JATROPHA
(Jatropha curcas L.)
A PRODUCTION MANUAL
FOR ZIMBABWE

Danisile Hikwa and Busiso Mavankeni
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CHAPTER 1: INTRODUCTION

Global interest in renewable energy plants that have potential to produce oil and ethanol for biofuel has increased in the last few decades. There is pressure to reduce global warming caused by greenhouse gas emissions from burning fossil fuels; reduce the potential impact of declining oil reserves and minimize oil import bills and total dependence on external energy supplies by various countries.

Among trees and shrubs in Southern Africa, potential biofuel crops include Jatropha (Jatropha curcas L.), Pongamia (Pongamia pinnata), Moringa tree (Moringa olifera) and Castor plant (Ricinus communis L.). Annual crops that could be grown as feedstock for biodiesel production in southern Africa include sunflower (Helianthus annuus L.), soybean (Glycine max L.), groundnut (Arachis hypogaea L.) and cotton (Gossypium hirsutum L.). However, the annual plants are food crops and therefore, can only be used for biodiesel if grown in excess of food and nutrition requirements.

*Jatropha curcas L.*, generally known as Jatropha, is a perennial, deciduous, sub-tropical shrub or a small tree that belongs to the Euphorbiaceae family. Its centre of origin is believed to be Mexico and Central America. However, the current distribution shows that Jatropha has been predominantly cultivated in tropical savannah and monsoon climates. Although it is well known for thriving under arid and semi-arid conditions, it can be successfully grown with mean annual rainfall above 850 mm per annum and annual temperature ranges of 19-33°C.

In the past few decades, Jatropha has drawn special attention from plant scientists, farmers, environmentalists, industrialists, policy makers and investors worldwide. The attention emanated from the fact that Jatropha could be used to generate biodiesel, oil and other valuable products. Given the change in climate being currently experienced, exacerbated by greenhouse gas (GHG) emissions from fossil fuels, biofuel from Jatropha has been viewed as one of the
alternatives to fossil fuels. If produced in large amounts, Jatropha could mitigate the impacts of climate change through reductive consumption of fossil fuels. Furthermore, Jatropha could be grown in areas where production of other crops is limited by abiotic factors such as low rainfall. For the latter reason, it is viewed as a crop that would present less competition to food crop production and therefore, to food security. Apart from bio-diesel, other identified benefits of Jatropha include its medicinal properties, use of its oil in making bath and laundry soap and other cosmetics, lighting oil and polish among many products. Many countries started considering Jatropha in their development agendas, with countries such as India and China including it in bioenergy projects in the last few decades.

In the past 15 years or so, the Government of Zimbabwe identified Jatropha as a potential source of renewable energy worth investing in. A 2007 Cabinet white paper on Principles for Bio-fuels Development and Use articulated the country’s intention to pursue bio-fuels development by growing Jatropha curcas and processing its seed into bio-diesel for blending with fossil diesel. That culminated in the development of a National Biodiesel strategy with the goal of producing at least 10% of Zimbabwe’s diesel requirement. The Jatropha plant was selected as a source of feedstock because of its low production input requirements and a reasonable average oil yield of about 30-35%. The implementation plan envisaged 126 000 ha being under Jatropha production in both smallholder and commercial sectors within a period of 5 years from implementation. Two Jatropha processing plants were commissioned, one in Mt Hampden (with a capacity of 60 000 L/day) on the outskirts of Harare and another in Mutoko (with a capacity of 10 000 L/day), to kick start bio-diesel production from Jatropha. Energy is a key enabler to productivity and socio-economic development, particularly for the implementation of the economic blue print ZIMASSET, which requires a sufficient supply of energy to succeed. Fossil fuels are imported into the country, requiring costly logistical arrangements that result in high cost of the landed fuels. Therefore, the role of plants such as Jatropha needed to be considered in the economic development of Zimbabwe. However, on its own, Jatropha may not generate enough feedstock
for national bio-diesel production. Therefore, it may be economically prudent to consider its contribution to renewable energy in a basket of other complementary oilseed crops in order to increase feedstock availability.

The National Energy Policy of 2012 highlights the need to support and encourage research and development in renewable energy sources, including bio-fuels. However, absence of investment in Jatropha breeding (unlike countries such as India and China that have invested in such research) means that there are no locally improved/selected certified Jatropha varieties. As a result, current yields obtained from available Jatropha germplasm provide insufficient feedstock for commercial Jatropha biodiesel production.

This manual seeks to address some of the challenges by giving a detailed description of the recommended agronomic and other management practices for commercial production of Jatropha. In conjunction with the same project that produced this manual, a parallel activity was undertaken to identify Jatropha provenances as a first step towards developing improved Jatropha varieties for Zimbabwe.
CHAPTER 2: ECOLOGICAL REQUIREMENTS AND DEVELOPMENT OF THE JATROPHA PLANT

Soils

Jatropha can grow on most soils including gravelly and shallow soils, sandy and clay soils. It can thrive on poor stony soils and can even grow in rock crevices. However, the plant thrives in well drained sandy loam soils. Soil pH preferred by the plant is between 5.5 and 6.0, on the calcium chloride scale, but it can also grow in soils with a pH of up to 7.0. In commercial production, liming should be done, if pH is less than 5.0.

Rainfall

Jatropha responds well to high rainfall of 800-1000 mm per annum, but can be produced in drier regions (such as Zimbabwe’s Natural Regions III and IV) that receive rainfall ranging from about 450 mm to 650 mm. Fairly reasonable yields can also be realized when the crop is grown in low rainfall areas that receive 250-350 mm per annum, further demonstrating the plant’s elasticity.

Temperatures

Jatropha thrives well in hot areas. The optimum temperature range is 20°C to 26°C. Low temperatures at planting do delay germination and emergence of plants from seed and vegetative growth is also affected by low temperature, especially if it is coupled with low moisture availability. Very high temperatures may precipitate pollen abortion resulting in reduced yields of seed.

Elevation

The plant thrives mainly at lower elevations of 0-500 m.a.s.l. and this shows that it is fairly adapted to high temperatures. In Zimbabwe it
has been grown in the mid altitude areas of up to 1100 m.a.s.l. such as Kadoma Research Station in Natural Region II, bordering on III.

**Frost**

Young Jatropha plants are susceptible to ground frost, while mature ones can withstand light frost, but are susceptible to heavy ground frost. As a general rule, it is best to avoid frost-prone sites.

**THE DEVELOPMENT OF THE JATROPHA PLANT**

**Germination of the seeds**

The germination of the Jatropha seed takes about 10 to 14 days. The seed shell splits and the radicle emerges, with four peripheral roots formed. Soon after the development of the first leaves, the cotyledons wither and fall off.

**Flowering**

Flowering can begin during the first year in fifth month after sowing, but this is only under extremely favorable conditions. Normally, flowering follows a longer period of vegetative development. Fruit development takes about 90 days, from flowering to seed maturation. In Zimbabwe, flower formation is induced by the availability of moisture. Plants that received water flowered within four to five months after transplanting.

**Plant development**

Plant growth corresponds to availability of moisture. Information generated from the provenance trial established at Kadoma Research Station and at Chingamuka Primary School in Mudzi, confirmed the response of Jatropha plants to moisture availability. The trees at Chingamuka Primary School started fruiting seven months after transplanting. Generally, very little growth and development occurs during the dry season. Vegetative growth increases mainly during the rainy season in response to increased moisture.
CHAPTER 3: MORPHOLOGICAL CHARACTERISTICS OF JATROPHA CURCUS L.

Seed

The seed pod, a three, bi-valved cocci, contains 2-3 large seeds that are black in colour and are ovoid oblong in shape (Fig. 1). The diameter ranges from 15 to 40 mm. The seeds have a resemblance to those of the castor plant. Seeds mature when the capsule changes from green to yellow, two months after fertilization of the inflorescence.

Leaves

Jatropha has large green to pale-green leaves, alternate to sub-opposite and three-to five-lobed with a spiral phyllotaxis (Fig. 2). In winter, all the leaves fall and the shrub remains leafless as a way of conserving plant moisture.

Fruit

Fruits are produced whenever temperatures are high and in the presence of moisture. When moisture is not limiting, flowering and fruiting can occur twice within the same year. Under rain fed conditions the fruits are produced mainly during the summer cropping season.
Each inflorescence yields a bunch of approximately 10 or more ovoid fruits (Fig. 3). A three bi-valved cocci is formed after the seeds mature and the fleshy exocarp dries.

**Root formation in a jatropha plant**

The root system depends on the type of propagation method used. The roots of plants generated from seed have 4 lateral roots and a tap root (Fig. 4). Seedlings propagated from cuttings do not develop a tap root.

![Fig. 3: Fruits of a Jatropha plant](image1)

![Fig. 4: Seed-propagated root](image2)
CHAPTER 4: NURSERY MANAGEMENT AND PROPAGATION METHODS

Raising seedlings from seed in a nursery

Jatropha could be grown straight from seed, where soil moisture is not a limiting factor. However, being an oil tree crop, seeds take long to germinate and emerge and would likely require supplementary irrigation to assure successful germination. In most environments where the plant is grown, moisture is generally a limiting factor at germination and emergence. That is the reason why raising seedlings in a nursery is the best practice for a Jatropha crop.

Raising seedlings could even be done during the dry season in a garden nursery, where the plants could easily be watered. Seedlings are then transferred into the field during the rainy season, when they reach a size that minimizes seedling mortality.

Some of the advantages of raising Jatropha seedlings are as follows:

- Jatropha grows very slowly during the establishment phase and if sown directly in the field, the seedlings are most likely to be suppressed by weeds.
- To minimize problems associated with losses during germination and emergence, newly emerged seedlings of most tree species need to be closely nurtured for survival. It may not be practical to give each tiny seedling, spaced at 3 or 4 m apart in a plantation, the care needed for survival against weeds and other pests. Raising Jatropha seedlings in the nursery and transplanting them out gives the plants advantage over weeds. Generally, seedlings raised free of any competition until they are ready for transplanting, have higher survival rates in the field.
- A grower is able to provide good growing conditions for healthy vigorous plants in a nursery because the area is small and easier to manage. This allows for effective seed bed preparation, fertilization
and maintenance (including watering and weeding).
• Raising seedlings allows a grower to produce adequate planting stock for the field and minimizes the potential for a large number of gaps to be filled in the field - as is potentially the case with direct seeding.
• Nursery-raised seedlings ensure uniform growth and make it easier to replace dead seedlings in the field. Whereas, seedlings that fail to establish with direct seeding in the field have to be replaced either during the year of establishment or the following year.

**Good Nursery Practices**

In tree crop production, good nursery practices should be followed in order to produce good quality seedlings that promote good productivity in the field.

**Requirements in a Nursery:**

• The nursery should be near a reliable water source.
• A good source of potting media is necessary for use in a nursery. Examples of potting media include well drained sandy soil, nutrient rich forest soil or top soil.
• Ventilation should be good to allow for free air circulation and air exchange with the outside to aid in controlling temperature and humidity.
• The selected site must also be warm, with plenty of light and should be lightly shaded to avoid direct sunlight for more than one hour during the hottest time of the day. On the other hand, dense shade should be avoided.

**Potting media:**

Growers can use readily available potting media as indicated above. The media must:
• Retain enough moisture to lessen the frequency of watering.
• Be firm and dense to hold the cuttings or seeds in place
• Be porous enough to allow excess water to drain off, while allowing adequate water retention and aeration, and
• Be free of weed seeds, high level of toxic salts, harmful fungi, bacteria or insects.

**Seed collection from the field and storage before propagation:**

• In order to maintain genetic diversity, seed should be collected from at least 30 different trees.
• Collection should cover a broad geographical area, including environmental extremes, unless the harvest is from established source nurseries.
• Mature capsules may be collected by hand plucking and shelling should be done thereafter. Seeds can be cleaned by winnowing on small farms or by use of a blower on big plantations.
• For improved storability, seed should be stored at 12°C or lower. Where there is no refrigeration, seed can be stored at room temperature in a cool dry place.
• Seed should be mature, healthy and well dried before storage. Hessian bags (or any other well aerated bags) can be used to store the seed.
• Ideally, fresh Jatropha seed should be sown immediately after collection. One year old seed could also be used, but it may result in lower germination percentage.

**Pre-treatment of Jatropha seed**

Jatropha seeds can take up to 14 days or more to germinate. Therefore, pre-treating the seed before planting is highly recommended to speed up the germination process. Pre-treatment breaks dormancy and shortens the time taken to germination. There are various methods of pre-treatment of seed that could be used for Jatropha and such methods are highlighted below:

*Hot water treatment:*
The seed is dipped in very hot water at approximately 100°C for one minute and then taken out. This is followed by cooling and immediate planting thereafter.

**Plastic sheet method:**

The Jatropha seed could be placed in a single layer on a black plastic sheet and covered with another black plastic sheet. The seed is then placed in direct sun for two to three days.

**The moist bag method:**

This method is similar to the plastic sheet method. The seed is placed between bags (preferably, hessian) and kept moist and warm until it germinates. Using this method, germination takes place within three to four days in warm conditions or up to 10 days, in cooler conditions.

During cold weather, germination is slow and may result in seeds rotting before they germinate. If fungal growth is observed on the seed between the moist bags, use of fungicides such as Thiram or Captan is suggested. The fungicide is sprinkled lightly on the seed.

**Cold water treatment:**

Seed is soaked in cold water for 12-48 hours to soften the hard coat. Planting should follow immediately after the soaking duration.

**Cattle dung water treatment:**

Seed is soaked in a cattle dung water solution for twelve hours and then kept under a wet hessian bag for another 12 hours before sowing.

**Mechanical method:**

Jatropha seed is nicked with a sharp object such as a knife or a nail clipper, or is abraded lightly on a rough concrete floor or surface to crack the seed coat.
**Propagation**

1. Generative Production methods

Generative methods involve the use of seed.

**a) Bare root method:**

- The bare root method involves the planting of seeds in seed beds. A barrier is placed to a depth of 300 mm to restrict outward growth of the root system. For the latter, a thick plastic or iron sheet can be used as a barrier.
- In this method, the seeds are planted in furrows that are 20 mm deep and about 50 mm apart. In the row, the seeds are planted 20 mm apart.
- Seeds should be covered with a thin layer of soil and pressed down lightly. Deep sowing should be avoided. This method is used when seedlings are left in the nursery for about one to two months.

**a) The bare root method is used:**

- If containers (planting pockets) are not available;
- When cost of containers is too high;
- When seed is old or when germination rate is unknown;
- When the objective is to select seedlings of uniform size; or
- When mass production or rapid multiplication of seedlings is desired.

*Advantages of the bare root method:*

- Less soil is required;
- Seedlings are easy to transport to the field;
- Smaller holes are required for planting, meaning labour is reduced; and
- Production costs of seedlings are lower.
Disadvantages of the bare root method:

- Lifting seedlings from beds may result in some damage;
- There is competition for light, nutrients and water in the seed bed;
- To reduce mortality, seedlings need hardening before transplanting into the field.

**b) Sowing seeds in pockets/ sleeves:**

- Sowing seed in pockets or sleeves for raising seedlings is now common practice. This method ensures that there is minimum soil disturbance around the root system during transportation to the field. Establishment is also higher as there is very little transplanting shock.
- The containers should be prepared in advance. Ripe and well filled seed should be used. One to two seeds are sown in each plastic pocket at about 15 to 20 mm deep. Watering should be done regularly to avoid drying out of the soil. Heavy/ excessive watering over long periods should be avoided. Thinning to one healthy seedling per pot later is recommended.
- If seed is old, it is advisable to test it for viability before sowing. Generally, it takes between 7 and 21 days for seedlings to start emerging. In order to curb uneven and excessive growth of seedlings, the position/ direction of the pockets should be shifted at regular intervals.
- If seedlings are going to be kept in the nursery for more than three months, then bigger pockets should be used. Generally, planting pockets of about 150 mm x 250 mm for seedling growth of up to six months, and 100 mm x 200 mm for seedling growth of up to 3 months, are recommended.

**Time of establishing seedlings**

In Zimbabwe, it is advisable to establish seedlings during the month of August for transplanting during the month of November or December.
2. Vegetative propagation methods

- This method involves the use of cuttings. Cuttings are collected from selected mother plants. Cuttings of about 20-40mm thickness and 200-450mm long are most suitable.
- The longer and thicker the cutting within the measurements stipulated above, the better the establishment. Cuttings should be taken from the lower portion of a selected branch.
- In Zimbabwe cuttings are collected towards end of winter (July-August) and left out for about two weeks to lose some of the excess moisture before planting.
- Cuttings are planted in pockets to root and shoot before being transplanted out in the field. Seedlings can be left in the nursery for 3-4 months and the same pocket sizes mentioned above, can be used.

Hardening of seedlings

- As a good handling practice, seedlings need to be hardened to reduce the effects of transplanting shock and to increase post-transplant survival.
- Hardening is done by removing seedlings from partial shade into full sun, and this should be done at least one to two weeks before transplanting. However, regular watering should be maintained during this period.
- It is advisable to give heavy watering to all seedlings a day before transplanting into the field.

Seed rates

Seed rate depends on seed size and normally a rate of about 4-6 kg/ha is used. Small-sized seeds will have a lower rate, with the upper limit being for large seeds.
A total of 8 provenances were identified and collected in Zimbabwe in 2011 (Fig. 5). The provenances were from Binga, Guruve, Mudzi, Mutoko, Nyanga and Rushinga. From Mutoko and Mudzi districts two provenances each were collected to make up the total of 8. Planting of these was done and characterization is currently underway. Table 1 shows characteristics of some of the provenances.

Table 1: Selected attributes of provenances from Mudzi and Mutoko

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Mudzi</th>
<th>Mutoko</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant height, cm</td>
<td>(to be measured)</td>
<td>(to be measured)</td>
</tr>
<tr>
<td>Days to flowering</td>
<td>&gt; 7 months</td>
<td>&gt; 7 months</td>
</tr>
<tr>
<td>Days to fruiting</td>
<td>&gt; 7 months</td>
<td>&gt; 9 months</td>
</tr>
<tr>
<td>Seed yield, kg/ha/yr</td>
<td>over 700</td>
<td>over 200</td>
</tr>
</tbody>
</table>

Note that yield per annum is expected to peak by year five/six, as the plants mature and then taper off in old age (up to 30-40 years depending on tree care).
CHAPTER 5: FIELD ESTABLISHMENT AND MANAGEMENT

Land preparation

- When establishing Jatropha plantations, strip ploughing to leave grass strips between rows, can be done on the land where Jatropha seedlings are targeted for planting. There is no need to plough or rip the whole field unless a soil compaction problem is known to exist in the area.
- A hoe can then be used to dig up a hole of sufficient size in moist ground to take the seedling. The recommended size of a hole is about 300 mm x 300 mm, with a depth of 300 mm.

Transplanting

- After preparing the holes, planting is done by slipping off the pocket around the seedling, while making sure that soil disturbance is as little as possible around the root ball.
- The hole is filled with loose soil to support the seedling. The final soil level should neither be above nor below the original soil level in the pocket.
- When transplanting of the seedlings is done before the onset of the rainy season, each hole is watered with at least two litres of water at transplanting.

Direct seed sowing

Direct seeding can also be done in the field at the onset of the rains. Preferably, two seeds are sown at each planting station at a depth of 20 to 30 mm. Thinning should be done 30 days after emergence, with one healthy seedling being retained per planting station.
Cropping niches for Jatropha

Live fences or hedgerow planting:

- Jatropha can be planted in single row hedges. The following spacing between plants could be used, i.e. 200 mm, 300 mm or 500 mm. Spacing plants at 500 mm apart, resulted in rapid growth, but lower survival rate.
- A spacing of 200 mm and or 300 mm within the row under a single row hedge is recommended to ensure high survival and better soil coverage.
- Planting new seedlings alongside existing live fence lines will provide maximum protection for the young plants. Gap filling will be required where plants in the existing live fence have died or have been removed.

Plantations:

Large scale plantations may be preferably planted on marginal lands on which annual food crops cannot be produced. Plantations will have the advantage of a concentrated harvest area. Possible plant spacing are as follows:

- 2 m x 2 m for a density of 2 500 plants/ha
- 2.5 m x 2.5 m for a density of 1 600 plants/ha
- 3.0 m x 3.0 m for a density of 1 111 plants/ha

Planting more closely at 2 m x 2 m is recommended when producing Jatropha under rain fed conditions. Under irrigated production, the moisture regime gives vigorous growth resulting in higher branching. Therefore, a plant density of 1111 plants/ha (3 m x 3 m) is recommended, especially in the middleveld areas of Natural Regions IIb and III, when supplementary irrigation is availed. This guideline is based on current work at Kadoma Research Station in NR IIb.
Soil Fertility management

Response of Jatropha to organic and inorganic fertilizers:

• Jatropha responds to the application of cattle manure, Jatropha seed cake and inorganic fertilizer in the form of Compound D (7%N, 14%P₂O₅ and 7%K₂O).
• Cattle manure or the Jatropha seed cake may be applied at the rate of 5,000 kg/ha, whereas basal compound D fertilizer can be applied at the rate of 200 kg/ha, with the latter calculated for application to individual plants in a hectare. The fertilizer or cattle manure is applied at planting and mixed in the top 50 mm of the soil.
• The Jatropha seed cake is applied in the planting station and should be covered with a layer of soil of about 50 mm. However, direct contact of the seedling or seed with the Jatropha seed cake should be avoided as the cake generates much heat during the initial stages of decomposition.
• In work done in Zimbabwe, effects of organic soil amendments could still be observed in the third season after the initial application. On the other hand, inorganic fertilizer effects were only observed during the first and second seasons after transplanting of seedlings. By implication, organic fertilization is encouraged. Combinations of organic and inorganic fertilizer applications are desirable, where both are available.

Planting time

• Planting of seed or transplanting of Jatropha seedlings into the field is best done with the first effective rains, where there is no irrigation.
• Where direct planting of seed is practised, it should be done after at least 30 mm of rainfall has been received since this amount is considered enough to stimulate germination or stabilize the transplanted seedlings.
Moisture requirements

- In drier areas of Natural Regions IV and V, watering is recommended at least once a week, with an application of about 5 to 10 litres of water per plant (Fig. 6).
- In mid elevation to high potential areas, watering with 20 litres per month per plant is suggested, as long as the temperatures are not too high to cause increased evapotranspiration.
- During dry spells, watering should definitely be done, especially paying particular attention during the normal dry season of May to November of each year.

Figure 6: Watering of a young Jatropha plant at Kadoma Research Station
CHAPTER 6: CROP PROTECTION

A number of potential pests of Jatropha have been identified in Zimbabwe. However, there is need for a study to quantify the extent to which they cause damage to Jatropha. All pests of economic importance in the country are recorded by the Plant Protection Research Institute of the Department of Research and Specialist Services, in the Ministry of Agriculture, Mechanization and Irrigation Development in Zimbabwe. Currently, no pests of economic importance on Jatropha have been recorded. Nevertheless, potential pests of Jatropha are listed in the Table 2.
### Table 2: Potential Pests of Jatropha

<table>
<thead>
<tr>
<th>Pest/Disease</th>
<th>Damage caused</th>
<th>Management/treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golden flea beetle</td>
<td>Mature beetle causes small punctures on leaves, reducing the area for photosynthesis. Larvae feed on roots, thereby reducing plant vigour.</td>
<td>Can be treated with:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Chlorpyrifos,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fipronil,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Imidachloprid or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Thiamethoxam</td>
</tr>
<tr>
<td>Scales</td>
<td>Dieback of branches. Sap sucked from all plant parts where scales are found.</td>
<td>• Dimethoate could be used to control.</td>
</tr>
<tr>
<td>Mealy bugs</td>
<td>Feed on leaves and fruits, resulting in chlorosis, stunting, drying of plants, deformation and early fruit drop. They can also lead to the development of sooty moulds due to development of honeydew.</td>
<td>The following chemicals could be used:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Diazinon</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Dimethoate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Malathion</td>
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<tr>
<td>Termites</td>
<td>Jatropha plants are attacked at the base, causing damage and die back of plants.</td>
<td>Insecticides suggested include:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cypermethrin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fenveralate</td>
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<tr>
<td></td>
<td></td>
<td>• Fipronil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Chlorpyrifos</td>
</tr>
<tr>
<td>Blue green cotton bug (Fig. 7)</td>
<td>Sucks sap from the leaves</td>
<td>Dimethoate could be used to control.</td>
</tr>
<tr>
<td>Powdery mildew (Fig. 8)</td>
<td>It covers leaves and reduces leaf area, thereby affecting photosynthesis of the plant.</td>
<td>Fungicides suggested include:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Copper Oxychloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mancozeb 80 WP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Propineb 70%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Difenoconazole 10%</td>
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As a cost cutting measure, it is advisable to use pesticides only where there is a high incidence of pests. Studies are still to be done to determine pest threshold levels in Jatropha, especially for the Zimbabwean environment.

**Weed management**

It is important to keep fields of Jatropha weed-free during the seedling stage. Seedlings are susceptible to competition from weeds during early development. Thereafter, the shrub generally out-competes the weeds. In Zimbabwe, there are no herbicides registered for use in Jatropha as yet. Depending on scale and intensity of production, it may be uneconomic to use herbicides. Mechanical weed control can be used during seedling stage on small fields. In plantations, basins can be maintained around the trees and the remaining area be kept under grass and mowed or slashed throughout the season. The basins are best kept weed-free to conserve moisture and nutrients.
CHAPTER 7: JATROPHA HARVESTING AND YIELDS

Harvesting

Jatropha capsules turn green, yellow and then brown upon reaching maturity. The brown capsules should be plucked before they detach from the plant and fall to the ground. The yellow capsules will require further drying before shelling. The seed can be stored in hessian bags at 10-12% moisture content.

Seed Yield

Jatropha starts to bear fruit from the first year after planting, i.e. from about seven months, if it is well watered, or in the second year of production when grown under rain fed conditions. Seed yield of Jatropha is highly variable across different environments. The yield so far attained and recorded from provenances planted at Chingamuka Primary School in Mutoko, during the third year after establishment, varied according to provenances. The provenance collected from Mudzi had an average yield of 218 kg/ha, whereas the one collected from Mutoko attained an average yield of 711 kg/ha in the third season of fruiting. Jatropha yields reportedly stabilize from the 5th year onwards. The plant can give an economic yield for up to 30-40 years, if it is cared for well.
REFERENCES


