction are air pollution, acid rain and chemical runoff into watershed. Other issues related to the environment are deforestation, soil erosion, desertification and poaching.

Zambezi River is merging with the border of Zimbabwe in south which is the lowest part of Zambia. The lowest altitude is 329 m above sea level. The highest point is found in Mafinga Hill

2301 m above sea level. The official language is English, but 80 other native languages are spoken. Zambia has 2173 km of railways and 91.440 km of roads. Of this, 20.117 km is paved (The Commonwealth Secretariat/Yearbook Internal). The mud roads can be hazardous during the rainy season.

Through the 1980's and 1990's the economy was hurt by declining copper prices, prolonged drought and corridor disease on cattle. A big range of different NGO's with different tasks are found in Zambia.

Data were collected from Choma, Chongwe, Chisamba, Chipata, Kabwe, Katete, Lusaka, Mum-bwa and Petauke. These places are situated in the Agro ecological zone IIa which covers the fertile plateaus of Eastern- Southern- and the Lusaka province. This is the most productive agri-cultural land in Zambia. The rainfall is between 800 and 1000 mm annually. A variety of crops are found in this area like maize, sunflower, soyabeans, groundnuts, irrigated wheat, tobacco and other crops. 85% of the labor force is engaged in agriculture, 6% in industry and 9% in services.

Zambia has a dual land tenure system. *State land* is administered by state authorities (e.g. ministry of lands). Anybody can buy this land. This land is found in towns and cities. 40% of the total land area is state land. The remaining area is *customary land* and regarded as traditional land. The jurisdiction over customary land is exercised by chiefs and their headmen for agri-culture and settlement. In uncultivated areas customary land is utilized in accordance with customary practices and tribal norms (Jere, P. 2004).

The study was done in 2007 from Oct. the 1$^{th}$ to Dec. the 18$^{th}$ when the dry season ends. The year is divided in four different seasons in those regions:

| Dec-Feb | Feb-April | May-Aug | Sept-Nov |
|---|---|---|---|
| Wet & Warm | Wet & Cool | Dry & Cool | Dry & Warm |

Most of the time spent on agricultural activities takes place in the beginning of the rainy season. The rainy season is in general busy for the farmers. Harvesting takes place from March to May and is followed by a period during the dry season with idle time and few activities for the farmers.

# 2 RESEARCH METHODS

## 2.1 Research Strategy and design

For the collection of data, a multi-strategy-design, which is a combination of qualitative and quantitative design, was chosen. To ensure reliability and replication, the emphasis in research strategy was to be quantitative. Semi structured interviews (SSI) was used to investigate all the objectives. The open-ended characters of the SSI allowed for flexibility and also lead to the formulation of new hypotheses or research objectives that may not previously have been identified. Different types of semi-structured interviews were used; individual interviews (mostly farmers), key informant interviews, group interviews (with farmer groups) and focus group discussions. Nearly all of the individual interviews and the group interviews were conducted with small scale farmers. Focus group discussions were done in the beginning of the field work to secure the quality of the questionnaire as well as supply and triangulate information. Key informants were agricultural experts, extension officers and field supervisors from both MACO and NGO's, the oil companies and other people engaged in the jatropha business. Because of its nature and combination of different aspects and issues, it is a typical cross sectional design.

## 2.3 Sampling

The main target group was farmers who already had some experience, skills, knowledge and knew how to utilize and grow jatropha. The secondary target group was farmers who, for some reason, had decided not to grow jatropha. During the three first weeks in Zambia, meetings were arranged with key informants who were supposed to know where to find growers of jatropha. Information about where to find growers of jatropha was given by CFU, D1 Oils, Marli Investment, Northwestern Biopower and Southern Biopower. Out of this information, three provinces were selected. These provinces seemed to have a higher density of trees and growers than the remaining provinces. The chosen study areas were Lusaka-, Southern-, Central- and the Eastern Province. Based on the given information about where to find jatropha growers, the following districts were chosen: Eastern Province: Chipata, Kabwe and Petauke.
Central Province: Mumbwa, Chongwe, Kabwe and Chisamba.
Southern Province: Choma.


Figure 10: Choice of study area; the places data were collected

NFU/CFU was chosen as the main partner during the data collection. Their field officers in the chosen districts would provide transportation and guidance in the field. They would also find the jatropha growers and work as translators when needed. After an introduction of the research with its objectives and the questionnaire for the field officer, we would go out in the field. The jatropha farmers were found in four different ways: a) The field officer would bring us to conservation farmers who were given seeds from CFU or use his local knowledge and lead us to jatropha farmers he knew about.

b) Sometimes, the field officers were not certain about the exact localization of the jatropha farmers. In those cases, we first went to ask the governmental extension officer (District Agricultural Officer, Block Extension Officer, Camp Officer) or other institutions who were supposed to know the jatropha growers and where to find them. c) After one interview, we sometimes had to ask the farmer to tell us where to find other jatropha farmers. He would follow

us or tell us about his ‘colleges’ and where they were localized. d) On some occasions there were clusters of jatropha farmers in the village. In those cases, the farmer would send his kids over to their farms and call them to the meeting. Non-probability sampling was the most suitable method to find the segment for the SSI’s and the rest of the interviews. Snowball sampling became the most suitable method for this purpose because farmers with experience and some skill in Jatropha growing were needed for the research.

### 2.3.1 Sample Size

The sample size was decided to be about one hundred farmers. According to Bryman, this is too scarce to be completely representative and to ensure validity in the research. 110 typical small scale farmers were interviewed before the rainy season started and made the farmers busy with sowing. Some were growing jatropha individually and some were participating in an outgrower scheme. In addition to those, nine persons who have experience and knowledge about jatropha growing were interviewed to add information about time use in the different stages of the growing.

## 2.4 Data collection

The first weeks in Zambia were used to collect data and background information from the key informants in MACO, ZNFU, University of Zambia and the oil companies. The period Oct/Nov is the end of the dry and hot season and the time during the year when the farmers have most of their idle time. As soon as the rain starts, they get busy preparing the soil, sowing and planting. Oct/Nov is a good time for interviewing farmers, but not good if the target is to observe their activities. Because of the low level of activity, it was impossible to do time studies by observations. During a day in the field, about 6 to 9 farmers were interviewed.

Questions about income from jatropha growing, both directly in cash and in terms of reduced costs to kerosene/paraffin indicate the economic benefits from jatropha. Other indicators were supposed to be differences in standard of living between the growers and non-growers of jatropha as well as changes in the jatropha grower’s livelihood security since they planted their jatropha plants.

To determine the labor costs of jatropha production, the time used at the different stages of the

process was estimated. By investigating the time use, it has been possible to find bottlenecks in production, labor costs and net profit. This has been compared with the net profit in production of crops like maize, ground nuts, potatoes, vegetables, cassava, sunflower, soya beans and so on. To investigate whether growing jatropha makes food production suffer in the terms of labor, the demand for work all through the year was compared between jatropha and traditional crops.

Figure 11: Meeting the farmers in a village near Choma

## 2.5 Challenges

A central criticism raised against quantitative research, is the failure of the researcher to address adequately the issue of meaning. Did the interviewees understand the questionnaire in the same way as I expected them to be understood? And was I able to understand their answers? To make it even more complicated, I was dependent on an interpreter. Using an interpreter may affect the level of rapport one is able to establish with the informant; while the questions were directed to the informant, they were nonetheless asked through a third person. Further, using an interpreter

might also affect the flow of the interview as there is constant need to wait for interpretation both for the interviewer and the interviewee.

It is also important to bear in mind that some people will pretend to be poorer than they are to a ‘mzungo’. Their answers should be double checked through the interview and visual farm observation. Finally; Zambia is still at a very early stage of the process. Jatropha is mostly grown as a living fence to protect yields from grazing animals. Only a few farmers grow jatropha with a commercial purpose. This had an impact on both the sampling method and the sample size.

# 3 FINDINGS

## 3.1 Comments to the farmers questionnaire

### 3.1.1 Household characteristics


Figure 12: The share between male and female household heads

37 of the respondents were female households and 75 male households. In most of the female households the female was a widow. In a few cases the husband declared the spouse as the head of the household.

Mean household size is 7,9 members per family. Household size includes parents and children. Adopted children are counted as well. In some cases the children were grownups and had their own families. Even if they lived far away or were localized to another village, they were counted. The extended family (grandchildren, nieces, cousins and so on) was not counted. In a few cases the male household head was a polygamist. The size of the household includes in those cases all his wives and children. The farmers were asked whether they were members of any farmer's union or not. The result is given in table 2.

| | | Frequency | Percent |
|---|---|---|---|
| Valid | Non- member | 48 | 40,3 |
| | NFU/ZNFU-member | 54 | 45,4 |
| | Member of cooperative | 47 | 39,5 |

Table 2: Membership in cooperative and farmer's union

47 of the interviewees are member of a cooperative and 54 are members of ZNFU. 48 of the respondents are neither member in any cooperative nor in ZNFU. 20 of the respondents are members of both a cooperative and the Farmers Union.

The most common land right in Zambia is customary land (see Figure 14.)

94,5% of the farmers have access to land through this arrangement. Customary land is also called traditional land or village chef land. The government is the formal owner. But all issues and questions concerning this land have to go through the village chef. The farmer cannot sell the land since he has no title deed.

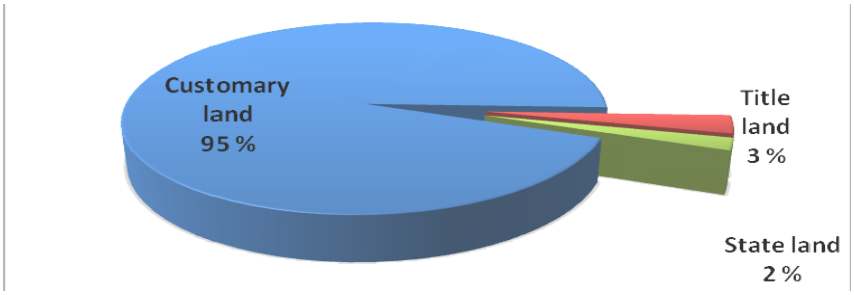


Figure 13: Distribution of ownership of land in the survey.

Average land size in the survey is 9,1 ha as shown in table 3. Figure 13 shows that the majority of the farmers had a less than 5 ha in production. 85% has access to less than 10 ha.

| | N | Minimum | Maximum | Mean | Std. Dev. |
|---|---|---|---|---|---|
| Size of land in production (ha) | 110 | 0,75 | 270,00 | 9,1 | 29,9 |

Table 3: Average farm size

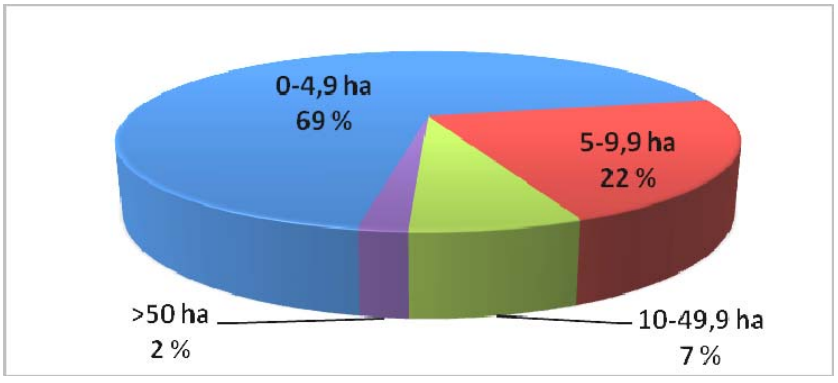


Figure 14: Land distribution among the interviewed farmers.

Customary land has no value as collateral for the farmer. Without collateral it is difficult to get

loans from a bank and access to finances. Some farmers mention that they can rent land if they want to extend their production of jatropha.

### 3.1.2 Costs and incomes

| | N | Minimum | Maximum | Mean | Std. Dev. |
|---|---|---|---|---|---|
| Annual costs in ZKW for paraffin, candles, diesel | 106 | 6000 | 864000 | 165204 | 140087 |

Table 4: Costs for lighting

As table 4 shows, the average cost for lighting in a household is ZKW 165.204 per year (About 260 Nkr). This is equivalent to ZKW 13.767 per month (21 Nkr). Kids of compulsory school age or a baby in the household will increase the costs for lighting. Candles and paraffin are supposed to be the best sources for lighting where there is no electrification. Because of limited access to paraffin and in some reasons because of the price, many farmers say that they put diesel in their lamps. Diesel is a very bad option because it gives smoke which stinks. It is harmful for the eyes and the throat in the long run. The pump price on diesel and paraffin is ZKW 6000 per liter and ZKW 5000 per l respectively (9,0 and 7,5 Nkr). The oil is bottled in town and sold in the rural areas at a double price. Jatropha can substitute both diesel as well as paraffin. Some of the household in the rural areas have solar panels. The solar energy covers their need for lighting.

A household can have income from one or several of these alternatives. Farm activities include growing of crops, vegetables and fruits for sale. This is shown in table 5.

| Ann income from: | N | Minimum (1000 ZKW) | Maximum (1000 ZKW) | Mean (ZKW) | Std. Deviation |
|---|---|---|---|---|---|
| Farm activities | 103 | 0 | 25000 | 1422379 | 3018657 |
| Livestock | 88 | 0 | 9000 | 371080 | 1102241 |
| Business | 89 | 0 | 3000 | 192472 | 494215 |
| Off-farm income | 89 | 0 | 100000 | 1478202 | 10657194 |
| Remittances | 85 | -2000 | 2000 | 63647 | 362425 |

Table 5: Income sources and size of income

Most farmers have some poultry for own consumption. Pigs and goats are found as well, but are not very common. Very few farmers have regular income from livestock. They will sell animals when they are in need of finances. Because of this, the variations in income can be remarkable from one year to another. Some of the owned animals are too young to give products for sale. Both the corridor disease and the mouth and foot disease have decimated the cattle rearing in large parts of Zambia. Some of the respondents have a small shop where they do business like selling food or second hand clothes. Making handcraft or brewing beer for sale is another option. Off-farm income includes payment for various services or jobs. Some are engaged in construction, others in agriculture as manual labor. Negative size of remittances means that the household gives away this amount of money to support family and relatives.

The data's in the questionnaire were given in number of packs.

One bag of maize, beans, ground nuts, sweet potatoes, cowpeas, sunflower and sorghum/millet contain normally 50 kg. The given amount of ground nuts are in most cases given before shelling. Tobacco is measured in kg and bells instead of bags. One bell will normally contain about 100 kg. In addition to the weight, the quality will determine the price on tobacco. Cotton is sold by weight rather than in bags. However, bags are still used and one bag of cotton contains about 100 kg. One bag of cow peas contains about 20 kg. Vegetables are not sold in bags, but in packs or kg. One pack contains normally between 25 and 30 kg. Most of the vegetables are sold at a market or directly to neighbors who come to buy.

The farmers sell one bag of coal at a price of 5000 Kwa.

Cotton and tobacco are typical cash crops and grown in an outgrower scheme. Experiences from contract growing can be extended to jatropha and useful for farmers who decide to join a jatropha out grower scheme. 5,9% of the interviewed farmers grow tobacco for Alliance 1. 26,9% of the farmers are growing cotton, mainly for Dunavant.

### 3.1.3 Farmers experience with jatropha

36,0% of the farmers who cultivates jatropha say that their production started or that they had received seeds during 2007. 17,7% started in 2006 and 18,5 in the period from 2003 to 2005. 9,9% of the existing trees have been growing from earlier than 2003, or as long as the interviewee could remember. *'It was planted by my grand grand parents'*. Even if the tree has been there for many years, the farmers don't know how to utilize it. In a few cases there is a tradition for using

the seeds for lighting. The black cover is removed and seeds are pierced on a metal string. By putting fire on the top seed, the string of seeds will burn like a candle. But normally the fruits have been swept and thrown away. In other areas, like Chilimanyame/Petauke, jatropha was introduced for the farmers only two weeks before our visit. The findings show an accelerating pace in distribution of seeds and planting of jatropha. This is shown in table 6 and figure 16.

| | Period when seeds were received | Frequency | Percent |
|---|---|---|---|
| Valid | November -07 | 30 | 25,2 |
| | June/July -07 | 14 | 11,8 |
| | November -06 | 19 | 16,0 |
| | Jan/Feb -06 | 2 | 1,7 |
| | 2005 | 9 | 7,6 |
| | 2004 | 11 | 9,2 |
| | 2003 | 2 | 1,7 |
| | Earlier than 2003 | 12 | 9,9 |
| | Total | 99 | 83,2 |

Table 6: Distribution of seeds since 2003

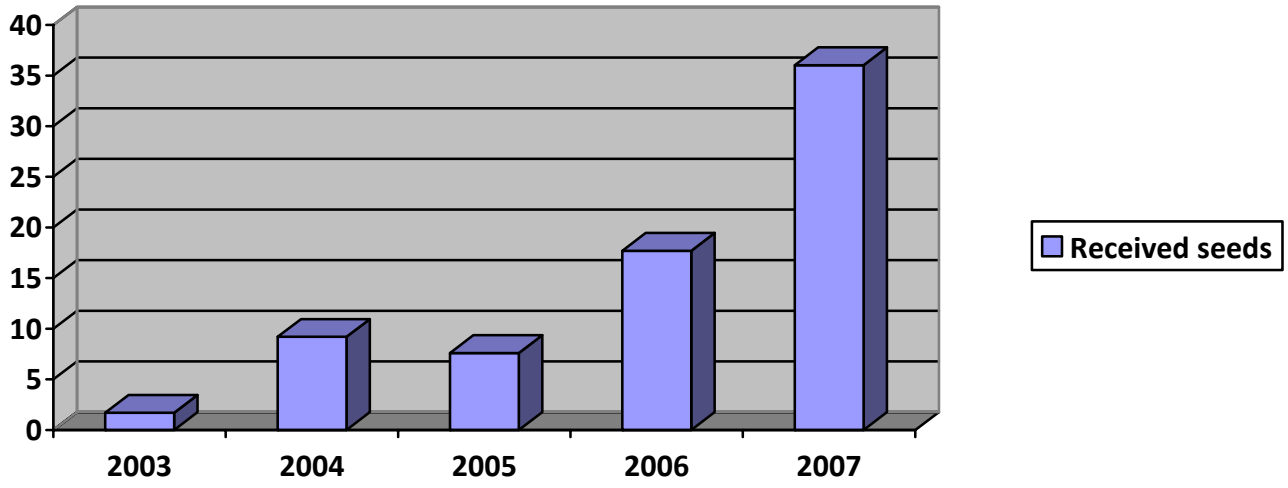


Figure 15: Pace in distributing seeds and planting of jatropha from 2003 to 2007

The number of promoters is increasing at the same time as their distribution is getting more efficient and more farmers are engaged in outgrower schemes. The number of mature trees is increasing as well.

Very few of the farmers express that their production of food crops changed after they started growing jatropha. One person said that the farming input had improved because she now was more aware of the weeds and did more weeding. One farmer had reduced the production of food crops. Because of very limited amount of land used for jatropha or because a very short time has passed by since the interviewees received seeds, very few changes were observed.

> *"Our food production has changed because we planted jatropha on most of our land. The spacing is 2x3 meters so intercropping is impossible. Since we planted the jatropha our production is reduced from 1200 to 800 kg of tobacco, 42 to 22 bags of maize and 9 to 3 bags of cowpeas"* (Maricia Banda).

58 % of the farmers who grow jatropha express that work related to jatropha growing is done with labor within the household. 8,4% will combine this with hired labor and 1,7% will base their jatropha growing on hired labor. The hired labor force will in some cases be a farmer with an ox and a ripper for preparing the soil for a jatropha hedge. In these cases the required time for preparing soil is said to be reduced to 1/10 of the time needed with a chaka hoe.

| | Frequency | Percent |
|---|---|---|
| Only family members | 69 | 58,0 |
| Family + Hired labor | 10 | 8,4 |
| Only hired labor | 2 | 1,7 |
| Total | 81 | 68,1 |

Table 7: Use of labour

### 3.1.4 Jatropha and gender

The farmers were asked "who owns the jatropha project in the household?". The question was meant to split ownership of jatropha within households which owns jatropha in a field or as a hedge and to find any connection between jatropha projects and gender. Different crops often

have different ownership in a household. Ground nuts are known as a typical female crop. The explanation is that it is a typical crop for own consumption. The female's responsibility is the goods used in the household. Since jatropha can give lamp oil and soap, it could be that jatropha will be recognized even more as a female crop in the future. When asked if they grow jatropha, some of the farmers' emphasize that it is their wife's project. In 49,6% of the cases, jatropha is identified as the male's project. 34,9% of the jatropha projects is owned by a female household or by the wife within the household. 1,7% of the respondents say it is a family project and in one occasion the village grow jatropha as a club. This is shown in figure 15.

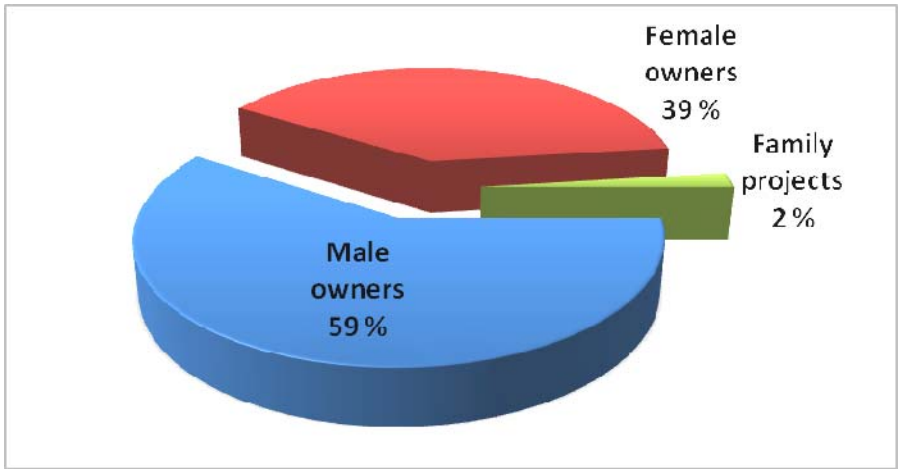


Figure 16: Connection between sex and jatropha ownership

Some farmers are not growing jatropha. The most important reason is that they are not aware of the potential and possibilities jatropha gives. 10 out of 18 gives this reason for not growing jatropha. 4 persons mention lack of skills. Lack of seeds is a reason mentioned by 2 persons

### 3.1.5 Who supplied you with seeds?

15% of the farmers tell that they got seeds or cuttings from their own trees.

Southern Biopower supplied 19% of the interviewed farmers with seed. Most of them got 1000 seeds and were encouraged to plant them in sleeves for later planting in a 1 ha field.

CFU has given 20% of the farmers' seeds. CFU advice to the farmers is to grow it as a hedge with 20-30 cm spacing. Most of CFU's contact farmers are given seeds for redistribution. The amount of seeds which is redistributed is between 5 and 10 seeds per household. Some contact farmers receive 1000 seeds for demonstration with the purpose of planting hedges.

5% of the farmers who has received seeds got them from D1. D1 is in many cases promoting

jatropha through ZAFEL, Alliance 1 Tobacco or Stancom. Lutheran World Federation is among "others" and one of the promoters in Chipata district in addition to D1 Oils and Alliance 1. All of these promoters use ZAFEL as a broker or middleman in areas around Chipata. Farmers who planted jatropha as a cutting got those in most cases from neighbors or relatives.

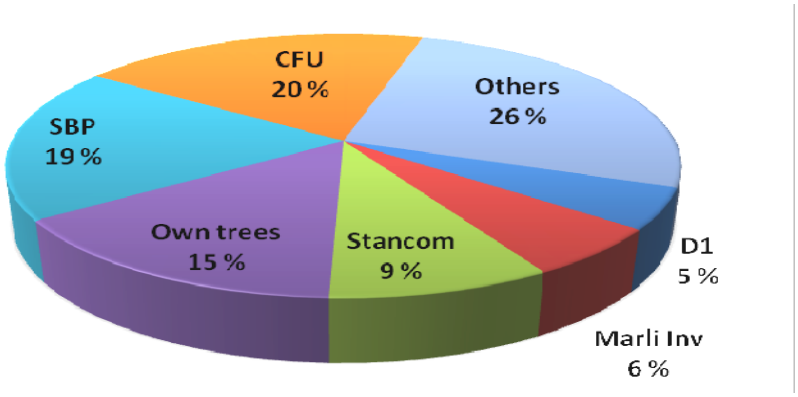


Figure 17: Where the farmers got their seeds from.

### 3.1.6 Connections between promoters and outgrowers

The farmers who had joined an outgrower scheme were asked which promoter they were connected to. In this term, connection does not mean a binding agreement through a contract between promoter and farmer. It is a connection formed by the presence of field staff from one of the promoters. The farmers will confirm that they are engaged by this promoter and cooperate with him. At the same time they refuse that they have signed any contract.

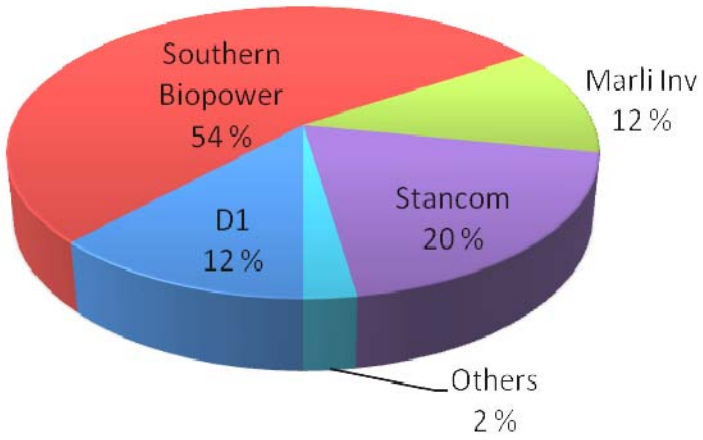


Figure 18: Rate of connection between outgrowers and promoters

### 3.1.7 Harvested seeds

| Kg's harvest in: | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| 2006 | 6 | 2,00 | 25,00 | 9,3 | 8,7 |
| 2007 | 10 | 1,00 | 180,00 | 42,0 | 55,8 |

Table 8: Yields in 2006 and '07.

As table 8 shows, 10 of the interviewees harvested seeds in 2007 compared to 6 in 2006. The mean weight of seeds harvested in 2007 was 42,0 kg per farmer, compared to 9,3 kg in 2006. Some of the farmers have old jatropha trees on their land. The trees were planted as a demarcation or to give shadow. Some of them were planted as cuttings, others as seed. The cuttings or the seeds came from friends, neighbors or relatives. None of the farmers know about the value or the purpose of the seeds. When they are ripe and fall down they are just shuffled away and thrown. A funny story from the Chilimanyame area in Eastern Province is that a promoter by occasion was offered seeds from some kids. The promoter asked for more and during a very short time the rumor was spread among kids in the village and neighbor villages that jatropha seeds could be a very good way of financing candies. The price this promoter offered the kids is unknown. It took some time before the parents understood the kid's interest for jatropha seeds. However, 3,6 tons of seeds were collected during a very short time and sold to the promoters in this way from the Petauke region. CFU bought 7 tons of seed for redistribution in 2007 in the Eastern Province. World Vision and Marli Investments are recognized as actors in this market as well. A very rough estimate for 2007 is that between 20 and 30 tons were purchased from this province. 12 of the farmers sold seeds in 2007 or had been given a price if they were willing to trade with seeds. The lowest price was offered from D1 when they bought a 14 kg bag from a farmer at a price of ZKW 1500. The highest obtained price in the survey was ZKW 2500 per kg, but in certain cases, it is known that seeds have been sold at prices up to ZKW 4000 per kg. The price SBP offers the farmers for their seeds are ZKW 500 per kg. SBP pay ZKW 25 for cuttings with a length of 30 cm. D1 Oils have been buying seeds for redistribution for a price at ZKW 1500 per kg. CFU offer the farmers a price of ZKW 1000 per kg.

| | N | Minimum) | Maximum | Mean | Std. Dev. |
|---|---|---|---|---|---|
| At which price pr kg | 12 | 110,00 | 2500,00 | 1159,2 | 679,8 |

Table 9: Seed price in 2007

*Unrealistic optimism:*

*There are rumors among some farmers about a new Klondike in jatropha: "Marli estimated the income for us to be 170 million Kwa/ha when the trees are fully mature: One tree will give 17 kg of seeds. With 1000 trees pr ha, this will give 17.000 kg/ha. A price at 10.000 Kw/kg will make a very good business for us!"*

Among the farmers who harvested, as many as 41,7% kept the seeds for own use. Two farmers sold their seeds to CFU. "Others" is represented by ZAFEL, Garry Brooks and MACO.
Some farmers say they will give away their seeds to family or neighbors. The result shown in figure 19 can be biased because the research was done mainly with CFU.

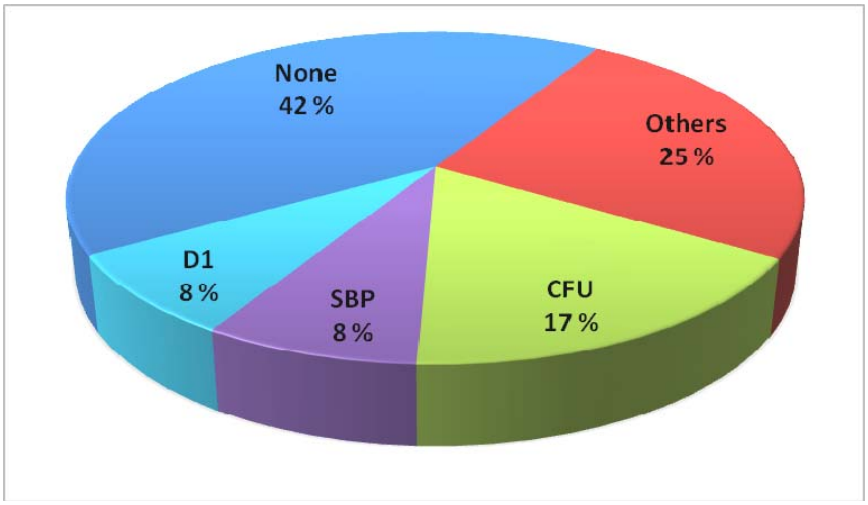


Figure 19: To whom did the farmers sell their jatropha seeds

### 3.1.8 Amount and purpose of jatropha trees

Jatropha has traditional been planted as a hedge with the purpose of protecting the garden or crops against grazing animals. Other purposes have been as a shelter around the bathroom (figure 3), as a fence around cattle crows and as a demarcation of boundaries. In general, the advice is to plant with 30 cm spacing if the purpose is a protective hedge. If it is planted as a demarcation

between different fields, the spacing can be increased. Table 10 shows that 51 of the farmers have planted jatropha as a hedge and 40 have fields planted with jatropha.

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Meters of jatropha hedge (m) | 51 | 3 | 1500 | 240 | 286 |
| Field size with jatropha (ha) | 40 | 0,1 | 10,0 | 1,5 | 1,9 |

Table 10: Field size and meters of hedge

Average length of hedges is 240 meters. Mean size of jatropha fields is 1,5 ha. This is equal to six Lima, which is the traditional way of measure land. One Lima is equal to ¼ Ha. In pure stand, jatropha is planted with 3x3 m spacing. 1 by 1 meter has been recommended from some promoters. This spacing will give 10000 trees per ha. The connection between spacing and number of trees per ha is shown in table 11.

| Spacing (m) | Number of plants pr ha | Spacing (m) | Number of plants pr ha |
|---|---|---|---|
| 1x1 | 10.000 | 2,5x2,5 | 1.900 |
| 1,5x1,5 | 4.500 | 3x3 | 1.110 |
| 2x2 | 2.500 | 3,5x3,5 | 860 |

Table 11: Spacing and number of plants per ha

SBP's outgrowers were introduced to the outgrower scheme in august -07. They got 1000 seedlings each the 04th of October and had still not prepared the field for transplanting.

## 3.2 The contracts

50 of the farmers already have some out grower experience. 32 of the farmers have some from cotton and 7 from tobacco, the remaining 11 from earlier experiences as outgrowers or from what their neighbors and farmer friends have told them about it. In some cases the respondents do not seem to decide whether they are in an outgrower scheme or not.

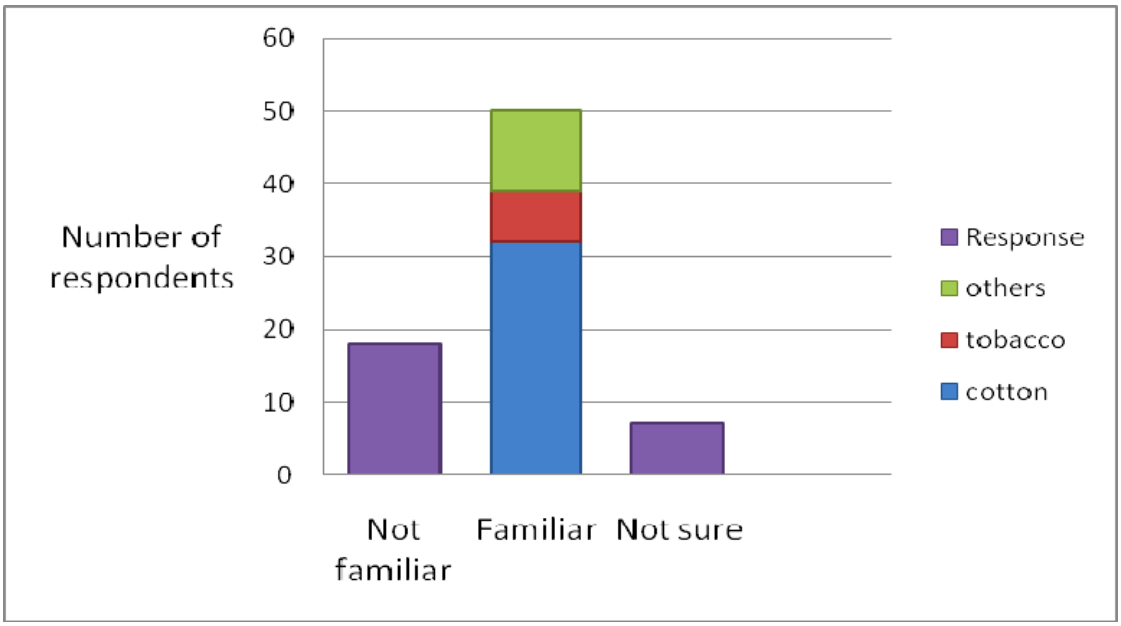


Figure 20: Shows whether the farmers are familiar with the outgrowing system or not, and from where they have their outgrower experience

### 3.2.1 Has the promoter introduced the contract for you?

66 persons were asked this question because a promoter had visited them. The farmers who had not been in contact with any promoter were not asked this question. 64 of the respondents said that the promoter had not mentioned any contract during his visitation. Only two had heard about any contract. D1 had supplied one of them with seeds. Lutheran World Federation was the other one. Other farmers are in a situation where the promoter has visited their village and told about the jatropha value chain and the possibilities the plant offer. A meeting between promoter and village starts normally with a presentation of the company and the possibilities jatropha offers. After the presentation, the chairman will give his comments to the promoter. Finally, the village's members can ask questions and give their opinion. It can take up to 3 hours before the meeting is closed. At this moment, the farmers have still not seen the contract or taken any decision whether they shall sign or not. Some of the comments from the farmers after the first meeting with the promoter are that they are positive and that they are willing to sign a contract. An individual contract can be made directly between the promoter and the outgrower. Group contracts are established between the promoter and a group of farmers. The promoter will explain the contract

for a geographical cluster of farmers who will discuss the terms and decide whether they will sign it or not. If they decide to go for it, their chief or coordinator will sign on behalf of the group. They see the possibilities for an emerging market and the possibilities to get a good and sustainable income even if they know very little about the price or terms in the contract.

Jatropha catch very easily the farmer's interest, especially when they hear that it is a perennial plant with low expectations to inputs and costs attached. In their minds, jatropha seems to be a safe cash crop compared to cotton and tobacco. Stability in terms of price, yields, time and natural hazards is important for the farmer's planning. 83% of the farmers who are engaged by one of the jatropha promoters answered that they had no contract with the promoter. Out of this rate it seems that the links between farmer and outgrower is very weak. Even if there is no written contract, an oral understanding of the principles of the agreement should be made between the promoter and the farmer or a group of farmers. 7% of the outgrowers had a contract. 10% of the farmers were unsure whether they had a contract or not. Many farmers seem to have been mislead. The promoter just gave them a paper and the message "*sign here and you will be given seeds and pesticides"*. But they were not given any copy at the time of signing and a copy of the contract never arrived by the mail. The cash they were promised given for free or as a loan, never came and the advisor who should guide them about how to grow never showed up.

### 3.2.2 Contract period

A contract made with Marli Investment is valid for 30 years. Marli uses group contracts. SBP/NWBP's contract period is 8 years. SBP has told the farmers about out grower schemes, but not given any information to the farmers about the contracts yet. They will practice group contracts.D1\Stancom time perspective concerning the contract period is unclear.

If the respondents were familiar with contract- or outgrowing schemes, they were asked what they thought was a reasonable contract period.. A contract between the farmer and the cotton-or tobacco companies is normally for one year. An issue is that the farmers do not know whether they will have this contract the following year or not. The farmers are not satisfied with this way of contract growing. The access they get to seeds and pesticides is the incentives to stay. A longer contract period would probably improve their situation because it is more predictable. Because jatropha is a perennial plant and can be harvested for a number of years, the farmers mindset is

that this should be reflected in the contract period. *"Everything between 2 and 15 years is ok"*, is quite representative for their answers. This one is a bit more extreme; *"Until death".*

### 3.2.3 Fairness of the contract

Nineteen persons were asked this question. The response is shown in figure 21. Twelve were positive, three didn't know and four were negative. The four farmers who respond negatively have contracts with D1 and Stancom. In the Chipata area, a "mzungo" from ZAFEL/Stancom Tobacco was promoting jatropha by using phrases like "this is money". After the meeting, the farmers were told to sign a paper. By putting their signature on this paper they would get seeds from ZAFEL/Stancom, advice about how to maintain the tree and regular follow up.

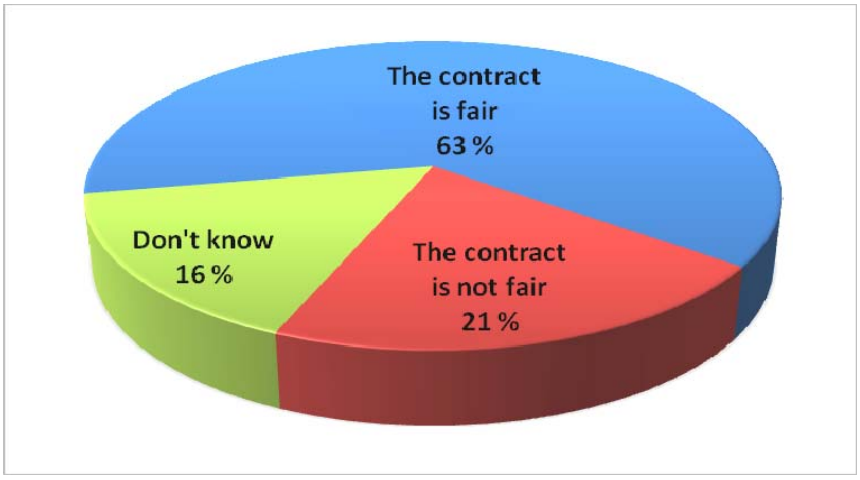


Figure 21: What the outgrowers think about their contract's fairness

The paper was not written in the local language, but in English. Nobody explained the farmers about the content in the paper. One year after, the farmers are upset and disappointed. There have been maximum four visits from the promoter, but no relevant information. In the meetings the promoter has encouraged the farmer to extend the production of jatropha and promised to buy the seeds when the fields give yields. They have been giving many promises, but no instructions about input and maintenance. About 15 farmers joined the first meetings. One year later, the number of farmers has decreased to six. One farmer who still joined the meetings with Stancom expressed that the gatherings were useless and that they had lost their visions. In spite of this, the farmers in the affected area say that they are willing to join an outgrower scheme, but not with Stancom. 'Trying is better than being quiet' was one of the farmers reply when I asked

him why he received 1000 seedlings as an invitation from the promoter to join an outgrower scheme even if he didn't know anything about the contract or the terms in it

Room for improvements in the contracts; some comments from the farmers

*-The contract was given from ZAFEL (D1). I signed and they took it to their office. But I never got any copy. I am not satisfied because ZAFEL does not follow up. We have got no advice about how to maintain the plant. We were promised a price at 4000 Kw/kg seeds*. (Olias Siwila).

*-Stancom is not following up in terms of monitoring, advising, giving information or in disease control. -They do not pay what they promised us when we signed the contract* (Tito).

*-The contract could have been better for us if we had been given more money* (Chemeo)

*-I am very frustrated because of the jatropha. I have resigned and given it up. D1 were passing through Stancom when I signed the contract. I was given 1600 seedlings for free and was promised cash to cover all costs for nursing and maintenance until the trees gave harvest. But they never paid and I have not heard anything more from them. No information, no guidance about how to care for the plants and no information about prices or markets* (Maricia Banda).

Some farmers express that they would like to grow jatropha instead of cotton because the oil price goes up when prices of other raw materials go down. They look for a cash crop which requires less labor as well.

Many of the farmers who have been invited to join an outgrower scheme by the jatropha promoters are disappointed because the promoter did not keep the promises they gave or followed up by guiding and feedback. In spite of the bad experience, many farmers are positive about being part of an outgrower scheme. Some even say that they will cooperate with the initial promoter if they improve their service and keep what they once promised. Other farmers express that they are positive to contract growing of jatropha, but with another promoter.

### 3.2.4 What kind of expectations do you have to the promoter if you join the program?

The farmer's expectations to the contract and the promoter are supply of seeds, pesticides and fertilizer given as a loan. This is confirmed by a case study done by CLUSA in 2004. Parker claims that *"The small-scale farmers' main interest is how to access inputs and credit facilities, and how to secure a reliable market for the produce."* This is easy to understand because commercial

lenders are not willing to issue loans to small-scale farmers because of their limited assets and lack of collateral. Even if they get access to credit the rate of interest are too high (40%) to make it economically sustainable.

The farmers also expect teaching, guiding and close follow up from the promoters' extension service. As figure 22 shows, this get the highest rank on the bar chart. Some farmers emphasizes that they put much confidence in the promoters' representative and look forward to interact and cooperate with this person in all the different stages from guiding and teaching to trading of seeds. In spite of the information from the promoter, many farmers say that they don't have any idea about their expectations to the contract or the outgrower scheme.

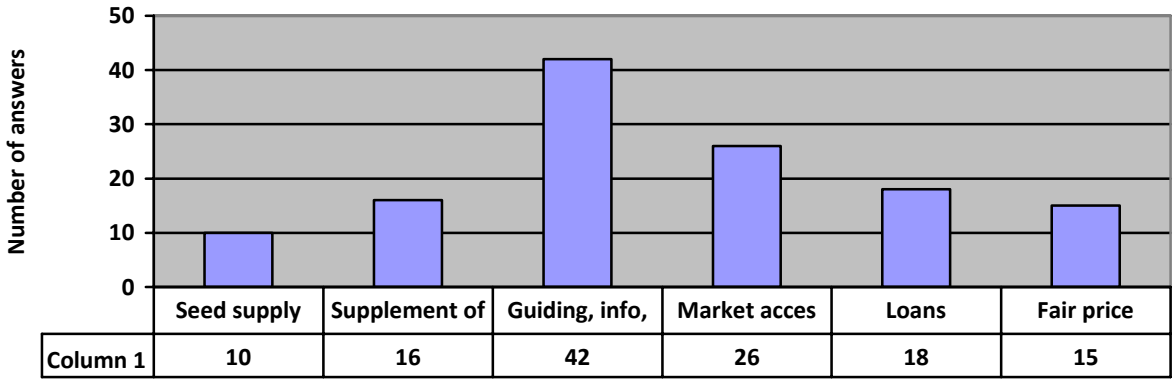


Figure 22: The farmers expectations from the promoter. Guiding, follow up and assistance are closely related and can be collected to one unit

One of the farmers said that he did not really know anything. He had not even been at the meeting with the promoter. His brother had received the seedlings after the meeting, but had lost the interest for jatropha in the meantime. So he gave all the seedlings to his brother. This may indicate a problem which will be more visible as time goes by; some farmers have put their names on the list only because their neighbors' did so or because they are tempted by the promise of cash, free seeds or access to loans. They do not really have any visions or ambitions about jatropha growing.

Financial expectations

In the areas where many farmers are in an out grower scheme or have knowledge about it, a

comment often heard is that incentives like seed, fertilizer and chemical input are good, but could be extended to financial incentives for labor and implements like tools. The farmers are aware that up to three years can pass by after planting when the tree gives no harvest. The promoter should take this concern seriously to secure the household's basic needs during this period. One of the problems for the promoter is loss of money when loans are not recovered. A consequence mentioned in Marli Investment's contract is to use bailiff and court actions on the defaulters to show that they are serious in loan recovery. However, the results will be limited because most of the farmers lack assets. Court actions are costly exercises as well. Experiences made by CLUSA show that the average rate of credit recovery in 2001-2002 was 53%. In 14 different areas of Zambia (Chibombo, Chongwe, Copperbelt, Kapiri, Luanshya, Mufurila, Mukonchi, Mumbwa, Choma, Mazabuka, Monze, Namwala, Ipongo and Fiwila). The variation was between 5% and 95%. Factors which have great impacts on poor loan recoveries are mainly the lack of field staff's authority and attitudes among farmers in certain districts. Mazabuka, for instance, is mentioned as a district where the communities expect to be given handouts. The CLUSA case study emphasizes the importance of strong field staff that is visible, service minded and able to screen the farmers before they are accepted as partners. Out grower schemes based on crops are fragile in relation to natural hazards or weather patterns. A drought might appear and the consequence is that the farmers are disabled to pay back their loans and to buy seeds, fertilizer and necessary input for the coming season. This should not be the situation for jatropha which is a perennial plant. It is resistant to weather patterns and the shrub will produce fruits even if one season should fail totally.

| |
|---|
| *I'm willing to sign the contract if the promoter will provide for seeds, pest- and termites control.* |

Transparency and reliability

A very clear statement from a farmer was that: "*Agreements has to be followed!"* and "*the promoter has to be honest and trustworthy"*. In a village, there was skepticism to NGO's (World Vision) after an episode where WV gave a lot of promises linked to an agricultural program, but was not able to follow up. These farmers feared a repetition of this story and wanted guarantees from any promoter about fulfillment of given promises about guiding, follow up, monitoring and

buying.

Guiding and feedback

"*A good investment for the promoter is skilled extension staff"* said a farmer.

Several farmers expressed that they were tired and disappointed over the company (D1/Alliance1) in Chipata.

Over and over again the farmers tell about extension staff that came and promoted jatropha and good incomes. They left, and since then they have hardly been seen in the villages. As the trees grow, the farmers wonder how to maintain them, but have nobody to ask. In some cases the extension staff show up to see the trees and how they develop. Then they leave without being really available for the grower. Some of them promised the farmers cash and teaching during the first two years. Two years passed by and the farmers are still waiting for the money and the guidance. The farmers lose hope when they are not visited frequently.

D1 use different agents like Alliance 1 and ZAFEL. The communication between outgrower and promoter seems to suffer when a middleman or a broker is engaged. With different agents their policy will not be homogenous and their approach to the farmers different. An expectation should be similar approaches to all farmers in the out grower scheme.

A fair price

The farmers are aware of the costs and that the input from the promoter has to be paid back from their harvest. In years with low prices or bad yields most or all of their harvest goes to the company. The little they get is at least something and better than nothing. The farmers express that they not are satisfied with the outgrowing system as it traditionally works.

*"From other outgrower schemes we have seen that the companies cheat us on the prices. They can give a fixed price (pre pricing), but afterwards they will come up with excuses why they had to change this price. Issues that are mentioned are changes in the US$, oil price, inflation and so on. We expect faithfulness from both sides. The company shall stand by the agreements on the paper and the farmers avoid side selling."*

### 3.2.5 Needed incentives, expectations and benefits

The farmers who are growing jatropha in a field or as a hedge were asked to list the benefits they expected from the jatropha. They were allowed to give more than one response.

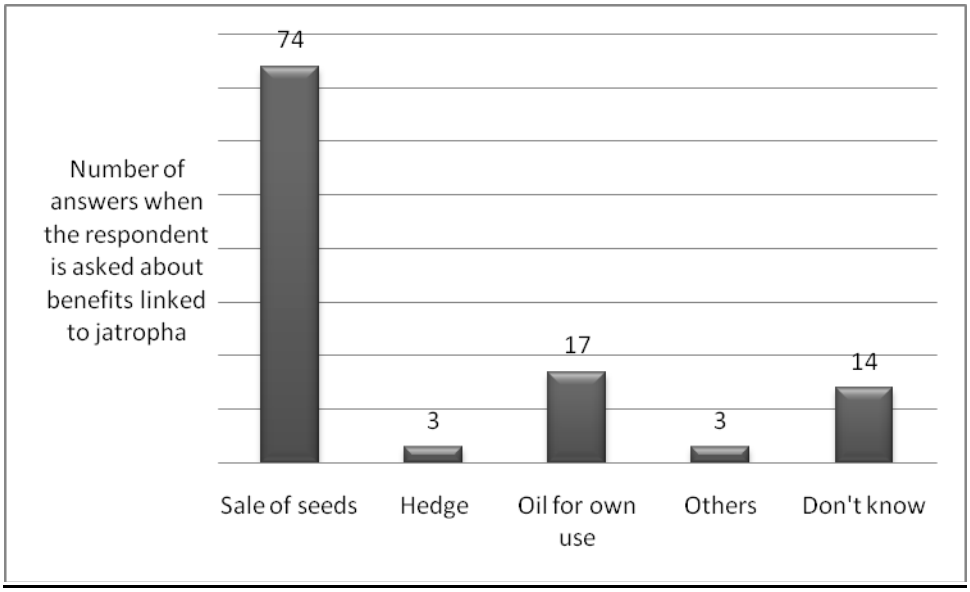


Figure 23: How farmers preceive they can benefit from Jatropha cultivation

Sale of seeds is the most obvious benefit the farmers see. Hedge as demarcation or as a protective fence is another purpose which is known among some of the farmers. Even if the farmer has planted jatropha as a hedge; it was very seldom mentioned as one of the benefits. Anyway, if a hedge was observed, it was ticked as a benefit. Surprisingly many (14) of the farmers who are growing jatropha did not know how to utilize the plant even if they already took part in growing. Six of them can be categorized as outgrowers; two from D1, three from Stancom, and one from SBP. One of them received seeds from CFU in oct-07 and was on his way to establish 300 m of hedge. The Stancom farmers had one, 1,5 and 1,4 ha each and had been growing jatropha since 2006/2004. The D1 farmers had 0,1ha and 400 m hedge. Both established their jatropha in 2004. The SBP farmer had one ha with jatropha and joined in Oct-07. The rest of the farmers were growing jatropha on their own initiative and got their seeds or cuttings from friends. One of them has established a 40m hedge, else they keep it as single trees.

John Brower is a pig farmer from Minnesota in USA. He gave a very exotic variant of how he could benefit from jatropha. His task in Zambia is to run a farm owned by the church. He has heard about a non-toxic variant of jatropha and wants this variety in his jatropha field. After extracting the oil he wants to use the press cake as fodder for pigs. The high content of proteins in the press cake makes it a valuable food for the pigs. John also wants to blend jatropha oil with diesel for his Toyota Land Cruiser and tractor on the farm.

The question "what incentives do you need for starting growing jatropha " was given to farmers who were not growing jatropha. It is a difficult question to answer if you do not know anything about the plant and is the reason why 31% of the farmers reply that they need more information about the tree, how to maintain it and utilize it. The farmers who mention seed as an incentive mention maize seeds as well as jatropha seeds. Loan is accepted as financial support. Pay back is done by giving the loaner a share of the yield. By implements farmers mention tools and equipment for production. Bags for packing of seeds are also mentioned as an implementation.

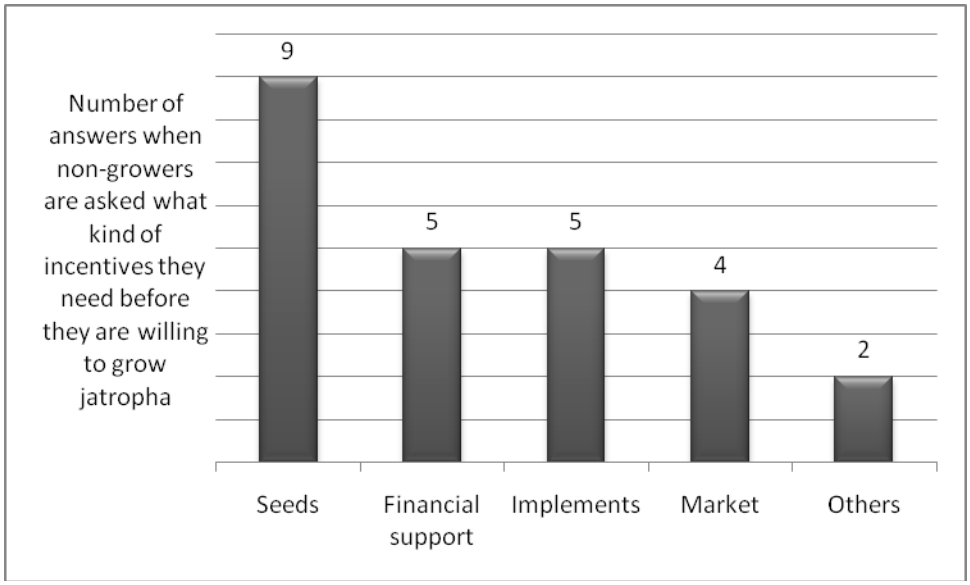


Figure 24: Incentives needed if non-growers of jatropha are willing to grow jatropha.

Farmers who not grow jatropha were asked how they could benefit from jatropha. The question was given to probe their knowledge about the tree. All together 11 respondents see the potential for income, which is 52,1% of the responds. Six of those think they will have an additional income

from jatropha and five will sell seeds. Three persons will establish a hedge either as protective or demarcation. One person think jatropha is beneficial because it is a perennial crop which requires little maintenance and one person will use it as a wind break. Four persons answer that they don't know how to benefit from jatropha.

### 3.2.6 Do you have any doubts or worries about jatropha?

The question was only asked to the farmers who obviously knew something about jatropha. 63,3% has no worries or doubt about jatropha. 11,7% does not know and 25,0% express that they have worries. Some of the farmers have heard rumors about jatropha and soil destruction. 'Is it true that the tree is destroying the fertility of the soil and makes it useless for food production', they ask. The background for their fear is concern raised from the MACO through news on radio and TV where they have claimed that jatropha can be devastating for the soil quality and that food cannot be grown on land which has been used for jatropha production. Some farmers in Chipata were worried because their trees were growing very slowly. They planted the seeds in seedbeds and transplanted the seedlings in December -06. One year after, the trees still remain lower than 20 cm. The supplier of these seeds, Stancom, imports seeds from India. The huge difference in provenience might be the main reason for the problem.

One concern is linked to lack of income in the period before the tree start production of seeds. Will the promoter or the creditor come and ask for money in this period? Other worries are related to the market. Where is it? Who is the buyer? How will the market develop? What price can we expect and will the price be fair? Some farmers express that they will see good and visible results from jatropha growing before they decide to plant it on their land.

Another answer is that they don't really know how much input it requires. 'Who will provide us with fertilizer, seeds and pesticides?' The farmers admit that they still have a minimal knowledge about this plant. Their worries are linked to damaging pests, diseases and especially termites and what they can do to the plant as well. There is also a constraint on labor in some cases.

### 3.2.7 Are you willing to grow jatropha even if your food-or cash crops will suffer?

17,0 % of the farmers is not willing to grow jatropha at the expenses of their other crops. 80,9% express that they are willing to grow jatropha even if their food- and cash crop will suffer. In

terms of land, many farmers answer that they can utilize idle or dormant and fallow land for that purpose. Available land is not a problem. There is idle and fallow land which is accessible. Concerning labor, the farmers often express that they will grow jatropha in their spare time. During the year, there are periods when they farmers rest and periods when they are very busy. The resting period is mainly from the end of the harvest in June and up to November when the rainy season starts. Concerning the extra requirement for labor, the answer often is that they can maintain the jatropha during their spare time.

Very few fear that their food production will suffer if they start the growing of jatropha. Their attitude is that they will still grow food crops on the best land and jatropha on the marginal soil. One farmer drew a parallel between farming and business. He emphasized that it was important for him to grow the plant which gave the highest net profit. Cotton was his main cash crop, but the future is not promising because of constantly falling cotton prices and increased costs for pesticides, fertilizer and labor. Jatropha seemed as a tempting option for this farmer. At the same time diversification and spreading of risk was important for him. If jatropha would give a good income, he would prefer to grow jatropha rather than food crops, and instead buy the needed food from the neighbors or the store. Food security affects more than substantial agriculture and food production. Food security can be obtained by increasing the income level in the household as well. Even today, many farmers are dependent on purchased food in periods of the year, especially in the hunger period between sowing and harvesting.

*"If jatropha make our food production suffer, how can we avoid starving in the period when the tree is not producing? What will carry us through the waiting period?"*
*"Until jatropha gives income, the tap is closed. It takes time to open a new tap and meanwhile we need support".*
*"If the income from jatropha is sustainable, our food security can be improved in spite of reduced food production".*
*"I have to answer you no. I am too old to start something new now. But if I was younger, the answer would have been yes" (*Tomaida Mwula, 60 years).

## 3.3 Estimated time use

Some of the activities, like spraying and mulching, are quickly done. The given time use from the farmers (given in area per day or number of plants per day) was transformed to time consume per

plant. To catch the fine nuances in operations which require marginal time use per plant like spraying, irrigating and mulching, the amount is given as used time in minutes per one hundred plants. The farmers give answers with wide variations. The mean value was found and is given in the table 3. By multiplying this by ten, we will find the time use per Hectare for the different operations. It is easy to transform this value to hours per Hectare per operation and then to person days. If we ignore harvesting and peeling, the operation which requires most time is pruning number four which is estimated to be 30 min/tree. At this stage the tree has reached the wanted height and developed a wide canopy. After this, a light trimming can be done each year instead of pruning.

| Estimated time use in different stages given in min/100 trees (1-12) or min/kg (13-14). | Respon-dents N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| 1 Prepare seedbeds | 22 | 3:00 | 761:30 | 142:00 | 214:20 |
| 2 Cracking and improving seeds | 1 | 3:20 | 3:20 | 3:20 | , |
| 3 Sow and nurse seedlings in beds | 22 | 1:10 | 156:30 | 36:10 | 37:40 |
| 4 Prepare and plant directly in sleeves | 8 | 18:00 | 1800:00 | 428:30 | 586:10 |
| 5 Transplanting | 18 | 18:00 | 1475:00 | 267:10 | 359:50 |
| 6 Prepare soil (and sow in fields) | 34 | 4:10 | 2592:00 | 348:10 | 617:20 |
| 7a Take and prepare cuttings | 11 | 30:00 | 1250:00 | 267:10 | 361:40 |
| 7b Plant cuttings | 4 | 60:00 | 240:00 | 132:30 | 81:20 |
| 8 Weeding one time | 29 | 8:20 | 2215:20 | 464:10 | 631:40 |
| 9 Spacing and uprooting | 1 | 1500:00 | 1500:00 | 1500:00 | , |
| 10a Pruning1 time | 7 | 6:40 | 60:00 | 23:30 | 18:40 |
| 10b Pruning2 | 3 | 16:40 | 366:40 | 134:30 | 201:10 |
| 10c Pruning3 | 2 | 21:20 | 1000:00 | 510:40 | 692:00 |
| 10d Pruning4 | 2 | 3000:00 | 3000:00 | 3000:00 | |
| 11 Spraying against pests/insects | 8 | 1:20 | 100:00 | 41:40 | 40:30 |
| 12 Irrigating | 1 | 0:10 | 0:10 | 0:10 | , |
| 13 Harvesting min/kg | 5 | 8:10 | 60:00 | 24:40 | 21:40 |
| 14 Peeling min/kg | 11 | 8:00 | 52:00 | 21:00 | 15:00 |

Table 12: Variation in time use for different stages in the growing of jatropha.

The third pruning is estimated to the third most time consuming operation with 5 min per tree. During the first four years, the pruning will take all together about 37 min/tree. The second most time consuming stage is the spacing/uprooting (thinning) which requires 15 min/tree. This has to

be done if the space between each tree is too narrow. Supplementary planting can be done to secure the field if the germination should fail. In some cases two seeds are put in the same hole for the same reason. In some cases, tight spacing can be a consequence of lack of knowledge. Weeding first time requires 4 ½ min per plant. Later, the weeding will take less and less time because of the shade from the canopy. When the canopy is fully developed, weeding is probably not needed. To plant in sleeves is the fifth most time consuming operation estimated to 4 ½ min per plant. The plastic sleeves have to be opened and filled with soil. The bottom should be cut open or perforated before the seed is put in the soil to avoid water logging. On the following places comes prepare soil and sow in field with 3 ½ min/pl, transplanting 3 min/pl and take cuttings with 3 min/cutting. By suggesting four different methods for establishing a field we can find which method is most time demanding. This is shown in table 13.

| Method | Time use (*min/plant)* |
|---|---|
| a) Nursery: Prepare seedbeds + sow seedbeds + transplant seedlings in field | 4:36 |
| b)Direct planting: Prepare soil and sow/plant | 3:29 |
| c)Cuttings: Take cuttings + plant the cuttings | 4:00 |
| d) Sleeves: Prepare /plant in sleeves + transplanting seedlings to field | 7:06 |

Table 13: Four different methods for establishing a jatropha field and needed time per plant.

One hectare will normally contain 1000 plants. To show differences between the three methods in man hours and man days, the time use per plant is transformed to man hours and man days for one hectare. To plant in sleeves and transplant seedlings in field is obviously the most time demanding method. Seven man days can be saved by planting directly in soil instead of choosing the most time consuming alternative. An overview is given in table 14. Weeding, pruning and spraying is supposed to be similar for the different concepts. During the first four years the estimated time of these operations will be close to 57 min per tree with weeding twice a year and pruning and spraying once each year.

| Method | Needed man hours to establish 1 ha (1000 pl ) | Needed man days (8 hrs/day) |
|---|---|---|
| a | 76,6 man hrs | 9,6 man days |
| b | 58,1 man hrs | 7,3 man days |
| c | 66,7 man hrs | 8,3 man days |
| d | 118,3 man hrs | 14,8 man days |

Table 14: Required time to establish one ha of jatropha depending of choice of method.

| | Mean min/100 plants | Used time during the first four years | | |
|---|---|---|---|---|
| | | min:sec per plant | Man hrs /1000 plants | Man days /1000 plants |
| 1 Prepare seedbeds | 141,9 | 1:25 | 23,7 | 3,0 |
| 2 Cracking and improving seeds | 3,3 | 0:02 | 0,6 | 0,1 |
| 3 Sow and nurse seedlings in beds | 36,2 | 0:22 | 6,0 | 0,8 |
| 4 Prepare and plant directly in sleeves | 428,6 | 4:17 | 71,4 | 8,9 |
| 5 Transplanting | 281,5 | 2:49 | 46,9 | 5,9 |
| 6 Prepare soil (and sow in fields) | 348,2 | 3:29 | 58,0 | 7,3 |
| 7a Take and prepare cuttings | 267,2 | 2:40 | 44,5 | 5,6 |
| 7b Plant cuttings | 132,5 | 1:20 | 22,1 | 2,8 |
| 8 Weeding (per time) | 464,2 | 4:38 | 77,4 | 9,7 |
| 9 Spacing and uprooting | 1500,0 | 15:00 | 250,0 | 31,3 |
| 10a Pruning1 time | 23,5 | 36:40 | 3,9 | 0,5 |
| 10b Pruning 2 | 134,4 | | 22,4 | 2,8 |
| 10c Pruning 3 | 510,7 | | 85,1 | 10,6 |
| 10d Pruning 4 | 3000,0 | | 500,0 | 62,5 |
| 11 Spraying against pests/insects | 41,7 | 1:40 | 7,0 | 0,9 |
| 12 Irrigating | 0,2 | | | |
| 13 Harvesting (24,6 min/kg) | | | 4100 | 512,5 |
| 14 Peeling seeds (21,0 min/kg) (*) | | | 3500 | 437,5 |

Table 15: Time use at different stages of jatropha production.

(*)One shrub will give totally about 10 kg during the first four years (0/1/3/6)kg.

## 3.2 Activity calendar for jatropha: Central & Lusaka province Zambia

Many farmers express that growing of jatropha not will be at the expenses of their food production because they can do it in between the other work. MACO's attitude is that time allocation and work demand for biofuel not shall overlap with other crops (Siamuyoba, 12.10.07). To investigate in which degree the activity calendars would overlap or not, an activity calendar for jatropha was developed in cooperation with growers, promoters of jatropha and MACO's Chief Agricultural Officer (see table 16).

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Planting beds** | | | | | | | X | X | X | | | |
| **Planting field** | | | | | | | | | | | X | X |
| **Trans-planting** | | | | | | | | | | | X | X |
| **Take/plant cuttings** | | | | | | | | | X | X | | |
| **Weeding** | X | X | X | | | | | | | | | |
| **Pruning** | | | | | | | X | X | | | | |
| **Spacing** | | | | | | | | | X | X | | |
| **Spraying** | X | X | X | X | X | | | | X | X | X | X |
| **Harvesting** | X | X | X | | | | | | | | | X |

Table 16 shows when the different activities find place in the production of jatropha. It is based on interviews with jatropha- growers and promoters.

The plant is dormant and without leaves from June to August. No spraying is required in this period. Termite control is done year around. To secure germination after planting in field, the seeds should be put in the soil when the rain period has started in Nov/Dec. In a nursery they can be irrigated and can be planted in the dry period. The seedlings are vulnerable and little drought resistant immediately after the transplanting. They should be transplanted in the rainy season. Cuttings can be planted when the end of the hot and dry period is approaching. Pruning is done when the plant is dormant.

| | Jan | Feb | March | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Landpreparation** | B | | | | | | | JM F | JMG C S F | JM G C S F | M G C B S F | B |
| **Add manure/fert** | B | | | | | | | M F | M S F | M G S F | G S F | B |
| **Plant field** | B F | | | | | | | | | | J M G C S | J M G B S F |
| **Planting beds** | | | | | | | J | J | J | | | |
| **Transplanting** | | | | | | | | | | | J | J |
| **Take/plant cuttings** | | | | | | | | | J | J | | |
| **Weeding** | J M G C B S F | J M B F | J | | | | | | | | | M G C S F |
| **Pruning** | | | | | | | J | J | | | | |
| **Spacing** | | | | | | | | | J | J | | |
| **Spraying** | J M G C B S | J M G C B S | J M G C B S | J M G C B S | J M C S | | | | J | J | J M G C B S | J M G C B S |
| **Harvesting** | J | J | J G B | M G B S F | M C S | M C S | C | C | | | | J |
| **Thresh, peel, winnow, bag** | | J | J | JM G B S F | JM G B S F | M S | | | | | | |
| **Busy months** | | | | | | | | | | | | |

Table 17 shows when different activities are going on in different productions. It is the jatropha activity calendar added to MACO's activity calendar for some of the most common crops. The most busy periods are red, the intermediate orange and the relaxed/easy green.

J=Jatropha M= Maize G=Groundnuts C=Cotton B=Beans, mixed S=Sorghum/Millet F=SunFlower

Source: Calendar of Activities for ox drawn implements and hand hoe farmers 2007: MACO/Chief Agricultural Officer

| **Busy period**<br>**Activity (min/plant)** | Intermediate period<br>Activity(min/plant) | Easy period<br>Activity (min/plant) |
|---|---|---|
| **April, November** | Jan, March, May, Oct, Dec | Feb, June, July, Aug, Sept |
| **Spraying 1:40**<br>**Weeding 18:34**<br>**Plant in field 3:11**<br>**Transplanting 2:49** | Spraying 1:40<br>Weeding 18:34<br>Plant in field 3:11<br>Transplanting 2:49<br>Land preparation<br>Spacing/uprooting 15:00<br>Take/plant cuttings 2:40<br>Harvesting<br>Peeling | Spraying 1:40<br>Weeding 18:34<br>Plant in beds 1:25<br>Plant in sleeves 4:20<br>Land preparation<br>Spacing/uprooting 15:00<br>Take/plant cuttings 2:40<br>Pruning 36:40 min/plant<br>Harvesting<br>Peeling |
| **Sum = 26:14 min/plant** | Sum = 43:53 min/plant | Sum = 80:15 min/plant |

Table 18 shows what activities the different periods require and estimated time use.

As seen from table 18, the most time demanding operations can be during the 'green periods' where work demands for the other crops are absent.

Time for spraying depends on when attacks appears. Weeding of jatropha is time consuming, should be done twice a year and will have to be done in the busy periods as well as the intermediate and easy period. To plant in sleeves or in seedbeds can be done in the easy period, but the transplanting has to be done in April or November which is the intermediate or busy period. Planting in field has to be done in this period as well. This is because of the rainy season which starts in November and ends in April. CFU emphasize the importance of land preparation immediately after harvest while the soil still is soft after the rainy season. Spacing/uprooting is done at the same time as the pruning, but it is possible to avoid the busy period.

## 3. 3 Cost benefit analysis (CBA)

A CBA is an estimation of the profitability in a project. The analysis will make visible both costs and benefits and prepare the ground for making decisions linked to a project. Some of the steps in the process of making a CBA is to:

- Collect data for costs to investments, operating costs and labour.
- Estimate future incomes from the project.
- Costs and incomes are applied in a spreadsheet (Excel) and the results evaluated and compared with other options.

The rates in table 19 are collected from MACO. Jatropha producer price and costs for seeds are estimated on interviews with buyer and sellers of seed. Redistributed seeds are in many cases subsidized or given for free. This explains the lower price.

Prices & Costs in agricultural production (in ZKW)

| | | | | | | |
|---|---|---|---|---|---|---|
| Producer Price | | 750 | per kg | Tractor hire | 100 000 | per day |
| Seed | | 500 | per kg | Casual Labour | 5 000 | per day |
| Basal Fertilizer | D Comp | 97 000 | per pkt | Oxen hire | 50 000 | per day |
| Top Fertilizer | Urea | 108 000 | per pkt | Combine hire | 200 000 | per day |
| Herbicide | Primagram | 76 050 | per lt | Own Fuel & repairs | 80 000 | |
| Insecticide | Thiodan | 30 150 | per lt | Transport & packing | 1 500 | |
| Fungicide | Dithane | 17 550 | per kg | | | |

Table 19: Prices and costs in agricultural production (Source: Budget Crops MACO Nov.2007)

All the collected data's are applied in four different spreadsheets (table 20 to 23): One table is made for each of the different alternatives which are described in chapter three. The main findings are finally collected in table 24 to simplify the comparison between the different alternatives. It is assumed that the different methods will produce the same amount of yields except alternative c) "cuttings". A medium amount of fertilizer is applied only once in the calculations. Spraying against insects is done once per year. Expenses to insurance and treatment against fungi's are not included. Weeding will be done manually until a canopy is

developed.

Pruning is easily done when the trees are small. Later each tree will require more time. Some people I met who are involved in jatropha production claim that time spent on pruning will decrease after five to six years. This is difficult both to confirm and reject, very little written information is available.

Promoters often suggest 3 by 3 m spacing in a pure stand of jatropha. This will give 1100 trees per hectare. If planted directly in field, it is suggested that 3 seeds should be dropped in each pit (Jatropha Handbook). This will be close to 3 kg of seeds all together (Jatropha Handbook). After germination, the surplus of trees is removed. Still some trees will die because of termites and diseases. The CBA is based on 1000 trees which give yield in a pure jatropha stand. The harvest per tree is estimated to be 6 kg per tree when the production peaks. This is based on calculations from field officers from CFU and the promoters. The Gtz Jatropha Manual suggest 0,3 to 9 kg per tree annually. Another estimate is between 2 and 12 kg per tree annually (jatrophaworld.org).

Explanation of some terms in the tables:

*Gross Margin* (GM)= Income-Total Variable Costs (TVC)

*Break-Even Yield* is the necessary number of produced bags sold at a given price to cover TVC= TVC/Producer Price

*Break-Even Price* is the needed sales prize for a given amount of yield to cover TVC=TVC/Yield

*GM return on variable costs*=GM/TVC. This is an expression of the profitability of the project

| ESTIMATED COSTS AND INCOMES (in ZKW) THROUGHOUT THE FIRST TEN YEARS FOR ONE HECTARE OF JATROPHA<br>Alt a) Nursery/seedbeds | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| OUTPUT | | | | | | | | | | |
| Yield Kg | 0 | 0 | 1000 | 3000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 |
| INCOME | 0 | 0 | 750000 | 2250000 | 4500000 | 4500000 | 4500000 | 4500000 | 4500000 | 4500000 |
| VARIABLE COSTS | | | | | | | | | | |
| Seed | 5000 | | | | | | | | | |
| Basal Fert | 97 000 | | | | | | | | | |
| Insecticide | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 |
| LABOUR COSTS | | | | | | | | | | |
| 1 Prepare seedbeds | 14800 | | | | | | | | | |
| 2Cracking and improving seeds | 345 | | | | | | | | | |
| 3Sow and nurse seedlings in beds | 3750 | | | | | | | | | |
| 5Transplanting | 29300 | | | | | | | | | |
| Weeding twice a year | 96700 | 96700 | 96700 | | | | | | | |
| 10a Pruning once a year | 2450 | 14000 | 53200 | 312500 | 312500 | | | | | |
| 11Spraying against pests/insects | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 |
| 14Harvesting | | | 256500 | 769000 | 1538500 | 1538500 | 1538500 | 1538500 | 1538500 | 1538500 |
| 15Peeling | | | 218500 | 655000 | 1310000 | 1310000 | 1310000 | 1310000 | 1310000 | 1310000 |
| TOTAL VARIABLE COSTS | 262740 | 124095 | 638295 | 1749895 | 3174395 | 2861895 | 2861895 | 2861895 | 2861895 | 2861895 |
| | | | | | | | | | | |
| GROSS MARGIN | -262740 | -124095 | 111705 | 500105 | 1325605 | 1638105 | 1638105 | 1638105 | 1638105 | 1638105 |
| Break-Even Yield | | | 851,1 | 2333,2 | 4232,5 | 3815,86 | 3815,86 | 3815,86 | 3815,86 | 3815,86 |
| GM Return on variable costs % | -100 | -100 | 18 | 28,8 | 41,8 | 57,2 | 57,2 | 57,2 | 57,2 | 57,2 |
| Break-Even Price | | | 638,3 | 583,3 | 529,1 | 477,0 | 477,0 | 477,0 | 477,05 | 477,0 |
| Accumulated Gross Margin | -262740 | -386835 | -275130 | 224975 | 1550580 | 3188685 | 4826790 | 6464895 | 8103000 | 9741105 |

Table 20: CBA throughout the first ten years for one Hectare of jatropha based on nursery and seedbeds

| ESTIMATED COSTS AND INCOMES (in ZKW) THROUGHOUT THE FIRST TEN YEARS FOR ONE HECTARE OF JATROPHA:<br>Alt b) Direct planting in field | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| OUTPUT | | | | | | | | | | |
| Yield Kg | 0 | 0 | 1000 | 3000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 |
| INCOME | 0 | 0 | 750000 | 2250000 | 4500000 | 4500000 | 4500000 | 4500000 | 4500000 | 4500000 |
| VARIABLE COSTS | | | | | | | | | | |
| Seed | 5000 | | | | | | | | | |
| Basal Fert | 97 000 | | | | | | | | | |
| Insecticide | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 |
| Fungicide | | | | | | | | | | |
| | | | | | | | | | | |
| LABOUR COSTS | | | | | | | | | | |
| 6Prepare soil (and sow in fields) | 36250 | | | | | | | | | |
| Weeding twice a year | 96700 | 96700 | 96700 | | | | | | | |
| 9Spacing and uprooting | | | | | | | | | | |
| 10a Pruning once a year | 2450 | 14000 | 53200 | 312500 | 312500 | | | | | |
| 11Spraying against pests/insects | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 |
| 12Irrigating | | | | | | | | | | |
| 13Mulching | | | | | | | | | | |
| 14Harvesting | | | 256500 | 769000 | 1538500 | 1538500 | 1538500 | 1538500 | 1538500 | 1538500 |
| 15Peeling | | | 218500 | 655000 | 1310000 | 1310000 | 1310000 | 1310000 | 1310000 | 1310000 |
| TOTAL VARIABLE COSTS | 250795 | 124095 | 638295 | 1749895 | 3174395 | 2861895 | 2861895 | 2861895 | 2861895 | 2861895 |
| | | | | | | | | | | |
| GROSS MARGIN | -250795,0 | -124095,0 | 111705,0 | 500105,0 | 1325605,0 | 1638105,0 | 1638105,0 | 1638105,0 | 1638105,0 | 1638105,0 |
| Break-Even Yield | | | 851,1 | 2333,2 | 4232,5 | 3815,9 | 3815,9 | 3815,9 | 3815,9 | 3815,9 |
| GM Return on variable costs | -100,0 | -100,0 | 20 | 28,6 | 41,8 | 57,2 | 57,2 | 57,2 | 57,2 | 57,2 |
| Break-Even Price | | | 638,3 | 583,3 | 529,1 | 477,0 | 477,0 | 477,0 | 477,0 | 477,0 |
| Accumulated Gross Margin | -250795 | -374890 | -263185 | 236920 | 1562525 | 3200630 | 4838735 | 6476840 | 8114945 | 9753050 |

Table 21: CBA throughout the first ten years for one Hectare of jatropha based on direct planting in field

| ESTIMATED COSTS AND INCOMES (in ZKW) THROUGHOUT THE FIRST FIFTEEN YEARS FOR ONE HECTARE OF JATROPHA: Alt c) Cuttings | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| OUTPUT | | | | | | | | | | |
| Yield Kg | 0 | 1000 | 3000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 |
| INCOME | 0 | 750000 | 2250000 | 4500000 | 4500000 | 4500000 | 4500000 | 4500000 | 4500000 | 4500000 |
| VARIABLE COSTS | | | | | | | | | | |
| Insecticide | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 |
| | | | | | | | | | | |
| LABOUR COSTS | | | | | | | | | | |
| 7Take and prepare cuttings | 27850 | | | | | | | | | |
| 7a plant cuttings | 13800 | | | | | | | | | |
| Weeding twice a year | 96700 | 96700 | 96700 | | | | | | | |
| 10a Pruning once a year | 2450 | 14000 | 53200 | 312500 | 312500 | | | | | |
| 11Spraying against pests/insects | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 |
| 14Harvesting | | 256500 | 769000 | 1538500 | 1538500 | 1538500 | 1538500 | 1538500 | 1538500 | 1538500 |
| 15Peeling | | 218500 | 655000 | 1310000 | 1310000 | 1310000 | 1310000 | 1310000 | 1310000 | 1310000 |
| TOTAL VARIABLE COSTS | 154195 | 599095 | 1587295 | 3174395 | 3174395 | 2861895 | 2861895 | 2861895 | 2861895 | 2861895 |
| | | | | | | | | | | |
| GROSS MARGIN | -154195 | 150905 | 662705 | 1325605 | 1325605 | 1638105 | 1638105 | 1638105 | 1638105 | 1638105 |
| Break-Even Yield | | 798,8 | 2116,4 | 4232,5 | 4232,5 | 3815,9 | 3815,9 | 3815,9 | 3815,9 | 3815,9 |
| GM Return on variable costs | -100 | 25,2 | 41,8 | 41,8 | 41,8 | 57,2 | 57,2 | 57,2 | 57,2 | 57,2 |
| Break-Even Price | | 599,1 | 529,1 | 529,1 | 529,1 | 477,0 | 477,0 | 477,0 | 477,0 | 477,0 |
| Accumulated Gross Margin | -154195 | -3290 | 659415 | 1985020 | 3310625 | 4948730 | 6586835 | 8224940 | 9863045 | 11501150 |

Table 22: CBA throughout the first ten years for one Hectare of jatropha based on cuttings

| ESTIMATED COSTS AND INCOMES (in ZKW) THROUGHOUT THE FIRST TEN YEARS FOR ONE HECTARE OF JATROPHA<br>Alt d) Planting in sleeves | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| OUTPUT | | | | | | | | | | |
| Yield Kg | 0 | 0 | 1000 | 3000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 |
| INCOME | 0 | 0 | 750000 | 2250000 | 4500000 | 4500000 | 4500000 | 4500000 | 4500000 | 4500000 |
| VARIABLE COSTS | | | | | | | | | | |
| Seed | 5000 | | | | | | | | | |
| Basal Fert | 97 000 | | | | | | | | | |
| Insecticide | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 |
| | | | | | | | | | | |
| LABOUR COSTS | | | | | | | | | | |
| 4prepare and plant directly in sleeves | 44650 | | | | | | | | | |
| 5Transplanting | 29300 | | | | | | | | | |
| Weeding twice a year | 96700 | 96700 | 96700 | | | | | | | |
| 10a Pruning once a year | 2450 | 14000 | 53200 | 312500 | 312500 | | | | | |
| 11Spraying against pests/insects | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 | 4350 |
| 14Harvesting | | | 256500 | 769000 | 1538500 | 1538500 | 1538500 | 1538500 | 1538500 | 1538500 |
| 15Peeling | | | 218500 | 655000 | 1310000 | 1310000 | 1310000 | 1310000 | 1310000 | 1310000 |
| TOTAL VARIABLE COSTS | 288495 | 124095 | 638295 | 1749895 | 3174395 | 2861895 | 2861895 | 2861895 | 2861895 | 2861895 |
| | | | | | | | | | | |
| GROSS MARGIN | -288495 | -124095 | 111705 | 500105 | 1325605 | 1638105 | 1638105 | 1638105 | 1638105 | 1638105 |
| Break-Even Yield | | | 851,1 | 2333,2 | 4232,5 | 3815,9 | 3815,9 | 3815,9 | 3815,9 | 3815,9 |
| GM Return on variable costs | -100 | -100 | 17,5 | 28,6 | 41,8 | 57,2 | 57,2 | 57,2 | 57,2 | 57,2 |
| Break-Even Price | | | 638,3 | 583,3 | 529,1 | 477,0 | 477,0 | 477,0 | 477,0 | 477,0 |
| Accumulated Gross Margin | -288495 | -412590 | -300885 | 199220 | 1524825 | 3162930 | 4801035 | 6439140 | 8077245 | 9715350 |

Table 23: CBA throughout the first ten years for one Hectare of jatropha based on planting in sleeves

| ESTIMATED COSTS AND INCOMES (in ZKW) THROUGHOUT THE FIRST TEN YEARS FOR ONE HECTARE OF JATROPHA: Comparing the different alternatives | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Alt a) NURSERY/SEEDBEDS** | | | | | | | | | | |
| **Year number** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **GROSS MARGIN** | -262740 | -124095 | 111705 | 500105 | 1325605 | 1638105 | 1638105 | 1638105 | 1638105 | 1638105 |
| **Break-Even Yield** | | | 851,1 | 2333,2 | 4232,5 | 3815,86 | 3815,86 | 3815,86 | 3815,86 | 3815,86 |
| **GM Return on variable costs %** | -100 | -100 | 18 | 28,8 | 41,8 | 57,2 | 57,2 | 57,2 | 57,2 | 57,2 |
| **Break-Even Price** | | | 638,3 | 583,3 | 529,1 | 477,0 | 477,0 | 477,0 | 477,05 | 477,0 |
| **Accumulated Gross Margin** | -262740 | -386835 | -275130 | 224975 | 1550580 | 3188685 | 4826790 | 6464895 | 8103000 | 9741105 |
| **Alt b) DIRECT PLANTING IN FIELD** | | | | | | | | | | |
| **GROSS MARGIN** | -250795,0 | -124095,0 | 111705,0 | 500105,0 | 1325605,0 | 1638105,0 | 1638105,0 | 1638105,0 | 1638105,0 | 1638105,0 |
| **Break-Even Yield** | | | 851,1 | 2333,2 | 4232,5 | 3815,9 | 3815,9 | 3815,9 | 3815,9 | 3815,9 |
| **GM Return on variable costs** | -100,0 | -100,0 | 20 | 28,9 | 41,8 | 57,2 | 57,2 | 57,2 | 57,2 | 57,2 |
| **Break-Even Price** | | | 638,3 | 583,3 | 529,1 | 477,0 | 477,0 | 477,0 | 477,0 | 477,0 |
| **Accumulated Gross Margin** | -250795 | -374890 | -263185 | 236920 | 1562525 | 3200630 | 4838735 | 6476840 | 8114945 | 9753050 |
| **Alt c) CUTTINGS** | | | | | | | | | | |
| **GROSS MARGIN** | -154195 | 150905 | 662705 | 1325605 | 1325605 | 1638105 | 1638105 | 1638105 | 1638105 | 1638105 |
| **Break-Even Yield** | | 798,8 | 2116,4 | 4232,5 | 4232,5 | 3815,9 | 3815,9 | 3815,9 | 3815,9 | 3815,9 |
| **GM Return on variable costs** | -100 | 25,2 | 41,8 | 41,8 | 41,8 | 57,2 | 57,2 | 57,2 | 57,2 | 57,2 |
| **Break-Even Price** | | 599,1 | 529,1 | 529,1 | 529,1 | 477,0 | 477,0 | 477,0 | 477,0 | 477,0 |
| **Accumulated Gross Margin** | -154195 | -3290 | 659415 | 1985020 | 3310625 | 4948730 | 6586835 | 8224940 | 9863045 | 11501150 |
| **Alt d) PLANTING IN SLEEVES** | | | | | | | | | | |
| **GROSS MARGIN** | -288495 | -124095 | 111705 | 500105 | 1325605 | 1638105 | 1638105 | 1638105 | 1638105 | 1638105 |
| **Break-Even Yield** | | | 851,1 | 2333,2 | 4232,5 | 3815,9 | 3815,9 | 3815,9 | 3815,9 | 3815,9 |
| **GM Return on variable costs** | -100 | -100 | 17,5 | 28,6 | 41,8 | 57,2 | 57,2 | 57,2 | 57,2 | 57,2 |
| **Break-Even Price** | | | 638,3 | 583,3 | 529,1 | 477,0 | 477,0 | 477,0 | 477,0 | 477,0 |
| **Accumulated Gross Margin** | -288495 | -412590 | -300885 | 199220 | 1524825 | 3162930 | 4801035 | 6439140 | 8077245 | 9715350 |

Table 24: Comparison between the four different CBA's

### 3.3.1 Gross Margin

Jatropha is a perennial crop and the costs and income will change from one year to anoher. There will be variations over time as figure 25 and 26 show. The figures compare income, total variable costs and gross margin during the first ten years for alternative “nursery and “cuttings”. Alternative “direct planting” and “sleeves” are very similar to “nursery”. All the alternatives have much in common, like a high income and high costs. Because it requires less labor to establish a field from cuttings and because the cuttings give yield faster, the gross margin in “cuttings” gets positive earlier than in any of the other alternatives. The decrease in total variable costs from year 5 is caused by a supposed lower need for pruning.

A general misunderstanding among people who have some meanings about jatropha is that the highest costs are linked to the planting, that the field more or less can maintain itself and requires few or no costs during the lifespan. That is completely wrong. The costs for planting are insignificant compared to the later expences for weeding, pruning, picking and peeling of seeds. And they will continue throughout the lifespan of the plant as figure 25 and 26 shows. Even if there are some differences the first three years between “cuttings” and the other alternatives, they will establish a gross margin very similar to each other in the coming period assumed that cuttings give the same yield annually.

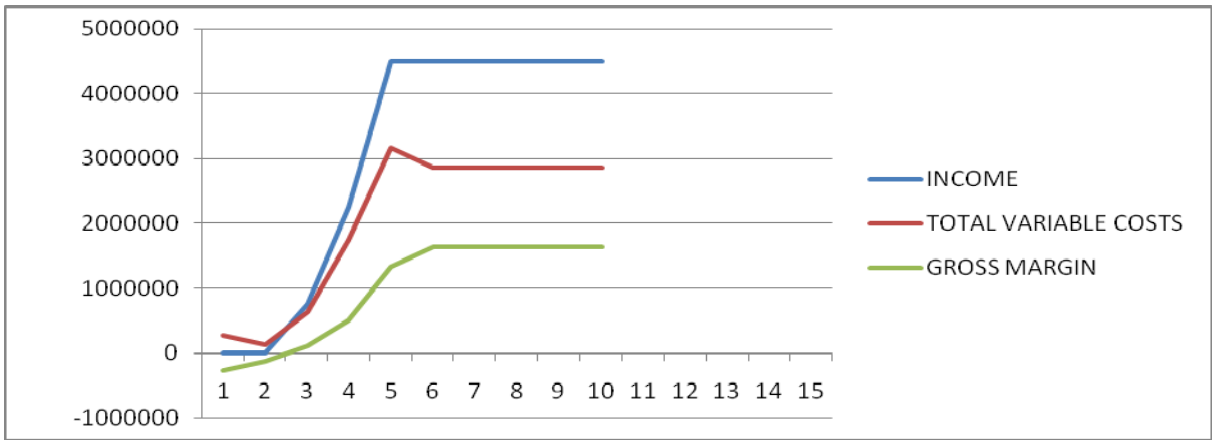


Figure 25: Alt C: Cuttings; Comparing total variable costs, income and gross margin (In ZKW)

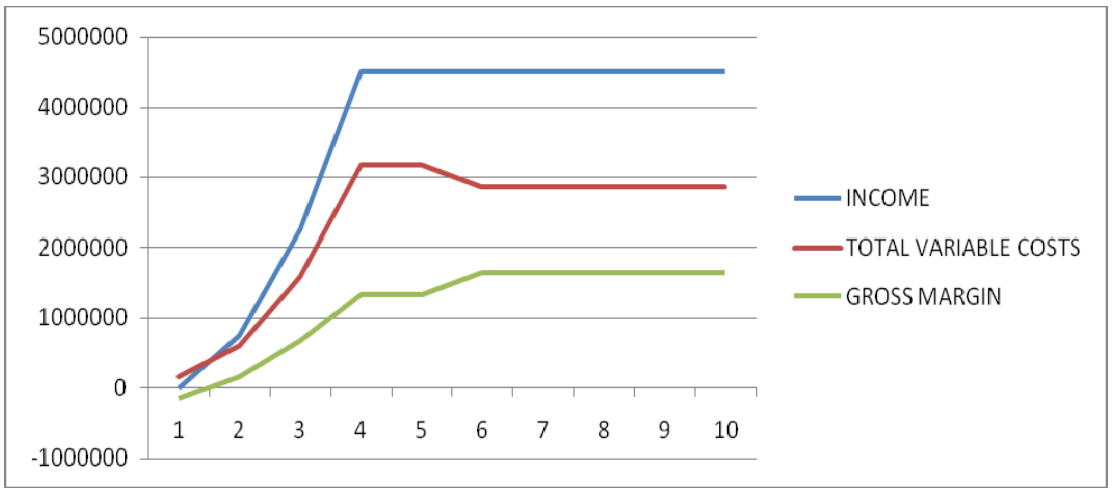


Figure 26: Alt A, Nursery. Comparing total variable costs, income and gross margin (In ZKW)

### 3.3.2 Competing crops

The best jatropha alternative (cuttings) will give a Gross Margin similar to ZKW 1.638.105 per year from year number six when the production peaks. The conditions are given in table 19 and 22. It is natural to compare jatropha with typical cash crops like cotton and tobacco. GM for these are US$ 121 and 740 per ha respectively (Source: The Zambian Paprika Case Study 2005). Converted to ZKW, this will be 408.375 for cotton and 2.565.000 for tobacco (1ZKW=3.375US$ per 12.05.08).Profitability for jatropha and other common crops in Zambia is compared in table 25. As we can see, soya beans and tobacco give a higher Gross Margin per ha than jatropha.

| Prices & Costs (in ZKW) in 1 Ha<br>Small Scale Management Level (<10 Ha) | Maize | Castor | Soya Beans | Sun-flower | Sorghum |
|---|---|---|---|---|---|
| Gross Margin | 654 311 | 403 300 | 2 759 720 | -225 500 | 132 520 |
| GM Return on variable costs | 51 % | 34 % | 131% | -30 % | 14 % |

Table 25: Profitability for some of the most common crops in Zambia
(Source: Budgets Crops MACO Dec 2007)

GM return on variable costs jatropha when the production peaks is 57% for cuttings (not discounted).

The corresponding values for cotton and tobacco are respectively 87% and 102% (*). (Source: The Zambian Paprika Case Study 2005). Soya beans, as well as cotton and tobacco give a higher GM Return on variable costs than jatropha.

*) The Zambian Paprika Case Study defines profitability as profit divided on revenue (or Gross margin divided on Income). It does not make sense to compare these values directly with GM return on variable cost. Instead of using profitability, I divided the profit (GM) on the revenue (Income). This outcome is similar to GM return on variable costs.

### 3.3.2 Net Present Value (NPV)

Jatropha is a perennial plant. Planting of a jatropha requires costs, and income will not appear before 2 to 4 years after planting. This is a significant difference between jatropha and other crops. To get a true picture of the cash flow and profitability, the gross margin should be discounted every year to find the NPV.

This is done by the formula:

$$\mathrm{NPV} = \sum_{t=0}^{N} \frac{C_t}{(1+r)^t}$$

*t* - the time of the cash flow

*N* - the total time of the project

*r* - the discount rate (the rate of return that could be earned on an investment in the financial markets with similar risk.)

$C_t$ - the net cash flow (the amount of cash) at time *t* (for educational purposes, $C_0$ is commonly placed to the left of the sum to emphasize its role as the initial investment.).

(Source: Wikipedia)

By discounting, the size of the gross margin will change. If a discount rate of 10% is used, the results will be as shown in table 26.

| | Nursery | Direct planting | Cuttings | Sleeves |
|---|---|---|---|---|
| NPV, Gross margin ZKW | 4.222.085 | 4.234.030 | 5.656.213 | 5.213.465 |
| NPV, GM return on variable costs | 44% | 45% | 48% | 44% |

Table 26: NPV GM and GM return on variable costs

The conditions are given in table 19 and 22. Real interest rate is used in the calculations. This is found by subtracting the inflation rate away from the nominal interest rate. A rate of 10% is rather high and not too optimistic. A lower real interest rate would result in an even higher profitability. It seems like cuttings is the most profitable alternative. There is only a slight difference between direct planting, nursery and sleeves. In this calculation, *N* has been defined to 10 years. The lifespan of jatropha can be as high as 40 to 50 years. If *N* is increases, the profitability of the project will be improved. If we focus on sleeves over a period of 20 years, the GM return on variable costs will increase to 103%. After 30 years, it has changed to 162%. In the long run, jatropha is more profitable than any of the competing crops.

### 3.3.3 Sensitivity analysis (SA)

The purpose of a sensitivity analysis is to study the vulnerability of the investment. Changes in price, yields, labor costs and rates of interest may occur. A long term investment is sensitive for changes in those factors. The SA tries to investigate how the profitability will change if one or several of the factors are changed. The oil price has increased steadily the last 8 years (Europe Brent Spot Price Jan 2000) and will probably not be a critical factor in the SA. I will focus on the three remaining factors: labor costs, rate of interest and yield. To simplify, only alternative 'Nursery' is used. The calculations are based on a period of 10 years. As mentioned in 3.3.1, if this period is extended, the overall profitability will improve.

Change in real rate of interest

By increasing the discount rate, the NPV will decrease as shown in figure 27. The *internal interest* of the investment will be found where NPV=0. In this case, only the real interest rate changes. The internal interest will be 91%, which is extremely high. It seems that the investment is robust related to changes in rate of interest. (Discounted GM on return on VC=42% when internal interest is 10%) Labor costs, yield and price of seeds are still the same as in table 19 and 22.

| Discount Rate | NPV |
|---|---|
| 0,1 | 4762927 |
| 0,5 | 450756 |
| 0,9 | 6076 |
| 1 | -26157 |

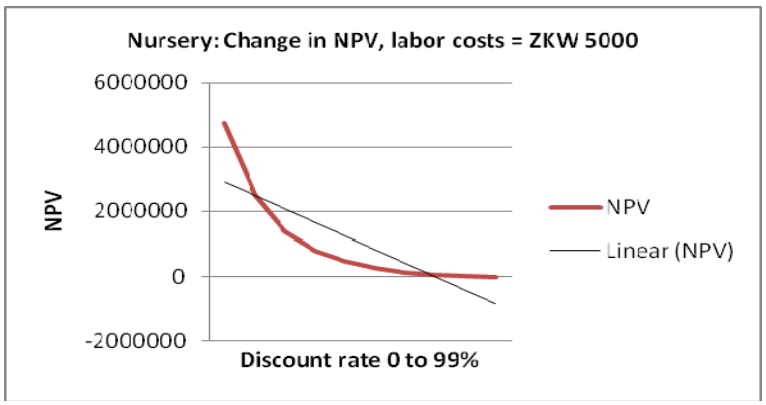


Figure 27: Internal interest when labor costs are ZKW 5000 per day and the discount rate increases.

Change in labor costs

Figure 28 shows how NPV decreases when the labor cost is ZKW 7000 per day and the rate of interest increases. The yield and price of seeds are unchanged. The internal interest will be about 22%.

(Discounted GM on return on VC=2% when internal interest is 10%)

| Discount Rate | NPV |
|---|---|
| 0,1 | 532850 |
| 0,2 | 57879 |
| 0,22 | 3491 |
| 0,23 | -20352 |

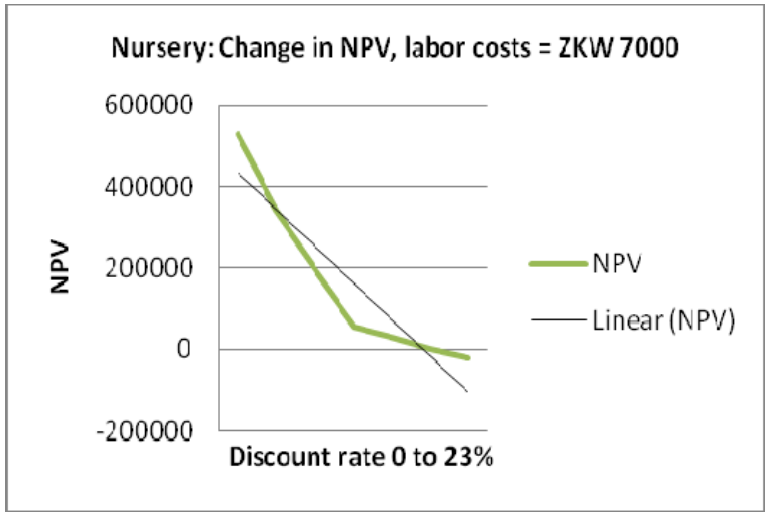


Figure 28: Internal interest when labor costs are ZKW 7000 per day

Change in yield

If the yield drops from 6 kg to 4 kg and the seed price and labor cost is unchanged the internal

interest will be 29% as shown in figure 29. (Discounted GM on return on VC=2% when internal interest is 10%)

| Discount Rate | NPV |
|---|---|
| 0,1 | 300870 |
| 0,2 | 96590 |
| 0,26 | 27250 |
| 0,29 | 1560 |
| 0,3 | -5970 |

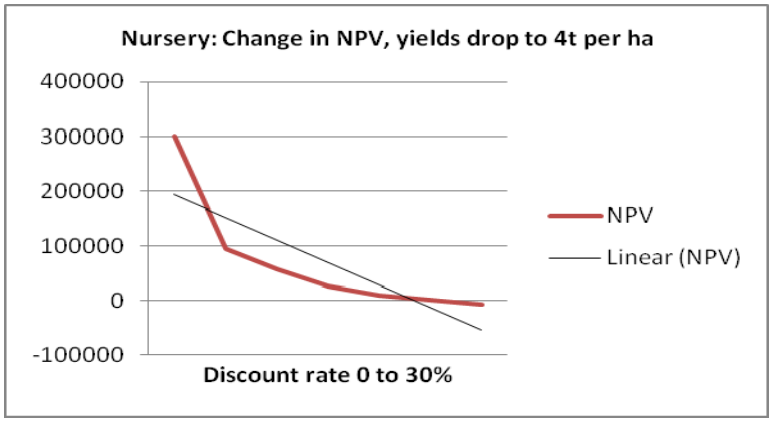


Figure 29: Internal interest when yield drops to 4t per ha annually.

All these examples give very high internal interest rates. This is strengthening the impression of jatropha as a good cash crop. To make this assertion even stronger, the oil price is increasing steadily. The yields seem to be less vulnerable for natural hazards than competing cash crops.

## 3.4 Focus Group Interviews

The first group interview was done in the Mumbwa Region, which is localized 150 km north of Lusaka. The visited localizations were Mulendema, Mumbwa and Moono. 12 farmers from CFU participated in the group discussion. It is not ideal to have so many participants, but this happened accidentally. The plan was to conduct individual interviews, but because of a misunderstanding the 12 suddenly appeared.

A reason for criticism is the appearance of CFU's field supervisors' and the regional manager. The presence of CFU staff may have biased the answers of the farmers. The second group interview was done in Choma, Mukonde society on Monday 05/11. Six farmers who are outgrowers for SBP participated

*What kind of information have you received about Jatropha?*

The CFU- farmers answered that they planted jatropha as a hedge to prevent livestock from destructing their food crops. The hedge is also a wind breaker between the fields and will

reduce the soil erosion. A full grown hedge can stop a wild fire and protect the fields.
Jatropha will give them seeds, which in turn can be used as fuel or bio diesel. It is a drought resistant plant and it remains for many years. When the leaves drop, they decompose in the soil and can in this way be used as manure.
The SBP-farmers answered that they have received scarce information, but have expectations to the promoter and trust and believe that SBP will be helpful for them. A good contract will give access to a market where the company will buy their seeds. They also hope the promoter will supply them with fertilizer given as a loan. Pay back is done when the jatropha is harvested. As a part of the contract, the farmers receive sunflower seeds. They hope this can be extended to improved seeds of maize, beans and ground nuts. The farmers admit that they have very little knowledge about the maintenance of the jatropha and need follow up, teaching and guiding.

*How can the jatropha oil benefit you in domestic use?*
Many rural people use kerosene or diesel for lighting even if it smells bad and gives smoke. They know that jatropha oil can burn very clean and can be a cheap and good substitute for kerosene.

*This is obviously a good tree, why haven't you started before?*
Jatropha is still a new plant for the farmers which they have heard very little about. If the knowledge was there, they would have started earlier.

*From where have you received this information?*
What the farmers know is from CFU, SBP, news in radio, TV and newspapers.

*Are there any diesel engines in this area like tractors, aggregates or hammer mills?*
Tractors are too expensive to buy or rent and nobody can afford one in the visited area.
The farmers have access to hammer mills. Some are privately owned and some are owned by the community. There are both diesel and fuel generators as well. They are owned individually or for business purpose.

*Do you fear that j will make your food production suffer?*

When jatropha is limited to be grown as a hedge it will not consume land. The best soil will be reserved for the food crops. There is plenty of dormant land in the district which can be used for oil production.

The plant does not seem to require much time. The farmers say they can do the work in between other tasks and doings.

*Do you have any concerns or worries about the jatropha plant?*

None

*How much extra work are you willing to put into extraction of j.oil to substitute paraffin?*
"We are willing to put effort in that. You know we are farmers and should work hard all the time."

## 3.5 Meetings with the Ministry of Agriculture and Cooperatives (MACO)

**12.10.07 and 29.11.07: Philip Siamuyoba, MACO's jatropha expert**

The role of MACO is in general to deliver agronomical facilitation and extension service through the extension officers in the villages. MACO has an organizational structure where the Director of Agriculture is on top. In declining order follow the Provincial Agriculture Officer, the District Agricultural Officer, the Block Extension Officer and the Camp Officer. The Extension Officer is taking care of the day to day activities. They give advice to the farmers about good agronomic practices. They have a focus on environmental impact of new methods and crops. Other public Institutions which are engaged or involved in the jatropha issues are: The Ministry of labor and social services, the Forestry Department, the Environmental Department and the Energy Department.

The governments' concern about jatropha is:

-There is a growing need for biodiesel.

-Which impact will big scale jatropha production have on the environment?

-Can large scale production of biofuel somehow be harmful?

-Which impact will big scale jatropha production have on food security? MACO supports producing biofuel, but the production of biofuel should not make food crops suffer in terms of capacity, land and labor. Plants grown as sources for biofuel should be grown as a supplementary crop. MACO encourages growing biofuel plants on marginal land. Production of biofuel must be harmonized with food security.

-Contract growing. MACO emphasizes contract growing as a concern. Large scale farmers are making contract with small scale farmers to make them grow jatropha. This can be a threat to the small scale farmer's livelihood diversification and household security. It is not common to sell titled land as a coping strategy to get access to credit in Zambia (confirmed by LCMSR 2004). Renting customary owned land or state land has to go through the village board or the village chief.

The development of contract growing and leasing of land for production of biofuel is going faster and is ahead of what the government expected. There are many enterprises and commercial interests. Investors are lobbying farmers and the villagers to get access to land for jatropha growing. The updating has to be paced up on the areas of legislation and legal framework.

-Need for policies and legal framework: There is a need and demand for a biofuel police with respect to how to handling biofuel plants and the value chain. The Ministry of Energy and the Ministry of Labor and Social Services are central in this work. The legal framework is still only a draft. It is unclear when it will be launched, but it depends on the Ministry of Energy.

Mr. Siamuyoba emphasized that future research is needed in the areas of:

-It has to be scientific confirmed that jatropha will give harvest and income in the period between January to July when most farmers experience shortage and food insecurity.

-Look at the activity calendar compared to other crops. The time allocation and the work demanded for growing biofuel should not overlap with other crops.

**15.10.07:**

**Mr. Gottfried Mwanza (Chief Agric.Specialist Farm Power and Mechanization).**

**Mr. Martin N. Sishekanu (Chief Agric. Specialist Land Husbandry (Tree crops)).**

**About costs linked to jatropha growing**

There are very few data available since jatropha still is a new crop.

**Contract Farming**

MACO is very uncomfortable with the situation right now. The development is ahead of their agenda and the work with the legal framework and regulations of the market. One of the problems is contracts like Marli Investments (MI) are doing. Illiterate farmers do not really understand what they are signing. They get the seedlings for free, but the contract binds them for 30 years. The price they are offered for the seeds is fixed and determined by the promoter (MI). It is so low that it hardly covers the costs for labor and other inputs to the farmer. If the farmer breaks the contract, MI will claim that he covers their losses. No farmer can afford to do so. MI will sue them; take the case to the court and the farmer will probably lose his land.

**Environmental aspect**

-Social environmental aspect: In the case of small scale farmers (< 10 ha); sale of jatropha seeds will still give a small income. Another and traditional problem is that husbands will waste the money on alcohol and other women. This leaves the households worse off.

-Food security aspect: Jatropha will replace food crops. MACO's fear is that the argument of growing jatropha on wasteland is abused. Is the definition of wasteland clear and well understood? Maybe aggressive promoters just use the argument about growing jatropha on wasteland to get the farmers hooked? Growing on wasteland can show itself not to be economic sustainable and in the next term jatropha ends up being grown on the best land? We also ask the question if jatropha will supply the farmer with enough money to cover his costs and sustain his livelihood.

-How will jatropha react if it is grown in the best soil? Will the plant or the oil remaining in the press cake be harmful to the soil when it is used as fertilizer? We also fear an interaction between the oil residuals and the plant nutrients. What will be possible to grow in this soil later?

-We know the seeds are poisonous and harmful to birds and mammals. We have to be concerned about the wildlife as well.

**In general**

MACO will let the activities go on, but there is a need for more research. Jatropha can be a very useful plant. It is drought tolerant and less vulnerable for natural hazards. It is known that farmers have traditions for making fences with it. Some of them even extract the oil and use it as a substitute for paraffin or make soap out of it. As on-farm-biofuel, the use is limited because few of the small-and medium size farmers have tractors. Tractors are most common among the commercial farmers with more than 20 ha of land. And it is those farmers who will be able to make investments without depending on the government.

**16.11.07**

**Mr. Kelvin Mooya: Camp Officer; Mkanda Agricultural Camp Office**

Mr. Mooya's primary goal in this period is to follow up the contracts which have been made between the farmers and the promoters of jatropha in his district. He collects all contracts and keeps them in the camp office. His impression of the contracts is that they contain a lot of irregularities. Relevant data is often missing. The contracts are incomplete and the promoter's extension service incompetent and understaffed to handle this sort of issues. In too many cases, Mr. Mooya see how the promoters are exploiting, deceiving and cheating the farmers by not explaining the content of the contract or giving a true picture about the strings attached. Instead of profiting and benefiting from jatropha growing, the farmers end up working as cheap labor for the companies.

Mr. Mooya's advice to farmers who still have not signed any contract is that they should claim a written, not an oral agreement. The contract should be formulated in the local language. A matter of understanding has to be in place if a contract is to be valid and viable. A good solution would be to bring both the promoter and the farmer to the camp office. Together with the camp officer they should go through the contract and thereby make sure that the parts agree and have a common understanding.

In the cases where contracts already are signed, both promoter and outgrower should be told that the contracts are not complete and valid because of the reasons mentioned above. Mr. Mooya is encouraging both parties to come and discuss the formulations and content in the

contract. He is positive to assist them in editing and improving the contracts. When a complete contract is formulated, they should be resigned by the outgrowers and the old contracts destroyed.

*"Another and traditional problem is that husbands will waste the money on alcohol and other women. This leaves the households worse off."*

## 3.6 Meetings with the promoters

**Available Land**

**D1:** D1 claim that all together 35.000 ha land is available through their 21.100 out growers in 2007. D1's vision for 2008 is to double the number of out growers. To recruit farmers, D1 cooperate with other NGO's (CARE and CFU was mentioned) as well as the governmental extension network of camp officers.

(8000 ha in Southern Province,3500 ha in Eastern Pr, 1000 ha in Lusaka Pr, 600 ha in Copperbelt Pr, 5000 ha in Northern Pr, 500 ha in Chisamba Pr.)

Concerning Mr. Chungu, D1 Oils possess their own land as well:

-40.000 ha in Lusaka province, the Chongwe district. (10.000 ha of this will be planted in Nov 2007).

-50.000 ha in Northern Pr, the Kasama district. 300 ha has been planted and 10.000 ha more is planned.

-60.000 ha in NW Pr, Luanga, Lumwana. 370 ha is already planted.

All together, 194.000 ha land is available for D1 Oils. This is good soil on arable land.

D1's vision is to increase this to 1.000.000 ha, which is 2 % of the arable land in Zambia.

Only a limited area is planted because of lack of funds. The pace of the planting will hopefully increase because of BP's involvement from 01.01.07, when BP bought 50% of D1's stock capital.

**MI:** In 2007 Marli Investments Zambia Ltd. have signed contracts with 25.000 out growers in Zambia. The farmers become members of the *Jatropha Outgrower Scheme* when they sign the

contract. It is difficult to estimate any land size because the out growers only plant jatropha on parts of their land. Marli Inv is also encouraging their out growers to do intercropping, for instance cotton/jatropha, maize/jatropha or other mixtures. Marli Inv has incentives which promote planting of 5000, or more, jatropha trees on the farm. The remuneration consists of seeds given for free and a monthly amount of 75.000 Kwacha pr 5 ha (or 5000 trees) for two years until the trees start producing. If the average land used for jatropha is 5 ha/farmer, estimated available land will be very roughly about 125.000 ha.

**SBP/NWBP:** SBP and NWBP are in the process of recruiting Jatropha out growers on a contract basis. Those who grow 1000 or more jatropha plants or cultivate more than one ha with jatropha are called 'BioPartners'. In 2007, SBP made contracts with more than 300 growers in this category, and NWBP with more than 500 groups with five farmers in each group. The second category is current small scale growers who have the potential to increase their number of jatropha plants, but still consider or are waiting. Typical for this group is that they grow jatropha as a hedge or living fence. This category is called 'small scale farmers'. There is no lower limit, but there is no contract or support to establish a plantation for very small out growers, and the farm gate prices offered differ with the quantity of the production.
NWBP is cooperating with SNV, a Dutch NGO which promotes capacity building among people in private sector and civil society. So far, Cooperation with the government is limited to agricultural shows/Farmer's crusade where they are able to exhibit their products and service, since MACO has still not yet adopted Jatropha as a product to be promoted. The challenge and problem with governmental extension officers on village level is the organizational hierarchy. Cooperation requires always agreements and allowances from a head on a higher level and this is slowing down the process and is a hindrance for cooperation.

**Smallest Farm size**

**D1:** The farm size is not important for D1, but the farmers must produce jatropha on at least 1 ha of their land. The expected outcome should be 5-6 ton seeds per ha per year.
**MI:** There is no limit for the lowest farm size. The smallest farm size among the out growers is one *lima* (0,25 ha)

**Contract Period and contract force**

**D1:** The contract is signed for a period of 5 years. Then it is up to the farmer whether he wants to sign for a new period or not. Because of the short perspective, withdrawals from contract are not any real issue.

**MI:** The contract period an out grower signs is for 30 years. According to Mr. Grobler, this is the farmer's suggestion. Initially, Marli's suggestion was 10 years. The farmers found it strange that the contract was for ten years while the tree was able to produce for at least 30 years. That's the background for the choice of 30 years.

Any break of the agreement from the farmer will result in exclusion from the Scheme of the Association and court action. To avoid breaks, mainly in terms of side selling, the company's main policy is to put 5% of its profit into a Legal Trust Company. All money generated from this profit will be led back to the outgrowers' community as community driven projects related to health, education, improved infrastructure and so on.

**SBP/NWBP:** SBP/NWBP offers the farmers a contract period of eight years.

To avoid that farmers drop out of the contract, SB's strategy is to put 5 and 5 farmers together in solidarity groups. NWBP has also a special way to select farmers for the solidarity groups. A broad segment of farmers are offered training at Farmer Field Schools. NWBP is focusing on those with a genuine interest and tries to encourage these farmers to join the solidarity groups. They are empowered through free extension service in the solidarity groups.

**Buying of seeds from the farmers**

**D1:** The price will be determined according to the market price of seeds. In 2007 this price was 2 US$/kg (extremely high!) according to Mr. Chungu. Mr. Chungu mentioned also 250 Kwacha/kg (very low!) and an intern price of 50 US$/ton (extremely low, similar to 0,05 US$/kg) in 2005.

**MI:** Members of the outgrower scheme are obliged to sell their seeds to Marli Inv. To promote growing jatropha, the company allows the outgrowers to give away seeds to their neighbors, family and friends. A goal is to secure a market related price. Just now, the price given to the farmers is 400 Kwacha/kg (0,60 nkr or 0,10 US$). The current world price of oil determines the

price of the seeds. Marli Inv operates with a profit margin for the company somewhere between 30 and 40 % of the pump price on diesel. The kg-price of the seeds is then determined by counting and subtracting backwards.

**SBP/NWBP:** SBP/NWBP offers the farmers a minimum prize. This prize will increase if the prize on seeds or oil is going up. But it will never be lower than the minimum prize. In 2007 the price to the farmer was between 400 and 1000 Kwacha. With this, the companies offer a secure market for the product with guaranteed minimum prices, which was a major problem for Jatropha (and other products propagated by NGOs) before.

**Other beneficiaries than the individuals**

**D1:** Incentives are given to cooperatives and groups in terms of field days where t-shirts, caps and meals are given for free. D1 will also subsidize traditional sermons, lamps and stoves which are modernized for jatropha oil. Finally they encourage inter cropping on the jatropha fields to give some income during the first year and prepare some agreements with potential buyers.

**MI:** As mentioned above, 5% of the company's profit goes to the outgrower's community.

**SBP/NWBP:** NWBP offers free Farmers Field Schools. The duration of the courses is not known. Free extension service is offered to the BioPartners.

**Potential for improvements**

**D1:** From the farmer's point of view the statement should be "*So far, so good*". It is still very early in the process. One year after planting, the expected harvest is 0, 7 kg/ shrub. This will increase to 1,7 and 3 kg/shrub the following two years. A jatropha hedge with 0, 25 m spacing can produce 0,7 kg of seeds pr meter.

The market for oil and j products must be extended and improved.

From D1's point of view one of the challenges is that variations in oil quality from different varieties can occur. There is a need for future research in this area. Possibilities for tracking seeds by identifying their 'fingerprints' have to be developed.

**MI:** It is still very early in the process and difficult to do any evaluation. One experience is related to the (lack of) cooperation with governmental institutions. The Ministry of Energy was given the responsibility to make the legal framework related to jatropha. It seems like MACO

lost prestige in this determination and now, somehow try to slow down and disturb the further process. "*You can make them listen, but nothing will be implemented and you very seldom get any feedback" (H.Grobler)*

**SBP/NWBP:** From the farmer's point of view: More knowledge about growing is desired and needed. Improvement of the incentives should be implemented in form of input like tools and pesticides against termites. From SBP's/NWBP's point of view, the market for oil and jatropha products must be extended, strengthened and improved. Will the use of own extracted oil for lighting or cooking be a signal to the community that you cannot afford paraffin? If so, this is negative, because it can lower the jatropha oil user's status in the society. How can we raise the jatropha oils' status and make it trendy to use it? Or even better: Find purposes which requires larger amounts of oil and is not so easily substituted by other energy sources. An improved technique for processing has to be developed. It is still a potential to improve the linkage between the company and the farmers.

**Logistics and transportation costs**

**D1:** D1 will organize and pay the transport from certain collection points to their refinery. From the farm to the collection point it is the farmer's responsibility to organize and carry the costs of transport. The collection points are established every 10 km.

**MI:** Marli Investments will organize and pay the transport from certain collection points/sales centers to the refinery in Kabwe. From the farm to the nearest collection point it is the farmer's responsibility to organize and carry the costs of transport. The collection points are established within a radius of 8 km from each outgrower. About 50 outgrowers are located within each circle.

**SBP/NWBP:** Like D1, SBP/NWBP has established collection centers with storage facilities. The farmers are given polyethylene bags for transportation of the seeds to the collection centers. The transport from the farm to the collection center is carried by the farmer. The remaining transport costs will be covered by SBP.

**Extracted amount of seeds**

**D1:** D1 operates with three different phases and is still in phase one which is called the

*Agronomy Phase.* The main focus in this phase is to establish nurseries and plantations. Most of the seeds D1 buys from the farmers will be planted and not extracted in this period. 140 tons of seeds were bought in 2007. 40 tons were extracted and 100 tons planted. D1 is 'vacuuming' the market and buy everything what they can get of seeds. During 2008, D1 will move into the next phase which is called the *Refining Phase.* The majority of machinery will be in place during January 2008. The extracting capacity is therefore limited right now.

**MI:** In 2006 and 2007 no seeds were extracted. All produced seeds were redistributed for planting. The goal for 2008 is to extract 250.000 liter oil. This will increase to 960.000 in 2009. Because the plantations reach maturity and even more jatropha will be planted, the rate of growth in production is estimated to be about 100-200% annually. This requires a number of 50.000 ha planted every year.

**SBP/NBP:** So far, the seeds are extracted in the NW Province in the Zambesi district.
1000 kg's was extracted in 2007. The goal for 2008 is to extract 10.000 kg, with facilities to be added in Solwezi and Choma.

**In general**

***D1:*** *'Jatropha is a crop for lazy people. Even simple management will give a yield of 5 ton/ha* (statement from Chungu, 2007).

Harvesting is in the rainy season, similar to crops and that is a bit tricky. Maybe this could be delayed by breeding?

D1 is planning to do mechanized harvesting. It will be necessary to increase the spacing and Mr. Chungu's suggestion is 2x3 m to get access with a tractor.

**MI:** Marli Investment is an independent Zambian company. The head office is located in Kabwe, 140 km north of Lusaka. Mr. Grobler is emphasizing that it is not a branch of any Indian or South African business, which is a rumor sometimes heard in the jatropha surroundings.
The owners are two Zambians, two South Africans and one Indian.

**SBP/NWBP:** SBP/NWBP is emphasizing the importance of markets which works well. So far, jatropha is an unknown brand in the energy term. Soap and lamp oil is not enough to make any take off for jatropha. Electrification will in the close future reduce the need for lamp oil even

more. The first choice in cooking in the rural areas is firewood because it is free and still relatively easy to collect. Bio fuel is probably the solution for larger scale production. Hammer mills, tractors, generators and vehicles in the rural areas can be run on plant oil. Fuel is expensive there because of the transport. Since there is an increasing demand and because the volume is big, this can speed up the market for biofuel.

*"'Jatropha is a crop for lazy people….."* (G. Chungu, 2007).

## 3.7 Interview with Agri Business Forum (ABF)/Felix Chizhuka

ABF is a Zambian NGO funded by USAID and Norges Vel (Royal Norwegian Society for Development). They are localized in Kabulonga, 3 km east of Lusaka. ABF was established in 1998 with the purpose of meeting the interests of both private sector companies and farmer producer associations. ABF's mission statement is *to facilitate the development and application of innovative approaches to contract farming for profitable smallholder farm production and agribusiness development.* The farmers mentioned, are mostly directly or indirectly linked to outgrowing. ABF is in this way the neutral third party, helping the private companies to formulate contracts and ensuring that the farmers understand the contract properly before they sign. ABF also works to identify the outgrowers and bring them together. A term they sometime use about themselves is *"the outgrowers voice"*. So far, of commercial companies involved in biofuel, it is only Southern and Northwestern Biopower which are members of ABF. D1 is listed and Marli Investments will be listed, which means that they are invited and welcome to participate in meetings arranged by ABF. ABF offer private companies, NGO's and individuals membership. So far, they have 20 members. These are again linked to more than 150.000 smallholder farmers/outgrowers.

ABF suggest group contracts rather than individual contracts between private companies and farmers. It is easier to pursue a group than individuals. A group consists of about 25 farmers geographically clustered. The manager, or the board of the group, take responsibility and signs the contract on behalf of the individuals in the group. The group approach is lowering the

transaction costs in the contract signing process. Another benefit is that through this extension model, the contract will be discussed in the group and among the farmers before signing. Through this process they will improve their general understanding of the terms in the contract and the chance for contract failure is reduced. This is ABF's main task. In addition they use their existing web to create a forum for private and public sector involved in contract farming. This is a foundation for better communication between their partners. Another task is to create linkages for members to financial and business development service providers and to improve the access to the agricultural market. ABF has a control mechanism as well; they gather information about their members, verify this by visits and make a profile about the specific company. More information to flow openly improves the transparency and should make the involved companies more trustworthy for the farmers and the general society as well.

Figure 30: Promoter's representant meets the village board

# 4 DISCUSSION

## 4.1 Time use

When the farmers are asked about their time use in different operation, the answers vary to a large degree. To cross check, the questions sometimes were asked in two different ways. In the first question the farmers were asked to estimate the used time for the whole process, like for instance transplanting. In the follow up question they were asked to estimate the time used per plant in the same operation. The follow up answers are probably under-estimated because the necessary movements linked to the specific operation and idle time easily will be forgotten. Cross checking is sometimes a discouraging affair; in a certain case the farmer was asked to estimate his time for taking cuttings. All together 16 hrs were needed for taking 2400 cuttings. By dividing consumed time by the number of cuttings, the needed time pr cutting is approximately 29 seconds. When he was asked how much time he needed pr cutting, he answered 10 to 15 minutes. Another example is Evaristo in Kabwe who estimated time for weeding to 180 man hours, translated to 4320s/10 plants. When he was asked to estimate the time for weeding a circle with the plant in the centre, he suggested 600s/10 plants. An even worse case is Christopher in Kabwe where the variation of time needed for weeding is estimated to respectively 11660 s/10 plants and 600 s/10 plants. The variation is not systematic, but goes in both directions when the total consumed time is compared with the estimated time pr plant. This can be understood as there is a lot of idle time when the work is done. All logistic is included in the total estimate as well as breaks and interruptions. Still the variation is huge.

### 4.1.1 Past or present

For some farmers, time has passed since they performed the operations. To remember exactly the consumed time is even more difficult when we remember that this so far has been an onetime event for the farmers. It is probably easier to get precise answers concerning regular activities linked to the annual crops.

### 4.1.2 Skills and experience

Most farmers get help from their children when they come from school. The schools break at 12:00. As soon as the kids are home they join the work. But are the kids very helpful? In some cases it seems that the work is slowed down when the kids join. This is very visible in the Chilimanyame area in Petauke where the farmers just had received seeds from CFU and were on their way to plant hedges. CFU suggests furrows instead of planting basins for hedges with a spacing of 33 cm. This will give 33 plants per 10 meters. The performance of one male was 65 s/10plants. When husband and wife worked together this performance went down to between 160 and 200 s/10 plants. When kids joined the work the performance decreased to between 260 and 460 s/10 plants. It depends of course on the kid's age. Work is a school where the parents are the teachers and often assisting of kids is at the expenses of own work. Many farm activities are parallel. Some farmers are doing the work on their jatropha fields or hedges in between other tasks and vice versa. This fragmentation of time makes it difficult to estimate the consumed time. The degree of experience and skills will have influence on their answers and estimates. The physical condition of the worker has a great influence as well; a farmer said that if he did the weeding in the morning, he would spend about 1 ½ min per plant. At the end of the day, he would become very tired and the time per plant would increase up to 5 minutes, he told us.

### 4.1.3 Soil

In addition to the farmers' skills and work capacity, the type of soil will have an influence on used time. The treatment of the soil also counts. Rocky soil and heavy soil with a high content of clay requires more input than lighter soils. In some cases preparation of soil also contains clearing of land. Removing of trees and shrubs can take the same amount of time as the process of digging planting basins, adding manure and light covering with soil.

### 4.1.4 Pruning

The first pruning is easily done by just cutting the top of the plant. If this is successful, the growth of new side branches will be stimulated. The shrub will develop more branches which again have to be cut in the second pruning. The secondary branches are cut in the third pruning

and so on. The increase of work from one year to another is closer exponential than a linear function. Jatropha is normally pruned four to five times.

### 4.1.5 Cuttings

Cuttings are mostly used for fencing with the purpose of demarcation or as protective hedges. In Katete, many of the farmers had 10 years old hedges. During the last months they had closed gaps in the hedge by filling in with cuttings. These cuttings are normally thick as an arm and about 80 cm. Because the distance between the gaps are very different, it is difficult to calculate time use for this operation.

### 4.1.6 Weeding

Weeding early in the season is much easier than weeding later when the rooting system of the weed has grown deeper. Weeding can also be done when the seedlings still are in the sleeves. It is obvious that this will be easier and faster when the seedlings are transplanted to the field. Time consume for weeding seedlings in sleeves was triangulated. Time was measured, without the women knowing, to 9,5 sec pr sleeve on an average. SBP's farm manager said that 23 women during one day (8hrs) are able to weed 20 beds with 2600 sleeves in each bed. The estimated time for weeding in this way will be 12,7 sec/plant. This seems to be reasonable because the measured time was effective time without breaks to drink water, chat, nurse the baby or receive instructions from the team leader. Mechanical weeding should be considered in larger fields of jatropha. It is important to remember that the tractor is space-requiring when considering the spacing between the plants. A tractor will weed about 1 ha in 3 hrs. Weeding is under normal circumstances required twice a year.

### 4.1.8 Establishment and planting

A variety of methods can be selected when a jatropha field shall be established. The different options are listed below:

-Cuttings.

-Sow in seedbeds and transplant the seedlings directly to the field.

-Sow in seedbeds and transplant the seedlings into plastic bags before planting in the field.

-Sow in plastic sleeves and transplant to the field. In general this seems to give a lower rate of germination. SBP's nursery in Choma operates with a rate of germination estimated to maximum 70%, which is low. One explanation is that it is difficult to control the right amount of water and that the rooting system of the seedlings drown and rotten because of too much water. High humidity will create a good environment for fungi diseases as well. Irrigation should be limited to maximum twice a day in the dry period and avoided in the rainy season. Sleeves which are not open or perforated in the bottom should be avoided for jatropha seedlings because it causes water logging in some cases. Another grower raised concerns related to the quality of the seeds he planted in the sleeves. In SBP's nursery the seeds are put in three different categories; A) black seeds, B) Brown seeds and C) Grey seeds. The lighter the seed is, the older it is. Rate of germination will decrease by increasing age and is registered to be as low as about 40% for a mixture of category 'B' and 'C' seeds.

-Sow directly in the field.

-Plant the seedlings given from promoter directly in the field.

In Chongwe and Petauke, the farmers got their seeds from CFU recently. They had prepared the soil for a hedge, but still it was not planted. The time consume for planting was estimated to be three hours per 500 meters hedge. Planting includes covering of the seed with a hand hoe. Translated, this will be 8,6 min per 100 seeds.

### 4.1.9 Spraying

Spraying against termites with Confider or Monocrophos is done when an attack is visible. Cuttings can be dipped in a blend of copper and dythene before they are planted.

### 4.1.10 Harvesting

Harvesting is done when the seeds are mature. The right time is when the fruits are yellow. The seeds will reach maturity at different times on the same tree. The mature fruits will be picked. The unripe is left until the right time is there. It is an ongoing process which is not finished there and then. Only five respondents have estimated time use for harvesting. The first real harvest will come about three years after planting and give about 1 kg from each shrub. The next two years the yield will increase to about three and six kg per shrub. At this moment the tree is fully

mature. The mean value for the first harvest will be close to 370 min per 100 trees. Given in time per tree it will be close to four min per tree. The second harvest will take about seven minutes per tree (6:50) and the third harvest 10 minutes per tree. This is a big difference from 60 min per tree estimated by one field officer from CFU. Who is right?

#### 4.1.11 Peeling

To peel jatropha seeds is an operation very similar to peeling ground nuts. Data from ground nuts could be transferred to jatropha. Since MACO lacked information on this, the farmers were asked about the process. The data from peeling of ground nuts are used in the SPSS. Ground nuts are trickier to peel than jatropha, but the seeds are a bit bigger and heavier. This can outweigh the disadvantage of easiness. One farmer who harvested both jatropha and ground nuts claimed that to fill a 10 liter bucket with jatropha seeds only would take 80% of the time compared to fill it with ground nuts. The farmers are probably not aware of the huge amount of work peeling jatropha seeds from one hectare of land will require. While ground nuts give about one ton per hectare, jatropha will give six tons when the production peaks. The peeling of jatropha will probably be done in the resting period during the middle of the day and after sunset when the family is gathered.

## 4.2 Jatropha in the biofuel debate

Criticism has been raised against production of biofuel based on use of agricultural land. Some is based on realities and technologically challenges like this from Natural Resources Research: *The worst case scenario is that production of 100 units' energy biodiesel from soy requires an input of 127 unit's energy. Is this good land use?* (Patzek, Ted and Pimentel, David et. Al: 2005). Other analyses are not that pessimistic and claim that five units of gas are required to produce ten units of biodiesel from soy (Proceedings of the National Academy of Sciences: 2006). Another criticism raised against biofuel production, is the low energy outcome per hectare compared to wind or solar. The rates are respectively 20.000, 150.000 and 400.000 kWh per hectare. (Piters, B, 2008)

Others base their criticism on politics or ethics. *The purpose is not to save the planet, but rather to find new ways to confront falling profit rates on a global level. The demand for biofuel*

*exceeds the supply of agricultural products and the existing production capacity of land available for this purpose worldwide (Castro 2007).*

*Cars, not people, will claim most of the increase in grain production this year. The amount of grain required to feed one person throughout a whole year is similar to the amount needed to fill the tank of a SUV.* (Brown, 2006). From a market mechanism point of view, the general rule is that an increasing demand leads to higher prices. If energy crops are grown at the cost of food crops for own consumption as well as for sale, less accessability to food will increase the food prices. (Rosen and Shapouri , 2008). A study from the World Bank shows that from 2005 to 2007, the price of maize increased by 80 percent and is still rising. The wheat price rose by 70 percent and the milk powder by 90 percent in the same period. The study explains that in developing countries, people in general will suffer because of higher food prices because they are net consumers of food. If the price of all staples increase by 10 percent, this will raise poverty by 0,6 percent in rural areas and 0,5 percent in urban areas in Zambia. (Ivanic M, Martin W: 2008). According UN Secretary-General Ban Ki-moon the reasons for increasing global food prices are many and complicated. "*Rising oil prices, growing global demand, bad trade policies, bad weather, panic buying and speculation, the new craze of biofuel derived from food products ……. In Kenya's Rift Valley, the bread basket of East Africa, farmers are planting only a third of what they did last year. Why, when you would think higher prices would prompt them to plant more? Because they cannot afford fertilizer, which is also skyrocketing in price".* (http://www.un.org/News/Press/docs/2008/sgsm11541.doc.htm).

Meijerink G (2006) claims that growing energy crops is only sustainable from a "people point of view" when it replaces (a) cash crops (b) with a lower profit and (c) which are not used as food for the developing countries. This is a good approach. But one should bear in mind that jatropha planted as a hedge or demarcation will not replace any food crop and at the same time give seeds which can be used in the household to reduce costs as well as generate income. In addition to this, the CBA show that jatropha gives a higher profit than cash crops like tobacco and cotton (The Zambian Paprika Case Study 2005). In Zambia, jatropha will not be planted on soil for food production because there is abundance of land. But labour is scarce and if the time

use cannot be reduced in harvesting and peeling of jatropha, the food production somehow may suffer.

## 4.3 Gender and jatropha

A “male” crop is a crop which can be brought to the market or sold to a promoter and changed for cash. Some crops have got the label “female crops”. Typical for those are that they can be directly useful for the household. Food crops for own consumption is an example. Jatropha can be directly useful if the oil extracted from the seeds can be a substitute for paraffin and the press cake replaces fertilizer. In this perspective, jatropha can develop to be one of those female crops. Now, surplus of seeds or oil can be sold at a good price and add income to a household. This can be useful to strengthen the women’s position in the society and within the household as well. While male household heads often vast money on alcohol, women, tobacco or luxury goods which are not beneficial for the household, female household heads and women have a different priority and tend to save money, buy food, medicines, pay school fees and school materials . Poverty will put households in a desperate situation. Especially female households are vulnerable. In very many cases this leads to transactional sex. Bie, S (2008) explains this as *“an economic coping mechanism practiced by women in order to raise essential resources for her family”.* This represents a risk for HIV infections in addition to reduce the woman’s dignity and self esteem.

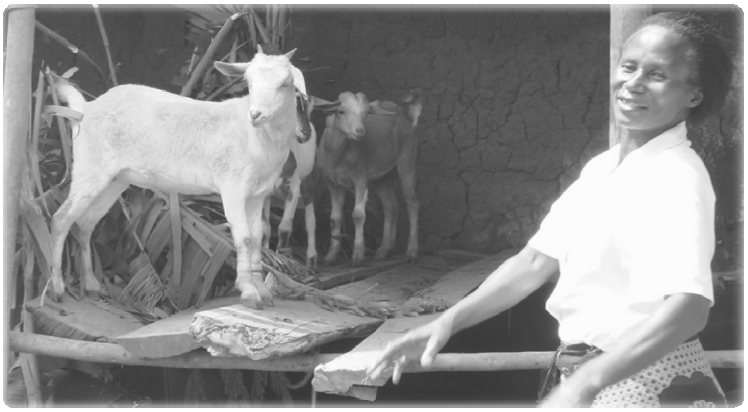

Figure 31: A female farmer and her goats

# 5. RECOMMENDATIONS

## 5.1 To the farmers

The most important advice to the farmers is probably not to grow jatropha at the cost of food crops for own consumption. Do it at the expenses of another cash crop. Use idle land or land with marginal soil. Consider your available time as well. Jatropha growing fits for a large part well into most activity calendars so that regular food production will not suffer.

Take one step at a time and plant jatropha as a hedge or demarcation. Jatropha benefits in more ways than being a cash crop. By using cuttings instead of seeds, the canopy and rooting system will develop faster. The waiting period will be reduced and the trees probably more resistant to attack of termites and diseases. When planted in the field, make sure that the spacing will allow mechanized weeding, harvesting and other treatments. 3 by 3 meters is sufficient and make intercropping possible between the trees. Jatropha is not a crop for lazy farmers. In addition to weeding and pruning, harvesting and peeling is estimated to take 45 minutes per kg of seeds. When the production peaks, one tree will give about six kg of seeds and require 4,5 hours of work to harvest and peel. Some of the promoters have incentives for farmers who are willing to grow 1000 trees on one hectare. This amount can be translated to 1,5 person years of work. Who will assist you in harvesting and peeling the farm's six tons of seeds?

To establish a Jatropha field of some size has to be considered as a long term investment. The first income will not come before two or three years after planting seeds. Even if it is a perennial plant, there will be need for labor and finances for weeding, pruning, spraying and harvesting annually. Is the seed price high enough to cover your costs?

The lowest price to cover the costs (break even price) is estimated to be ZMK 480 per kg. To give the same profitability as maize, the price should be about ZKW 700 per kg.

Before entering any outgrower scheme and signing any contract, discuss the terms in the contract with the village board or other farmers in the village. Arrange an open village meeting with the promoter and a neutral third party, e.g. the extension officer or a staff from ZNFU. Discuss the terms and make sure that all aspects are clear before you agree and sign. Individual

signing should be avoided. Select a representative from the village who can sign on the behalf of the farmers who join the outgrower scheme.

## 5.2 To the promoters

The farmers who are invited to join an outgrower scheme have to be followed up and visited frequently. The linkage has to be improved by regular information, dialogue, guiding and assistance. The field officers have to be aware of this responsibility and that they are the promoter's face towards the farmers. To invest in relationship is necessary to keep the farmers in the outgrower scheme, being faithful to the contract and avoid side selling. Ethics in business is expected in the rural areas as well as in the urban ones. The farmers expect that the promoters give them correct and true information and that the company follow up what it promises. If the promoter does not stand by an agreement, it cannot expect that the farmers will do it. To avoid misunderstandings and confusion, the content of the contract must be clear to the farmers. Contracts should be written in the local language. Good contracts are judicially valid and without irregularities. A neutral, third part should join when the promoter presents the contract to the farmers for example agricultural extension officers or staff from ABF or ZNFU. This presentation should be done in a village meeting. Before any signing of the contract, the terms should be discussed and completely understood by everyone. Individual contracts should be avoided. Good incentives will motivate the farmers, keep them in the program and prevent side selling. Individual incentives like loans, seeds and input are necessary, but should be extended to common goods in the society like provision of improved health care, education and equipment. Developing a market for jatropha products is another task for the promoters. This can be done by returning extracted oil and press cake in change for seeds. At an early stage, this is probably better than encouraging local pressing of seeds.

## 5.3 Need for further research

Time use

More accurate data are needed to develop a more accurate cost benefit analysis. The estimate of time use should be assessed on a sample of farmers by measuring the time when the

activities take place. Triangulation would eliminate the insecurity linked to time use estimates based on what the farmers remember from scarce experiences. This is time demanding research because it will take place during the entire year. A large sample is needed because the farmers' ability and efficiency fluctuate both individually and during the day.

Production system

Alternative systems for growing jatropha should be investigated. The starting point and basis for this thesis, is pure jatropha planting. Research should be done where Intercropping is considered as an alternative. Inter cropping is on some occasions practiced with jatropha and e.g. maize, ground nuts or other crops. The benefits would be increased income during the waiting period and improved weeding results. This method combines harvesting crops with the weeding as an integrated method. The target should be to study what kind of influence this will have on the yields and the total demand for labor. How much time can e.g. be saved on weeding when plant 'x' is intercropped with jatropha? The benefits can be residual because the jatropha canopy will reduce the growth of weeds. Later, the harvesting of plant 'x' can be combined with the weeding in the intercropped field. What kind of spacing should be used and what kind of plants fits with jatropha are questions to be answered.

Improved manual methods

Harvesting and peeling take a lot of time. Labor is scarce in the rural areas and the high infection rates of HIV/AIDS is making the support of labor even more difficult.
Because the harvesting and peeling are bottlenecks in the production, improved methods and practices for manual labor have to be developed. More efficient harvesting and peeling are required if growing jatropha shall succeed completely in Zambia. There are different opinions about the importance of pruning after six years when the production peaks. Tests should be done to see how different models of pruning affect the yields.

Developing mechanical methods

Machinery has to be developed for harvesting and peeling in medium- and large scale production of jatropha. This task should not be difficult by using and modifying existing

technology for harvesting fruits or berries.

Calculations of costs for renting such machines should be done to find out whether small scale growers of jatropha can benefit from mechanization or not.

Developing local markets for jatropha products

Jatropha can generate income and make some more wheels spin in a local society. Access to a press where the farmers could take their seeds can help the households to save a good portions of money as they use oil and press cake as substitutes for fertilizer and kerosene. They can sell their surplus of oil as well at a good price. Because of the great variety of products and the easy ways to refine them through the value chain there are good possibilities for local entrepreneurs. Essential and absolutely necessary in a market model, is a press where the oil can be extracted. Due to lack of finances among small scale farmers, equipment for pressing the seeds and extracting oil should be owned by a group of farmers, a cooperative, the village or another institution. Good models for how to arrange the investment, ownership, the daily running and access for the farmers to such a press have to be developed.


Figure 32: A hammer mill can run on pure jatropha oil

# 6 CONCLUSIONS

## 6.1 Objectives and Conclusions

The overall research question was *'How will farmers benefit from the growing of jatropha?'*
This was broken down into the four following objectives:

***a) Will growing of jatropha reduce the costs and increase the household income?***

Objective 'a' was investigated by estimating the farmer's annual costs in areas where products from the jatropha value chain can serve as substitutes. This is mainly jatropha oil as a substitute for kerosene, candles or diesel. The press cake from jatropha is a powerful manure and can replace fertilizer. On an average, a small scale farmer's household spends KWA 160.000 per year on lighting, which represents about 10% of the household income from farm activities. This is equivalent with about 20 liters of paraffin per year. About 70 kg of seeds from ten single trees or 150 meters of jatropha hedge can supply the farmers with this amount of oil. The remaining 50 kg of waste, press cake, is rich on nutrients and equivalent with about 10 kg of NPK fertilizer. If the farmer has access to a simple press, the surplus of oil can be sold as lamp oil or fuel for hammer mills, local generators or diesel vehicles. The conclusion of this objective is that jatropha can reduce the costs and increase the household income.

***b) Will growing jatropha have any influence on the household's food production and food security?***

There is an abundance of idle land in Zambia. The farmers don't need to reduce their fields for traditional food-or cash crops. The activity calendar shows that most of the jatropha activities can be done in the more relaxed periods. Jatropha has no negative influence on food production in terms of land use and only a slight influence in terms of labor. Income from sale of jatropha seeds or oil can strengthen food security in the starving period. Saved costs by using jatropha oil as a substitute for paraffin or diesel can strengthen the household's physical and financial assets. Because of very limited amount of land used for jatropha or because a very short time has passed by since the interviewees received seeds, very few changes were observed.

***c) Would engagement in jatropha production translate in a better income than current activities?***

The farm interviews emphasized to quantify time used at the different stages of jatropha production. This was done to prepare the foundation of cost benefit analysis for jatropha growing. The cost benefit analysis is based on labor costs KWA 5000 per day and yields estimated to be zero in year one and two. The yields will increase to one ton per Ha the following year, then to three tons in year number four. Finally it will stabilize on six tons per Ha per year. Break-even price is about ZKW 480 per kg when the production peaks. This is the needed price to cover total variable costs. ZKW 750 per kg will give GM return on variable cost 52% which is better than most of the current productions. If the price is increased to ZKW 1000 per kg, the GM return on variable cost will go up to 110%. About 3,5 kg of jatropha seeds are needed to give one liter of oil. In the CBA the sales price for seeds are determined to be ZKW 750 per kg. Multiplied, this will be ZKW 2600 per liter of oil which is equal to 0,8 US$. The pump price on diesel in Lusaka is about ZKW 6000 per liter (01.05.08) and still rising in pace with the global price. The difference is ZKW 3400 and should cover costs for transaction, logistics, production and profit to producer and partners. Commercial production of jatropha oil based on supply from small scale farmers is sustainable because of the high global and national oil price and high yields per hectare. The bottleneck in jatropha production is linked to the waiting period before the plant gives yield and the high time use for harvesting and peeling. In spite of this, net present value -calculations show that engagement in jatropha gives a better income throughout the life span than current activities like cotton and tobacco. An even higher profit would be the outcome if the bottleneck were overcome.

***d) Is there a significant difference in livelihood between growers and non-growers of jatropha?***

Because jatropha recently is introduced by the different promoters and CFU, harvesting and trading of seeds are still sporadic and scattered. Most seeds have up to now been thrown away or redistributed. So far, it is not possible to answer objective ‘d’.

# 7. APPENDICES

GUIDELINES/QUESTIONNAIRE FOR GROWERS AND NON- GROWERS OF JATROPHA

1. Name of household head
2. Sex of household head 1=Male 2=Female
3. Age of household head
4. Education level of household head
5. Household size
6. Member of Farmers Union/Cooperation, specify 1=None 2=Cooperative 3=CFU 4=Others
7. Size of land in production in ha.
8. Land Rights 1=Title land 2=Customary/Traditional 3=Rented land
9. Estimate your MONTHLY costs for lighting (paraffin, candles, diesel)
10. Estimate the ANNUAL income from sale of farm activities in the household from the major crops.
11. Annual Income from Livestock.
12. Annual Income from other activities (business, piecework)
13. What are your three main crops and how many bags do they give annualy? 1=Maize 2=Beans 3=Gnuts 4=SweetPot 5=Tobacco 6=Cowpeas 7=Cotton 8=Sorghum/Millet 9=Vegetables 10=Others
14. Are you growing jatropha?
    If Yes: Who owns the project? 0=Not growing 1=Male 2 =Female
15. For how long have you been growing jatropha?
16. Who did supply you with seeds?
    1=Own 2=CFU 3=D1 4=South/NW.Biop. 5=Marli Inv. 6=Stancom 7=Others
17. How many kg did you harvest in 2006?
18. At which price per kg?
19. To whom did you sell your produce?
20. Estimate the ANNUAL income from jatropha?
21. Meters of hedge?
22. Size of land with jatropha planting?
23. How can you benefit from the jatropha plants? 0=Don't know 1=Protective hedge 2=Manure 3=Seeds own use 4=Seeds sale 5=Oil own use 6=Oil sale 7=Others
24. Who takes part in the work? 1=Only Family (men / women / children ?)
    2=Family+ hired labor 3=Only hired labor
25. Have your production of food crops changed after you started jatropha growing;
    0=No 1=Yes

26. How many ha of staple food crops did you grow before / after?
27. How many ha of tree crops did you grow before / after?

    Other observations: ……
28. Is there any change in your livestock size after you started jatropha growing?
29. Have your farming methods (input) changed after you started jatropha growing?
30. Estimate the required time annually for jatropha growing in person days.

    1=Prep seedbeds 2=Sow/Nurse seedbeds 3=Transplant 4=Prep soil and sow in field

    5=Take/prep cuttings 6=Weeding 7=Space/Uproot 8=Pruning 9=Spraying 10=Irrigating 11=Mulching

    12=Harvesting 13=Peeling
31. Do you have a contract for Jatropha farming? 0=No 1=Yes 2=Yes, but got no copy of it
32. With whom? 1=D1 2=South/NW.Biop. 3=Marli Inv. 4=Stancom 5=Others
33. For how many years?
34. Type of contract? 1=Individual 2=Group contract signed by….on behalf of the group
35. Do you think that this is a fair contract? 0=No 1=Yes
36. What should be improved? Comments……

    IF NOT Growing Jatropha:
37. Why do you not grow jatropha? 1=Not aware 2=Lack seeds 3=Lack skills and information

    4=No market 5=Others
38. What incentives do you expect for starting growing of jatropha? 1=Information 2=Market 3=Seeds

    4=Good price 5=See examples that it works 6=Others
39. How can you benefit from growing of jatropha? 1=Additional income 2=Protective hedge

    3=Demarcation 4=Sale of seeds 5=Easy to maintain 6=Windbreaker 7=Others
40. Are you familiar with the outgrower/contract farming-term?
41. Has the promoter introduced the contract for you? 0=No 1=Yes
42. What kind of expectations do you have to the promoter if you join the program?

    1=Supply of (improved) seeds (maize, g-nuts, cassava, etc) 2=Supply of implementations/tools

    3=Guiding and information 4=Follow up and feedback 5=Assistance 6=Market access
43. Are you willing to cooperate with the promoter or sign a contract? 0=No 1=Yes 3=Don't know
44. What do you think is a reasonable contract period?
45. Do you have any doubts or worries about jatropha? Explain.
46. Are you willing to grow jatropha even if your food production will suffer? (in terms of land and labor)

## QUESTIONNAIRE: D1 OILS – SUN BIOFUELS – MARLI INVESTMENTS

1. How many farmers do you have in your portfolio?
2. What is the smallest farm size in your portfolio?
3. How long is the contract period?
4. What is the consequence if a farmer withdraws from the contract?
5. Do you prefer oil or seeds from the farmers?
6. How is the price you offer the farmers determined? (Are the price fixed?)
7. Which price do you offer for seeds and/or oil
8. How will global price fluctuations influence on this?
9. What are you offering the farmers in addition to sale of seeds/oil?
10. Do you offer public goods to societies in addition to the individual?
11. What are your expectations from the farmers?
12. Are the farmers satisfied so far?
13. Where is the potential for improvements:

    -From D1's perspective

    -From the farmers perspective
14. How do you cooperate with farmers unions or the governmental extension service?
15. What incentives do you give farmers to improve their yields and performance?
16. What methods are in use among your farmers who grow jatropha? (Live fence/fields)
17. Explain the logistic from farm to refinery/place of processing.
18. Who carries the costs caused by transport?
19. How many liters of oil did you process in 2006?
20. What's the estimate for 2007 and the expected growth rate for the next years?
21. Contacts for further investigation

## QUESTIONNAIRE: Ministry of Agriculture

1. What are the task/purpose and the mission statement of MA?
2. Explain the organizational structure of the governmental extension service.
3. What are MA's vision for jatropha and biofuel in Zambia?
4. What is your recommended policy to obtain this vision?
5. What kind of policy is needed to create a win-win situation for both farmers and traders of jatropha oil?
6. What is your view on contract growing of jatropha?
7. Is contract growing sustainable in the long run?
8. What areas in regulations and legal framework have to be strengthened?
9. What is your advice to farmers who consider to debutante on the jatropha stage?
10. Is poverty considered as an issue in the rural areas?
11. Can you identify the vulnerable groups?
12. Can growing of jatropha improve these groups' livelihoods and food security?

# ADRESSES IN ZAMBIA

| Org. | Name | Phone | E-mail | Comments |
|---|---|---|---|---|
| CFU | Office<br>Peter Aagaard<br>Collins Nkatiko<br>Raphael<br><br>Tembo Frazier<br>Yvonne Nakachina-<br>Steven Nshimbi | 01265455<br><br>0977793999<br>0977153385/<br>0966753354<br>0979527863<br>0977664720<br>0977148598 | <br>paagaard@zamnet.zm<br><br><br><br>temfra@zamnet.zm | <br><br>½ way to Livingst. Farm visit<br><br><br>Field Supervisor Mumbwa<br>Regional Manager Mumbwa<br>Field Supervisor Mumbwa |
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