Potential of *Jatropha Curcas* in Improving Smallholder Farmers' Livelihoods in Zimbabwe: *An Exploratory Study of Makosa Ward, Mutoko District*

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Abstract

Jatropha curcas L. (JCL) is a deciduous shrub that grows up to a height of 3-5 metres and has a productive life of 50 years. It can be established on marginal land, paddocks, contour ridges, hilly slopes and gullies. The most promising and currently exploited uses of JCL are in rural agro-industrial development such as soap and candle making. A study was carried out in Makosa Ward of Mutoko District in Zimbabwe. A structured questionnaire, which elicited farmers' perceptions on JCL in terms of agronomic practices and utilisation, was administered to 60 randomly selected JCL growers. Most land for JCL production is prepared by digging with hoes and propagation is mainly by seeds. The shrub is used as a live fence since it is not browsed by cattle and goats. The other advantages of cultivating JCL as indicated by the farmers were its adaptation to the local environment, fast growth rate and its potential for income generation. The major limitations of JCL were its seed toxicity to both humans and livestock and its lack of a woody stem, which renders it unsuitable for use as firewood. JCL seed cake had a relatively high total nitrogen, phosphorous and organic matter content compared to chicken and cattle manure and therefore has potential in soil fertility improvement research agendas in areas where the plant is grown in abundance. Other potential research areas include fertiliser requirements, intercropping, irrigation requirements, effects of pruning, identification of different provenances through characterisation and evaluation, propagation methods and use of seed cake as a protein supplement to livestock feed.

Key words: *Jatropha curcas*, Zimbabwe, smallholder farmers, oil, seed cake, utilisation, sustainable

Introduction

Jatropha curcas L. (JCL) is a deciduous shrub that grows up to a height of 3-5 metres, and with a productive life of 50 years. It is a multipurpose shrub and is considered to have originated in Latin America but presently grows throughout the arid, semi-arid tropical and subtropical regions of the world (Hikwa, 1995; Henning, 1996; Makkar, Becker, and Schmook, 1997). The distribution of JCL beyond tropical America was facilitated by the Portuguese and Arab traders who transported the plant to Africa and Asia where it has since become naturalised and widely utilised on a local basis, and is now known by over 200 common or local names, indicating its occurrence in various countries (Jones and Miller, 1992). Examples of such names are physic nut, purging nut, pinoncillo, Habb-El-Meluk, black vomit nut, wild castor or diesel beans, depending on the region of the world where it is grown (Makkar *et al*., 1997). In Zimbabwe, the plant is locally known as *Mujirimono* or *Umhlafuto* in the Shona and Ndebele languages respectively (Zimbabwe Biomass News, 1996).

JCL can be established on marginal land, paddocks, contour ridges, hilly slopes and gullies. The most promising and currently exploited uses of JCL are in rural agro-industrial development where oil pressed from the seed is used in making soap, candles, and lubricants while the seed cake can be used as organic manure. In the majority of cases this requires little or no chemical processing of the oil. JCL is not browsed by cattle and goats, and hence is used as a live fence around homesteads and gardens.

In Zimbabwe the growing and management of JCL, be it on private, public or community lands, is poorly documented, with little field experience being shared amongst researchers and farmers. Currently growers are unable to substantially benefit from the plant, especially from its potential uses. The objective of the study was therefore, to elicit smallholder farmers' perceptions on the agronomy and utilisation of JCL and identify possible areas for its exploitation, promotion and research.

Materials and Methods

Study site

The study was carried out in Makosa Ward of Mutoko District in Zimbabwe's Mashonaland East Province. Mutoko District is in agro-ecological region III, a semi-intensive farming region with annual rainfall of 650-800mm. The region is also subject to severe mid-season dry spells and is therefore marginal for maize (*Zea mays*), tobacco (*Nicotiana tabacum*) and cotton (*Gossypium hirsutum*) production.

The vegetation is mainly the "*miombo*" woodland on predominantly sandy loam soils of low inherent fertility. The inhabitants of Makosa Ward specialise in wetland production of fruits and vegetables. Field crops under production are sweet potato (*Ipomoea batatus*); maize, a staple food crop; finger millet (*Eleusine coracana*); sorghum (*Sorghum bicolor*); cowpea (*Vigna unguiculata*); groundnut (*Arachis hypogea*); bambara groundnut (*Voandezea subterrenea*) and rice (*Oryza sativa*). The livestock types within the farming systems are cattle, goats and poultry.

Data Collection and Analysis

Data were collected through use of key informants, focus groups and questionnaires. The sampling frame was 200 farmers composed of both growers and non-growers of JCL. The data from focus groups and key informants was synthesized. A structured questionnaire was administered to 60 randomly selected JCL growers. The questionnaire elicited farmers' perceptions on JCL in terms of agronomic practices, advantages and disadvantages of JCL production, and utilisation.

Data was analysed using the Statistical Package for Social Sciences (SPSS) Version 10, and descriptive statistics were used to present the research findings.

Results and Discussion

Perceptions on agronomic practices

The agronomic practices in JCL cultivation are summarised into land preparation, propagation, cropping, anticipated intercrops, and the number of weeding operations (Table 1).

Most farmers (69%) prepare land by digging using hoes while the remainder prepare land by using ox-drawn ploughs (Table 1). The main method of propagation is by seed (44% of farmers), followed by use of both cuttings and seed (34%) (Table 1). Propagation through cuttings is more advantageous since seed can be harvested in one to two years while plants established from seed, set seed in three to four years. The use of the ox-drawn plough is along field edges where JCL is normally planted. JCL cropping is not as systematic as that of field crops like maize or groundnuts as about two thirds of the farmers use it as a live fence. The percentage of farmers who established JCL as a live fence varied with the type of niche. As an example the most common was around homesteads (67%) followed by gardens (20%) and lastly around fields (13%).

The likely crops which farmers thought could be best intercropped with JCL were mainly maize and groundnuts. These indicate possible research areas for development of appropriate technological packages.

About half of the farmers do not weed the JCL shrubs, since the shrub has a fast growth rate which quickly smothers weeds and that most farmers use it as a live fence. About a third of the farmers weed once while the remainder (18%) weed two or more times.

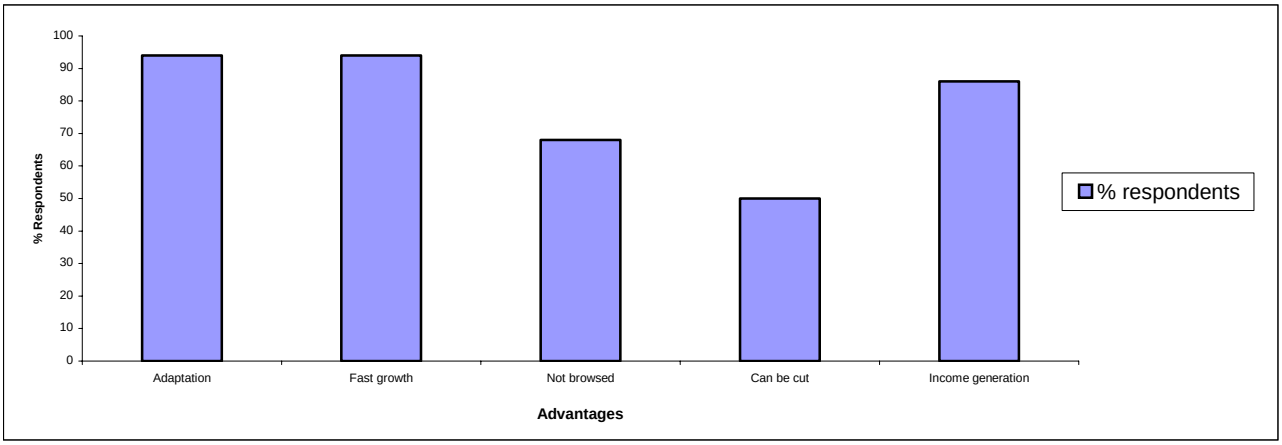
Table 1: Farmers' perceptions on agronomic practices for JCL production

Agronomic practices		Percentage (n = 60)
Land preparation		
	by ox-drawn plough	27
	by hoe	69
	both	4
Propagation		
	seed	44
	cuttings	22
	both	34
Cropping		
	intercrop	16
	relay	17
	fencing	67
Anticipated intercrops		
	maize	50
	groundnuts	25
	others	25
Number of weeding operations		
	none	52
	one	30
	two	14
	more than two	4

Perceptions on utilisation

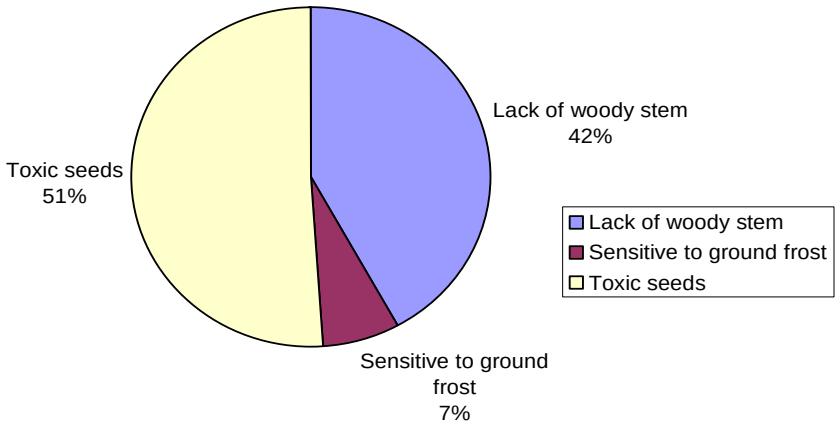
The main advantages of cultivating JCL as indicated by the farmers were its adaptation to the local environment, fast growth and its potential for income generation (Figure 1) through soap making, selling of seeds and seed cake. The seed cake is used as organic manure in horticultural production. The other reasons were that JCL cannot be browsed by livestock such as cattle and goats and cut branches sprout readily and grow rapidly, which makes it an effective live fence.

Figure 1: Advantages of JCL cultivation



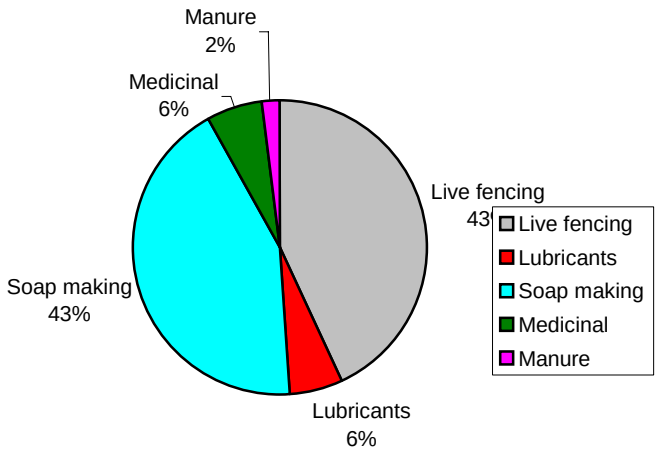
Despite its various advantages, one of the main limitations of JCL is its seed toxicity to both humans and livestock (Figure 2). A relatively large proportion of farmers (42%) also mentioned that JCL lacks a woody stem which renders it unsuitable for use as firewood. This is one of the major limitations in communal areas where the main source of fuel is firewood. A smaller percentage of the farmers (7%) highlighted that JCL seedlings are sensitive to ground frost during establishment.

Figure 2: Limitations of JCL



The majority of the farmers (86%) use JCL as a live fence (43%) and press oil from seed for soap making (43%) (Figure 3). According to a co-operative which is operating under Biomass Users Network (BUN), in Makosa Ward, the basic ingredients in soap making are 8 parts (JCL oil) : 1 part (caustic soda) : 8 parts (water). Hard water is not used for soap making since it results in cracks on the soap.

Figure 3: Main uses of JCL.



A minority of the farmers (2%) use composted JCL seed cake as organic manure in horticultural production, yet the seed cake from Makosa Ward analysed for N, P, K and organic matter, has relatively high total nitrogen, phosphorus and organic matter contents compared to chicken and cattle manure (Table 2). The potassium content of JCL seed cake compares favourably with that of chicken and cattle manure. With the ever increasing costs of inorganic fertilisers, there seems to be a potential for incorporating the seed cake in soil fertility research agendas in areas where the shrub is grown in abundance and oil is expressed. The seed cake is bio-degradable when used as an organic manure (Sharma *et al*., 1995; Mapako, 1998).

Table 2: Comparison of nutrient content of JCL seed cake with chicken and cattle manure

Nutrient	**Average Nutrient Content of Sample (%)**		
	JCL Seed Cake	**Chicken Manure**	**Cattle Manure**
Total Nitrogen	3.93	2.50	1.15
Potassium (K_2O)	1.73	2.00	1.01
Phosphorus (P_2O_5)	2.93	2.60	0.65
Organic Matter	87.84	45.00	47.50

The markets for the different producers have not been properly explored or quantified, nor have the costs or returns (both tangible and intangible) to supply raw materials or products to the markets. Consequently, JCL

growers and potential growers, including those in the subsistence sector, lack adequate information about the plant's uses and its economic potential (Mapako, 1998; Mushaka, 1998).

Sustainability of JCL production

The JCL shrub is adapted to marginal areas and is suitable for production under low rainfall areas of 200-250mm per annum, but also performs well in high rainfall areas. It is tolerant to high temperatures, low soil fertility, alkaline conditions and shallow or gravely soils.

Seed can be harvested from the shrubs for processing, and the shrubs have a productive life of 50 years in which farmers can harvest seed. Seed yields for JCL can be as high as 8-12t/ha under high management. The shrub is multipurpose and can be used for a wide range of applications such as live fencing, ecological rehabilitation (gully reclamation and control), bio-aesthetic uses, while oil from the expressed seed can be used for making paraffin substitutes, lubricants, bio-diesel, and for the manufacture of candles and soap. The press cake can be used as an organic manure (Plant Oil, 1995., Moyo, 1998). The oil is a regenerative source of energy, while the JCL based fertilisers and insecticides are biodegradable (Sharma *et al*., 1995., Mapako, 1998).

The propagation of JCL is easy, and is by seed or cuttings. Plants established from cuttings bear fruit within one to two years while plants established from seed can be expected to bear fruit within three to four years. In 2004, the Government of Zimbabwe declared the JCL shrub as a specified plant which should be promoted to harvest seed for processing into oil for bio-diesel generation. This has resulted in the massive promotion of the growing of the shrub across the whole country particularly by smallholder farmers, as a live fence around homesteads and gardens. Before the declaration of JCL as a specified plant, interest in JCL production had been limited to the smallholder farming sector, now the large scale commercial farmers are also venturing JCL production. The JCL shrub is not browsed by cattle and goats because of its poor palatability due to of high tannin levels which makes it an effective live fence.

Importance of research work to the sustainability of farmers in Zimbabwe

The JCL shrub is produced as a low input crop, with seed yields of up to 400g per shrub, per harvest, depending on management. Seed is harvested from May to August. This reduces labour bottlenecks since agricultural labour requirements for field crops will be off peak, after crop harvests. Fruit capsules are plucked off by hand when they turn from green to yellow and are dried. The capsules may be plucked off when fully dry and have turned brown. Threshing of the capsules is easy and can be carried out manually.

In Zimbabwe the most promising and currently exploited uses of JCL are in rural agro-industrial development. The oil is expressed with a hand operated ram press. On oil expression, 90kg of JCL seed yields 15-18 litres of oil on average. In the majority of cases, the oil requires little or no chemical processing, and the oil is used in making soap, candles and lubricants.

Since the JCL shrub has been declared a specified crop, this has empowered the female smallholder farmers who can now generate extra household income from the sales of seed and JCL seed cake. This has to some extent addressed gender equity in terms of income generation. Women involved in value addition such as soap and candle making generate more household income than those selling unprocessed seed. The use of JCL seed cake as an organic manure in vegetable production can boost production and income levels of resource poor farmers who may not own cattle, goats or poultry which provide manure.

The majority of the farmers cannot afford to buy barbed wire or security fence to protect their garden crops from stray cattle and goats, and therefore they resort to the use of the shrub as a live fence, since it is not browsed. Cuttings or seeds are spaced at 0.2m and plants grow and provide protection from stray animals. The use of the live fence also reduces fencing costs and the demand for fencing posts, thus reducing the level of deforestation.

The potential areas for research could include optimal fertiliser levels, use of the seed cake as an organic manure in vegetable production, intercropping, investigation of agronomic potential of other *Jatropha* species, irrigation requirements, influence of pruning on seed yields, identification of provenances with desirable characteristics according to use through characterisation and evaluation, generation of basic information on propagation methods, and use of the seed cake as a protein supplement to livestock feed. There is potential to carry out an economic evaluation of JCL production through the generation of optimal fertiliser response functions (curves) and the effects on seed yield and oil content, where the shrub is grown in abundance. Intercropping studies of JCL with cereal and non cereal crops would be ideal where the shrub is grown as a plantation crop. Optimum irrigation requirements and pruning could be evaluated to determine their effects on seed yields. Where toxic cultivars are grown, there is potential to detoxify the seed cake and use it as a protein supplement to livestock feed. There may be need to source germplasm of different *Jatropha* species and provenances from major *Jatropha* producing countries such as India, Nicaragua, Cape Verde Islands, Mali, Madagascar and Costa Rica, and conduct performance trials. In Zimbabwe, characterisation of JCL has not been carried out. The locally adapted JCL has to be characterised and used as a control so that the introduced provenances that out perform the control are selected and multiplied for large scale production.

With the ever increasing costs of inorganic fertilisers, there is potential of incorporating the JCL seed cake in soil fertility research agendas, especially in vegetable production, since its potassium content compares favourably with chicken and cattle manure, and has relatively high total nitrogen, phosphorus and organic matter contents compared to chicken and cattle manure.

Conclusions

The JCL shrub is produced as a low input crop and is adapted to marginal areas in terms of low soil fertility and low rainfall requirements. Propagation is easy by seed or cuttings. Seed is harvested during non peak labour periods when the fruit capsules turn yellow or brown. Seed yields of up to 400g per shrub per harvest

can be achieved, depending on management. The shrubs have a productive life of 50 years. JCL is a multipurpose shrub which can be used as a live fence, in gully reclamation, bio-aesthetic uses, paraffin substitutes, lubricants, bio-diesel, and manufacture of soap and candles. The use of JCL as a live fence has helped in reducing fencing costs where barbed wire or security fence and fencing posts could be used, and the level of deforestation is also reduced. The declaration by the Government of Zimbabwe of JCL as a specified plant has resulted in the massive promotion and production of the shrub.

There is high potential of JCL production and utilisation in Makosa Ward and most communal areas in agro-ecological region III of Zimbabwe. The use of JCL seed cake in soil fertility improvement is worth highlighting on and can be viewed as a "future" soil amendment. Rural empowerment in terms of income generation and emergence of small enterprises or cottage industries through the manufacturing of soap and candles is a potential area where JCL can play a pivotal role. JCL oil is a cheaper substitute for beef tallow used in soap making.

Possible research agendas could include generation of optimal fertiliser response functions, use of the seed cake as an organic manure, intercropping, irrigation requirements, effects of pruning, identification of different provenances through characterisation and evaluation, propagation methods and incorporation of the seed cake as a protein supplement to livestock feed.

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