PRACTICAL ACTION
Technology challenging poverty

PRODUCTION AND USE OF JATROPHA

technical brief

Introduction

The guide is intended primarily to guide smallholder farmers and other stakeholders involved in the production and use of the jatropha plant (Jatropha curcas). The guideline details the processes and procedures involved in the sustainable production of jatropha and the multiple contributions the tree and its products make to the livelihoods of vulnerable households in the semi-arid areas of Zimbabwe. Pictures have been inserted to illustrate some of the processes involved and the available technology options for utilizing the jatropha plant and seeds. It is our hope that the guidelines will be useful in the facilitation of Community Based Natural Resources Management interventions that build the resilience of vulnerable households in the fragile semi-arid areas of Zimbabwe.

The jatropha plant.

The jatropha (Jatropha curcas l) plant is not new to Zimbabwe. It has been cultivated since its introduction in the 16th century by Portuguese and Arab traders. Initially, jatropha was found predominantly in the north-eastern parts of the country but has now spread to other parts of country. It is similar in most aspects to the castor plant, the Shona and Ndebele names and similar to castor i.e. pfuta and ummlhafutho respectively. In Mutoko the plant has got the name Mujirimono.

Ecology/Agronomy

The plant originated from Latin America but is now wide spread throughout arid and semi-and tropical regions of the world. It is a drought tolerant plant that does well on marginal soils i.e. low fertility and alkaline soils. It is a perennial plant that can live up to 50 years. The plant produces seed that yield industrial oil (35%).The plant is fast growing and can achieve a height of 3 meters in three years. Planting of seeds, seedlings and cuttings is best done early in the rainy season. Seed yields for jatropha are as high as 8-12 tons per hectare.

Jatropha propagation

Jatropha seedlings can be produced in poly-pots and be natured until they reach plantable sizes. Dried sees are soaked overnight and sown directly in plastic bags measuring 10 x 20 cm. Poly-pots measuring are filled with a specially prepared soil medium containing a high concentration of organic materials (compost) about three months before the beginning of the rainy season. One seed is planted in each bag. Use of fresh seeds improves germination. Germination takes place after 12 days and continues for two weeks. Seedlings should remain in the nursery for up to three months.

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Alternatively jatropha seedlings can also be produced from seed sown in mass-production beds. Seeds can be sown directly 2 to 3cm in the soil three months before the start of the rain season. The resultant naked rooted plants can then be transplanted when they are 50 cm. This method is very appropriate for regions which receive an annual rainfall amount of not less than 500mm per annum. The advantage of mass production beds is that you don't need to spend money on poly-pots and you can equally produce healthy seedlings. However, great care is required when transplanting the seedlings as most of the seedlings experience some stress which may affect their establishment rate and at times lead to higher mortality rates if not appropriately done.

Figure 1: Planting of jatropha seed in poly-pots. Sowing of seed in mass production beds.

In situ planting of seed

The third method of producing jatropha from seed is planting it directly in the field where it will grow. This method is normally employed in areas that receive high rainfall of about 800mm per year. The seed is sown at the beginning of the rain season and the planting site needs good land preparation well in advance. The method is applicable where large amount of seed is available and thinning may be necessary six months after germination to ensure regular spacing between the saplings so as to avoid competition for nutrients and growing space. Normally the plants have a slow take-off and may grow slowly during the establishment year. Once established the trees may do better especially with good care.

Spacing

Jatropha hedgerows that are intended for soil conservation should be planted 0.15m-0.25m by 0.15-0.25m in one or two rows and 2m by 1.5m to 2.5m by 2m for plantations Thus there will be between 4000 and 6700 plants in each kilometre for a single hedgerow and double that for two rows. Closer spacing is recommended for marginal sites. In fertile and humid agro-ecosystems, jatropha trees tend to develop wider and deeper canopies and therefore require even bigger growing space.

Vegetative propagation

Jatropha can be propagated using cuttings or truncheons.

Production using cuttings

Cuttings should be older than one year, already lignified and about 60cm to 120cm long. The cuttings can be raised in a nursery in poly-pots or in mass production beds. The cutting can also be plated directly in-situ in the field. The best planting time is during the dry season when the plant is in dormancy before the rainy season starts. Planting of cuttings during the rainy season normally results in higher mortality rates due to rotting. For live fencing, cuttings can be planted like a fence of dead wood, one cutting beside the next. It takes 2 to 4 weeks for roots to develop. If well maintained, this kind of live fence can be knit well enough to keep even chicken out of gardens. With vegetative propagation, the first seed yield is higher. The fruits can be produced between 12 to 15months. However, seed yield becomes low as time goes by as the plant tires. It is important to remember that the productive life-span of jatropha trees grown from cuttings is shorter than those established from seeds. This is referred to in some books as longevity. For this reason it is important to include in one's plantation planting stock from cuttings and from seed.

Production using truncheons

Jatropha can also be produced from truncheons and the planting material must be collected and planted during the dry season when the plant is in dormancy. This method has the advantage of giving instant results as the trees establishes quickly and higher seed yields may be attained during the first year. This method may however result in higher mortality rates in areas of high termite infestations.

Management, harvesting and marketing

Jatropha is a fast growing plant. For hedges, it must be timely trimmed to achieve desired results. Harvesting time is usually May to August. Currently the only active buyer is NOCZIM. It is important to note that the major benefits in growing of jatropha is that it may result in the decline in rural dependence on manufactured goods such as soaps, candles and energy supply. It is also important to sell value added goods rather than to sell unprocessed seed.

Crop husbandry practices

Soil nutrient management

Depending on the soil chemical and physical characteristics, application of nutrients may be necessary initially, particularly in nutrient deficient sites. Experience from plantation development and smallholder production indicates that addition of nutrient improves biomass growth, general productivity and plant health. Such remedial nutrient additions may be needed for up to two years after establishment.

Commonly applied sources of Nutrient include:

- Farmyard manure-applied at a rate of 10-15 tons per ha
- Nitrogen fertilizers- at approximately 90kg per ha
- Phosphorus fertilizers- at 50kg per ha
- Potassium and sulphur based fertilizers should be used only on sites with P and S deficiencies

Supplementary irrigation

Provision of supplementary water may be necessary for successful establishment; especially in soils that do not have enough moisture. Mulching and rain water harvesting can be used to increase moisture availability for plants.

Inter-cropping

Inter-cropping of jatropha with an under-crop species is encouraged for effective use of available growing space and faster establishment. Compatible crops – such as groundnuts, cowpeas, beans, peas, vegetables are recommended, particularly in the early stages before plant canopy closes.

Pruning

Figure 2: Effects of pruning on seed production.

To stimulate growth, side branch development and seed production, older jatropha shrubs should be pruned a month before the onset of short rains. It is recommended to carry out top pruning by cutting the top off cleanly, 90 to 120 days, after planting in the field to stimulate maximum sprouting of branches, fruiting and seed development. Root pruning is recommended when jatropha is interplanted with vanilla or other food crops to reduce competition for nutrients below ground surface. Jatropha takes three years to produce seed if planted from seed and 12 to 15 months to produce seed if planted from cuttings or truncheons. Under rain fed conditions yields have been reported to be ranging from 200g to 2.5kg per Tree per year whilst under irrigation conditions reported yields range from 500g to 5 kg per tree per year.

Figure 3: Pruning increases number of branches.

Pruning of planted trees during the end of the first year will result in the tree developing many branches which can lead to higher seed yields of more than 45%. Pruning can also be done on an annual basis for mature trees and this results in rigorous regrowth from which more seed can be harvested. Branches

pruned off can also be used as planting material to extend live fences and plantations. Pruning also keeps the trees short and within reach for easy picking of seed by hand.


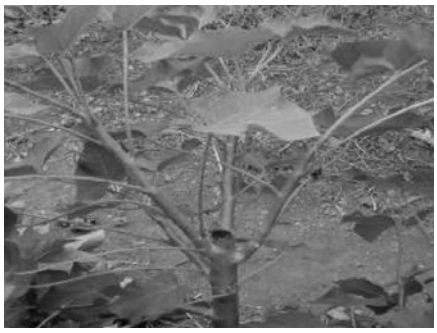

Figure 4: Pruned jatropha develops many branches which lead to more seed being produced per tree.

Breeding

Jatropha flowers during rainy season. In equatorial regions, flowering occurs throughout the year. Fruit development takes 90 days from flowering until seeds mature. The plant is cross pollinated, thus genetic improvement has to be based on populations. Plants for further genetic improvement can be based on oil yield, growth rate and resistance to pests and diseases.

Weed control

For hedges, weeds should be controlled from the time jatropha plants emerge until they reach a height of 40 to 50 cm. In plantations, regular weeding should be done and the dead weeds used as mulch.

Fire protection

Jatropha planted in hedges or plantation should be protected from fire. This is normally done by creating fire traces around the plantations or hedges towards the end of the rain season. Good weed control can also result in plantations being protected from fire.

Pests and diseases


Figure 5: Leaf defoliating insects.

Literature indicates that contrary to popular belief that toxicity and insecticidal properties of jatropha are a sufficient deterrent to insects that causes economic damage in plantations, several groups of insects can harm the plant. Particularly noteworthy is the Heteroptera insect order that has at least 15 species in Nicaragua that can extract nutrients from the physic nut. The stem borer from the Coleoptera family of Cerambycidae, known as a minor pest in cassava, can kill mature physic nut trees.

The relatively few leaf eating insects present are not capable of doing much damage once the trees have passed the seedling stage.

Biological control using beneficial arthropods composed of mostly polyphagous predators and specialized parasitoids either by conservation or augmentative release is recommended. The conservation approach of biological control is more cost efficient (Grimm and Maes, 1997). Powdery mildew damages leaves and flowers, Alternaria causes premature leaf fall, and golden flea beetles eat young leaves and shoots. Millipedes can cause total loss of young seedlings. In some areas of Zimbabwe, for instance, the golden flea beetle (Podagrica spp.) has been known to cause harm as it eats young leaves and shoots, particularly on young plants.

Jatropha is also host to the fungus “frogeye” (Cercospera spp.) common in tobacco. Other pests affecting Jatropha curcas include Clitocybe tabescens (root rot), Colletotrichum gloeosporioides

(leaf spot), and Phakopsora jatrophicola (rust). Mosaic disease can also attack jatropha, especially if the planting site has been under infected cassava crop.

Figure 6: Dumping –off and root rot.

Name	Damage and symptoms	Remedy
Phytophthora spp., Pythium spp., *Fusarium spp.*	Damping off, root rot	Heller (1992)
Helminthosporium tetramera	Leaf spots	Singh (1983)
Pestalotiopsis paraguarensis	Leaf spots	Singh (1983)
Pestalotiopsis versicolor	Leaf spots	Philips (1975)
Cercospora jatrophae -curces	Leaf spots	Kar and Dars (1987)
Julus sp. (millipede)	Total loss of seedlings	Heller (1992)
Oedaleus senegalensis (locust)	Leaves, seedlings	Heller (1992)
Lepidopterae larvae	Galleries in leave s	Heller (1992)
Pinnaspis strachani (cushion scale)	Die-back of branches	Van Harten, pers. comm.
Ferrsia virgata (wooly aphid)	Die-back of branches	Van Harten, pers. comm.
Calidea dregei (blue bug)	Sucking on fruits	Van Harten, pers. comm.
Nezara viridula (green stink bug)	Sucking on fruits	Van Harten, pers. comm.
Spodoptera litura	Larval feeding on leaves	Meshram and Joshi (1994)
Mosaic disease(Cited at Turkwel Gorge)	Shrunken leaves, Stunted growth similar to symptoms in Cassava	VJDF-Field Observation
Red Mite	Leaf spots	VJDF-Field Observation
Dowery Mildew	White Pecs on the leaves	VJDF-Field Observation

Table 1: Pests and diseases observed on jatropha.

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Harvesting

Ripe fruits are yellow, but harden into black hull when they dry as shown in figure 7 below. It is important to carefully plan harvesting of seed so as to keep people involved in the exercise motivated. This can be achieved by ensuring that people involved in the harvesting exercise have protective clothing so that their clothes are not stained by latex during harvesting. The latex is very difficult to remove from stained clothes and destroys clothes and this can be a very big disincentive to those picking up seed.

Figure 7: Yellow and brown capsules ripe for harvesting.

Harvesting is best done using a modified “apple picker”, a long wooden stick with a circular comb and a cotton bag at one end. With this tool, dry fruits can be picked from the trees without damaging leaves.

The seed should be kept free of any debris sand or stones as they may damage machines during oil extraction. Harvested seed must be stored left to dry under shade for three days and they should be stored in a dry place.

Figure 8: Removing debris, sand and stones before oil extraction.

Yield

Seed production ranges from about 0.4 tones to more than 12 tones an hectare annually, after five years of growth (Jones and Miller, 1992). In Mali, where jatropha is planted in hedges, yields of 0.8kg to 1kg of seed for a metre of live fence have been reported (Henning, 1996). This is equivalent to between 2.5 and 3.5 tons per hectare each year. In Zimbabwe, yields between 0.8kg to 3.0kg for each metre of hedge have been reported. Up to 8 tons of seeds from each hectare have been harvested annually from jatropha shrubs in plantations. One jatropha shrub in a hedge yields 0.25kg to 0.75kg of seeds a year, while a single jatropha shrub in plantations yields 2.0kg to 2.5kg of seeds annually.

Uses

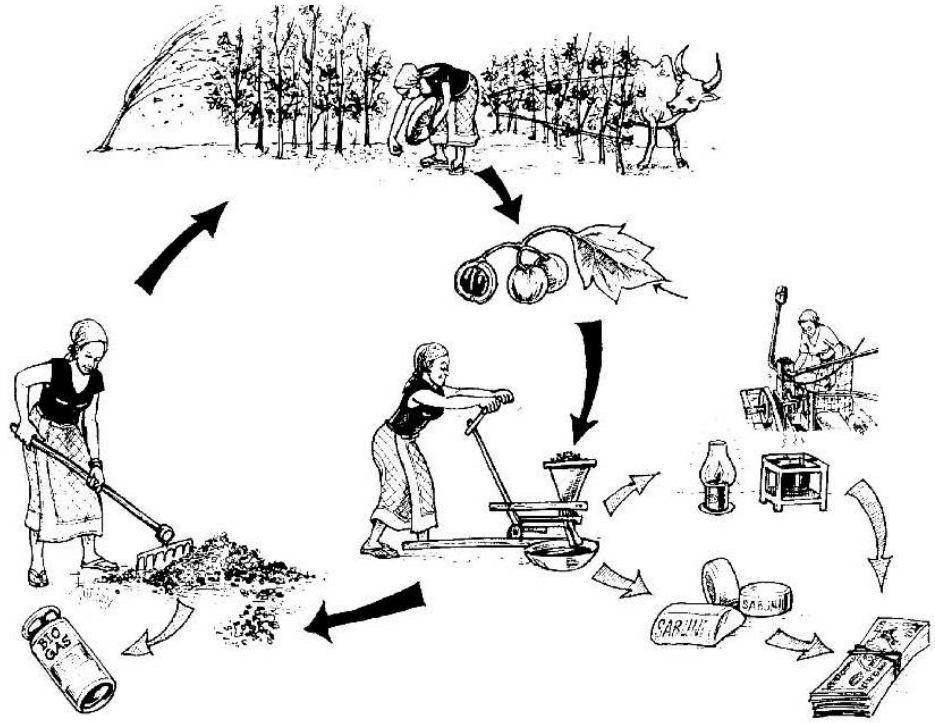

Figure 9: Jatropha value chain.

The jatropha value chain shown above in figure 9 shows a host of benefits which rural communities can derive. These include social, economic, financial and environmental benefits.

Oil processing

This can be done using simple hand operated oil presses or using motor driven presses. A manual oil press is used by many farmers in Zimbabwe and this press can press 5kgs of seed per hour. 5Kgs of seed gives a yield of 1 litre of oil. One of the advantages of using the manual press is that it can be used anywhere and it does not require electricity and it can be repaired and serviced in the village. The main disadvantage of using the manual press is that the oil should be filtered and this requires some time and only not all the oil is extracted from the seed. The machine is not very efficient , shown in figure 10.

Figure 10: A manual oil-press.

A Sundara electric press can also be used and this machine can press 75kgs of seed per hour. Using this machine, 3kgs of jatropha seed gives one litre pure oil and filtering may not be necessary. The machine requires electricity and operators need to be trained on how to use it. It is possible to improve the yield of oil during extraction by roasting the seed before oil extraction. This is recommended during cold periods.

Another way of improving oil yield is achieved by using press-cake to raise the temperature of the oil expeller and heat up the machine before expelling oil from seed.

Figure 11: A Sundara electric oil-presses.

Jatropha oil is an important product from the plant for meeting the cooking and lighting needs of the rural population and as a viable substitute for diesel. Substitution of firewood by plant oil for household cooking in rural areas will not only alleviate the problems of deforestation but also improve the health of rural women who are subjected to the indoor smoke pollution from cooking by inefficient fuel and stoves in poorly ventilated space.

The oil extracted is used in making soap, candles and lubricants. Jatropha is not browsed by livestock and is therefore used as live fence to keep stock out of homestead and fields. It is also used to reduce wind and water erosion. The jatropha seed cake after oil can be composted and used as manure. The manure has a higher nitrogen, phosphorus and organic matter content than chicken and cattle manure. The potassium content of jatropha compares favourably with that of cattle and chicken manure.

Jatropha can also help to mitigate the effects of climate change by reducing emission of greenhouse gases, meeting rural energy needs, protecting the environment and generating employment. Cultivation at the landscape level will help mitigate global warming considering its potential for carbon sequestration. Jatropha oil emissions are low in carbon dioxide since it has already assimilated carbon during the growth of the growth of the plant. The carbon dioxide balance therefore remains equable.

Conclusion

The production and use of jatropha can be promoted at the household and community level with a view to address environmental degradation and providing other complementally livelihoods options to the conventional crop and livestock management activities that smallholder farmers have been involved in. It is important to note that the manual does not provide a panacea for the realization of full value when one engages in the production and use of jatropha but this has to be blended with other natural resources utilization technologies that other organizations are promoting. Where results have been achieved this can be used as learning sites for increasing wider uptake by other smallholder farmers.

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