Jatropha curcas Production in Zimbabwe: Uses, Challenges and the Way Forward

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Abstract

The jatropha plant was introduced to Zimbabwe in 1940. Until recently, jatropha production was mainly done by communal farmers in marginal areas of the country. Being a multipurpose tree, the jatropha plant was being used to produce soap, lubricants and in soil conservation. Due to the fuel crisis that gripped Zimbabwe over the last decade, there has been a move towards producing biodiesel to complement imported fossil fuel. There is potential to produce animal and plant protectants, and organic fertilizer from jatropha. The current utilization of the plant is limited by lack of a clear government policy, unfavorable selling prices and unavailable agronomic information. There is need for government to come up with a policy that encourages production, research and utilization of biofuels. Information on jatropha propagation should be made available, not only in English, but vernacular languages also. Research should be encouraged so that varieties that are higher yielding are produced.

Keywords: *Jatropha*, Multipurpose, Biodiesel, Policy, Research, Government

1. Introduction

The jatropha plant (*Jatropha curcas* L), a shrub that originated in Central America, was introduced to Asia and Africa by Portuguese traders (Jepsen *et al*., 2006; Henning, 2008). It can grow in a number of climatic zones in tropical and sub-tropical regions (Heller, 1996). The plant was introduced to Zimbabwe in 1940 by Africa 2000 (now Environment Africa) (Hikwa, 1995). In Shona, it is called "Mujirimono" while the Ndebele call it "Umhlafutho". It is a multipurpose tree that grows to a height of between 3–5 metres, with an effective seed-bearing life span of 50 years (Singh *et al*., 2007). The plant can be propagated by seed or cuttings.

During the middle and late 2000s, Zimbabwe was gripped by a crippling fuel crisis emanating from depressed foreign currency reserves due to economic sanctions and high petroleum prices on the world market. Biodiesel, especially from jatropha, was identified as one potential answer to the fuel crisis. Biodiesel was found to have a number of advantages over fossil fuels, including being safe, non-polluting and renewable. Jatropha biodiesel in particular, has the same physico-chemical and performance characteristics as petro-diesel. It has a higher cetone number (51) than the other vegetable oils and petro-diesel (46 to 50) (Zimbabwe Biomass News, 1996; Kureel, 2006). This means it requires no modification in the engine, and so is a suitable alternative fuel. Several countries, including Egypt, France, Germany, Japan, South Africa and South Korea are already powering motor vehicles with biodiesel. Jatropha therefore represents a potential solution to Zimbabwe's fuel woes. This paper

therefore seeks to take stock of jatropha production trends, uses and challenges in the Zimbabwean context.

2. Production in Zimbabwe

Since its introduction in the 1940s, jatropha production has been relatively low and mostly by small scale farmers in marginal areas with less than 600mm annual rainfall and degraded soils. The main areas of production have been Binga, Mutoko, Nyanga, Wedza, Chiweshe and Mudzi (Jepsen *et al*., 2006). At first, jatropha production was largely on a non-commercial basis, with rural communities interested in by-products like glycerine and soap.

Jatropha exploitation as a biofuel was intensified in the 1970s and 1980s, with 2 000 hectares planted in 1997. From 2004, there was a deliberate attempt by government to establish jatropha plantations throughout the country. The National Oil Company of Zimbabwe (NOCZIM) spearheaded the process on behalf of government. At the end of 2009, it was estimated that there were 35 000 hectares under jatropha (Gandure, undated). NOCZIM's target is to plant 120 000 hectares of jatropha by 2010 through contracting willing farmers. To that effect, famers with less than five hectares participated in the National Jatropha Growing Program on a non-contractual basis, while those with more land were contracted to produce the crop.

A number of institutions, including the Scientific and Industrial Research and Development Centre (SIRDC), Masvingo and Harare Polytechnic Colleges, the National Oil Company of Zimbabwe (NOCZIM) and Environment Africa initiated research for *Jatropha curcas* biodiesel oil. This research, coupled with the publicity that the plant received, resulted in a number of oil pressing mills sprouting up in Harare, Mutoko, Masvingo and Guruve (Jimu *et al*., 2009). The country's biggest biodiesel plant was commissioned in Mount Hampden, 25 km north-west of Harare in November 2007. This plant has a capacity to produce 70 000 litres of biodiesel per month. At the moment, the plant is mainly using cotton and soyabean seed for biofuel production. The country has a target of 100 000 litres biodiesel per year which should substitute 10% of fuel imports by 2017 (Gandure, undated).

3. Current and Potential Uses of the jatropha plant in Zimbabwe

3.1 Current Uses

3.1.1 On-farm Uses

Oil expressed from jatropha seed is being used to lubricate farm equipment and machinery (Mauwa, 1995). The oil is also being used to soften hides when making ropes and whips. In addition, jatropha oil is used in torches and lanterns to provide lighting needs for rural communities. The oil burns cleanly with a smoke-free flame, hence no environmental pollution (Tigere *et al*., 2006). Farmers in Mutoko, Mudzi and Chiweshe are using the plant as a live fence to protect crops in gardens and irrigated areas from damage by livestock (Hikwa, 1995). The seed contains chemical ingredients which make jatropha a good detergent. The oil has potential to replace tallow which is expensive (Tewari and Shukla, 1982). In Makosa Ward, Mutoko, the basic ingredients for soap manufacture are 8 parts oil: 8 parts water: 1 part caustic soda (Tigere *et al*., 2006).

3.1.2 Conservation and Land Reclamation

The plant is being used for land reclamation and for conservation works. It is planted on marginal land, paddocks, hilly slopes and gullies. It has a good root system which easily binds soil particles and so reduces soil erosion. Its tap root strongly binds soil particles together and so these are not easily eroded (Jones and Miller, 1992). It can also be planted on slopes to fix small earth or stone dams thereby strengthening such structures. This was successfully done in Macheke Ward 30 on steep lands that were vulnerable to erosion. In addition, the plant's roots grow close to the ground surface, anchoring the soil like miniature dikes or earthen bands. These dikes effectively slow surface run-off during heavy downpours, thus causing more water to penetrate into the soil and boosting harvests. The plant is being used as a windbreak in the Lower Guruve Development Association Project. The wind breaks reduce erosion and also prevent crop lodging.

3.1.3 Medicinal and Veterinary Uses

In Mutoko and Binga, jatropha oil is being used in the treatment of rheumatism (pain in joints) and back-aches (Mauwa, 1995). The nut sap is used to arrest wound bleeding (Henning, 1996). In several districts of Mashonaland East, Masvingo and Manicaland, a decoction of jatropha leaves is used as an antiseptic after birth. Roots of the plant have been used as a remedy for snake bites. Seeds can also be used to fight constipation. The plant is also being used to fight skin diseases, and to remedy sores on domestic livestock. Its latex contains alkaloids (jatrophine, jatrophen, jatrophore and curcain) which are anti-carcinogenic. The latex can also be used to remedy alopecia, anasora, burns, dropsy, eczema, inflammation, paralysis and yellow fever (Heller, 1996).

3.1.4 Other uses

In Murewa, the jatropha plant is being planted around homesteads to prevent the entry of snakes. It is strongly believed that the plant repels evil spirits. It is also used to settle disputes when matters are brought before traditional leaders. If an accused person swallows a concoction and does not vomit, he is presumed guilty. The plant is also being promoted in bee keeping.

3.2 Potential Uses

3.2.1 Organic Fertilizer Production

Jatropha cake can be used in fertilizer manufacture. The cake has 6% N, 2.7% P_2O_5 and 0.94% K_2O, quantities which are relatively equivalent to those of castor bean and chicken manure (Tigere *et al*., 2006; Jones and Miller, 1992). This organic fertilizer can be a good substitute for inorganic fertilizers for smallholder farmers who cannot afford them. Also, with the advocacy towards organic farming, this would be a good fertilizer. However, farmers should be wary of phytotoxicity expressed as reduced germination. Therefore, organic manure from jatropha cake should be allowed to decompose before application.

3.2.2 Animal and Plant Protection

There is potential to produce insecticides, fungicides and veterinary chemicals from jatropha. Plant extracts have potential to control *Helicoverpa armigera*, *Aphis gossypii*, *Phthorimaea operculela*, *Sitophilus zea-mays*, and *Empoasca* spp. Leaf extracts also control *Sclerotium* and *Schistoseme* vector snails. In livestock production, leaves have been used to treat tick-related diseases and to kill bilharzias snails (Heller, 1996). More research has to be initiated locally in all these areas so that the jatropha plant can be put to better use.

4. Challenges facing jatropha production in Zimbabwe

Due to immense potential of the jatropha plant and the fuel crisis in the last decade, the government declared the jartopha plant a specified plant which has to be promoted to be produced and harvested for processing into bio-diesel. This led to massive promotion of the growing of the shrub around the country led by the Ministry of Energy through NOCZIM and Forestry Commission (Tigere *et al*., 2006). The Forestry Commission was tasked with the job of multiplying planting material and provision of extension services. Despite all government efforts, local utilization of the plant is beset by a myriad of problems. Some of these are discussed below.

4.1 Lack of Policy Direction

The hype surrounding jatropha production and use has suddenly died down. At the height of its popularity between 2004 and 2006, the jatropha plant was named the "Plant of the Year" in 2005 by the Forestry Commission. This meant all citizens of the country were encouraged to grow the plant. People, who had acquired large tracts of land during the land redistribution exercise, adopted the plant and dedicated large hectarage to grow jatropha. From the very beginning, the implementation of the project was driven by political pressure and a poor macro-economic environment (Tigere *et al*., 2006). Production was driven from the top to the bottom without a clear policy direction.

In February 2008, the government of Zimbabwe approved a draft energy policy for the first time since 1980. However, the Zimbabwean government has not yet formulated a comprehensive policy on biofuels. Although a biofuels programs was initiated in 2004 to reduce fuel imports through local biodiesel production, there is no framework that regulates and promotes investment, production, marketing, and use of biofuels. The absence of firm mandates or incentives has slowed down any meaningful development of the biodiesel sector. The government should put in place the necessary legislation to support and encourage research and development of biofuels. This is the case in developed countries like the USA (Esterhuizen, 2010).

Government promotions of jatropha have ceased. Between 2004 and 2008, the plant received a lot of publicity in both the electronic and print media. Production of the plant was heavily funded by the Reserve Bank of Zimbabwe. This funding has also ceased, making both production and research difficult. Poor coordination in the biodiesel sector also influenced government's decision to cut funding. Three government ministries i.e. the Ministry of Energy and Power Development, the Ministry of Science and Technology and the Ministry of Agriculture were all involved in biofuels development with no clear mandate or coordination among them. This makes it highly doubtful to achieve the targeted 10% biofuel substitution by 2017. (Esterhuizen, 2010).

4.2 Jatropha Agronomic Aspects

Literature on jatropha production is not well documented (Jimu *et al*., 2009). Farmers do not know how to raise seedlings. There is inadequate information with respect to the plant's fertilizer and irrigation requirements, planting patterns, plant spacing, intercropping and effects of management practices. Amongst communal farmers, for example, planting density depends on the farmer's objective, common of which are keeping out livestock from fields, gardens or homesteads, or as a boundary fence. Currently, only one species is available meaning that there is no breeding taking place to improve on species performance. Comprehensive information on local pests and diseases attacking the plant is not yet available. Even when pests and diseases occur, control is not done as this is perceived to increase production costs.

The jatropha plant is low yielding. Documented yield in Zimbabwe is 794kg/ha (Zimbabwe Biomass News, 1996), compared to 8-12 t/ha under high management in other countries. The net returns from the plant are therefore low. On oil expression, 90 kg seed yields an average of 15-18 litres of oil (Tigere *et al*., 2006), meaning that 44-53 litres are obtained per hectare. Zimbabwe's annual diesel consumption stands at one billion litres (2.74 million litres per day) (Esterhuizen, 2010). This means large areas of land have to be planted if sufficient quantities of biodiesel are to be obtained for national use. Most farmers in Zimbabwe have small land units on

which they have to prioritize between jatropha production, and food crop production. In all instances, people ensure household food security first before venturing into the production of jatropha. And given a choice between jatropha and other cash crops like tobacco and cotton, people have gone for the other crops. Therefore, there is need to improve on the productivity of jatropha if the plant is to be exploited for commercial biodiesel production.

When compared to other sources of biofuels like sugarcane, cotton and soyabeans, the production cycle of jatropha is long. Seed-propagated jatropha produces seed in 3-4 years, while that propagated by means of cuttings does so in one or two years (Tigere *et al*., 2006). However, yield in the early life of the shrub is very low. This translates to very low returns to the farmer.

4.3 Unfavorable Prices

When jatropha was declared as a specified plant in 2004, the government banned the export of jatropha seed and gazette producer prices. NOCZIM was the only mandated buyer of seeds from farmers. Prices offered by NOCZIM were ten times lower than those offered by private buyers. Moreover, private buyers paid for the seed in foreign currency while NOCZIM paid in Zimbabwean dollars. This was at a time when inflation was at its peak (running into several thousand percentage points). Payment by NOCZIM was not timely done. Private buyers, on the other hand, made on-the-spot payments for the seed. Farmers were therefore in a catch-22 situation, and ended up illegally selling the seed to private buyers. This meant the national biodiesel project suffered low deliveries.

4.4 Inherent limitations of the plant

Both the seeds and leaves are poisonous to humans and livestock. The plant contains toxic compounds like saponin, carcinogenic phorbol and a trypsin inhibitor. Ingestion can cause digestive irritation, including diarrhea and nausea. Deaths of livestock have been reported in some areas due to poisoning when livestock browse the leaves. The plant has no firewood value such that most rural folks who depend on firewood for cooking are no longer interested in the plant. The seed cake, when used as organic manure causes phytotoxicity.

4.5 Political situation in the country

From February 2009, there was a turnaround in the political situation of Zimbabwe. An inclusive government was formed. This new government unlocked some lines of credit. It therefore meant that there was reduced pressure on the meager financial resources from which the country was paying for electricity, fuel, medicines and other basics. The inclusive government adopted economic liberalization measures which stabilized the economic situation. One such measure was the adoption of multiple currencies as legal tender in Zimbabwe. Another measure was the authorization of private companies and individuals with free funds to directly import fuel into the country. All these factors contributed in making fuel available on the market. Therefore, the pressure to produce jatropha biodiesel subsided.

5. The Way Forward for Zimbabwe

It is not a secret that renewable energy sources are the way forward as we move into the future. Fossil fuels will run out one day. Therefore, the world has to think of renewable energy sources, of which biodiesel is one. The jatropha plant has potential, not only to provide the biodiesel, but to also provide a host of other products which the ever-increasing world population needs. Being a renewable energy source, the production of the jatropha plant has to be encouraged and supported. The Zimbabwe government had taken a positive initiative in ensuring sustainable fuel availability when it embarked on promoting jatropha production. This initiative needs to be revived so that the jatropha plant can be fully exploited for biodiesel production.

The shrub needs extensive research to attract investment and future potential exploitation. While the Government of Zimbabwe has ceased funding the jatropha growing project, it should create an enabling environment for the private sector to fill the gap that has been created by the government's decision. In the developed world, governments create enabling environments for the private sector to invest in research and development activities. For example, companies funding or doing research in critical areas receive tax rebates, and are allowed to import equipment duty free. Zimbabwe can learn something from these successful nations. For a start, the policy document on biofuels has to be in place so that potential investors know what they stand to gain or lose by undertaking research on the jatropha plant. Areas that require more research in Zimbabwe include the following:

- Identification, characterization and evaluation of local provenances with desirable characteristics for commercialization.
- Breeding for better yielding varieties and those with low poison content that can further be exploited in animal feed formulation and organic manure production.
- Pests and diseases identification and characterization.
- Use of jatropha as an animal and plant protectant.
- Incorporation of the jatropha cake as a protein supplement in livestock feeds.
- Use of the cake as an organic fertilizer, especially in vegetable production.

- Investigation into the agronomy of the plant. Critical areas include plant spacing, plant propagation, fertilizer application rates and irrigation.

There is need to source germplasm of different jatropha species and provenances from such countries as India, Mali, Nicaragua, the Cape Verde Islands, Madagascar and Costa Rica who are ahead of Zimbabwe in jatropha utilization. This material will be used to conduct performance trials. Once the locally available jatropha provenances have been characterized, they would act as controls in evaluating provenances from these other countries. The foreign provenances that outperform the local provenances will be selected and multiplied for commercial production.

There is need also to provide literature on jatropha production to farmers. This literature must be available not only in English, but also in vernacular languages like Shona and Ndebele. This will ensure that even the semi-literate people are able to read and understand jatropha production manuals.

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