Journal of Sustainable Development in Africa (Volume 11, No.2, 2009)

ISSN: 1520-5509

Clarion University of Pennsylvania, Clarion, Pennsylvania

SOCIO-ECONOMICS OF COMMERCIAL UTILIZATION OF JATROPHA (*JATROPHA CURCAS*) IN MUTOKO DISTRICT, ZIMBABWE

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ABSTRACT

Jatropha curcas L. (or physic nut), a previously underutilized tree species in smallholder farming systems, is fast gaining formal recognition as a very important tree crop in improving rural livelihoods. The Government of Zimbabwe is vigorously promoting the growing of Jatropha in marginal areas for bio-diesel production to save the country foreign currency in fuel imports. This study was carried out in 12 out of the 19 wards of Mutoko district in 2007 to analyze the socio-economics of Jatropha commercial utilization by smallholder farmers in marginal areas as a livelihood improvement strategy. The analysis involved categorizing farming households according to socio-economic characteristics and finding the effects they have on commercial and non-commercial (subsistence) utilization of Jatropha. The study employed binary logistic (Logit) and Tobit regression analyses in meeting the research objectives. Size of landholding, household's wealth status, and perception about the price were the socio-economic factors found to be significant in influencing decisions by households to adopt (or not adopt) commercial utilization of Jatropha.

Key Words: Socio-economic, Jatropha, commercialization (commercial utilization), Logit, Tobit

INTRODUCTION

Jatropha has been in existence in Zimbabwe for decades, mostly in smallholder farming areas where it has been grown as hedge or living fence around homesteads, gardens, and crop fields to protect against invasion by roaming animals. The tree crop has become popular in the country through advocacy by the government as a potential solution to the country's fuel problems, as a bio-diesel, while simultaneously improving livelihoods of the smallholder farmers in an environmentally sound and economically sustainable manner. The Government of Zimbabwe (GoZ) and other NGOs are promoting commercialization of Jatropha among smallholder farmers by encouraging massive production of the tree crop to harvest seeds for sale to the country's bio-diesel project and processing into various marketable commodities, such as soap, paraffin, and candles. The promotion of Jatropha production among smallholder farmers in drier marginal areas is being done to meet 10 percent of the country's diesel fuel requirements. The GoZ has already specified Jatropha and banned its export as it seeks to extensively develop it within the next five years and hopes to save foreign currency in fuel imports. However, Jatropha is being advocated amongst politicians and policymakers without full information on the socioeconomic and livelihood implications on the producers. Although Jatropha is now receiving formal recognition, growers are still unable to achieve optimum economic benefits from the plant, especially for all its various uses due to various social and economic constraints.

In spite of low returns to land, labor, and capital, smallholder farmers in dry land areas have long maintained indigenous strategies and options to manage risk and to deal with poor overall productivity. Agroforestry (AF) is one of the options that have been adopted by these farmers as a dynamic, ecologically-based, natural resource management system that, through integration of trees on farms and in the agricultural landscape, diversifies, and sustains production for increased social, economic, and environmental benefits (WAC, 2006). Plant species, like Jatropha, that can grow well on lands that may not be attractive for agriculture and supply raw materials for industry, fuels for basic energy requirements and improve the environment are, therefore, a promising option that needs careful and comprehensive assessment (SIRDC, 1998).

The oil plant, Jatropha, is a multipurpose and drought-resistant large shrub or small tree that is a native of tropical America but now thriving well throughout Africa and Asia. The wood and fruit of Jatropha can be used for numerous purposes including fuel. The shelled seeds of Jatropha contain (35% by weight) viscous oil (SIRDC, 1998), which can be used for the manufacturing of candles and soap, in the cosmetics industry, for heating and lighting on its own as a diesel/paraffin substitute or as a blend. This latter use has important implications for meeting the demand for rural energy services and also exploring practical substitutes for fossil fuels to counter greenhouse gas accumulation in the atmosphere. Various parts of the Jatropha plant are also of medicinal value; its bark contains tannin and its flowers attract bees, thus, making the plant a potential hub for honey production. Though Jatropha is not browsed by animals because of its toxic leaves and stems, after treatment, the seeds or seedcake can be used as animal feed; being rich in nitrogen, the seedcake is a good source of plant nutrients (Henning, 1996).

Jatropha oil is an important product from the plant for meeting the cooking and lighting needs of the rural population, or 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 will also improve the health of rural women who are subjected to the indoor smoke pollution from cooking using inefficient fuel and stoves in poorly ventilated space. This positive attribute of Jatropha, if fully tapped, may help save time for rural women of Zimbabwe who spend most of their time fetching firewood for household use, to perform other productive tasks. The Jatropha system is characterized by many positive ecological economic aspects that are attached to the commercial exploitation of this plant.

RESEARCH METHODOLOGY

Data Collection and Management

Both primary and secondary data on Jatropha production and utilization were sought and analyzed in this study. Socio-economic surveys were conducted to generate socio-economic data as primary data for the study. Informal discussions were also conducted with key informants who have vested interest, knowledge, and experience in the Jatropha system to generate both socio-economic data and other information on economic, technical, social, and political aspects of the Jatropha system. The key informants included local community leaders (e.g. village head) and resident Agricultural or Forestry Conservation extension personnel. The community leaders were asked to provide information on issues of land tenure, gender, and access to resources. The extension personnel were asked to inform on current technologies and practices in the Jatropha system; its production and utilization, as well as the level of adoption of these technologies in the area. The informal discussions with the informants sought information on the history, current work, and future plans on the Jatropha system in the area.

Secondary data were collected through literature study of various articles (both published and unpublished) on Jatropha and the Jatropha system, specifically on previous studies from the region and the rest of the world. The literature study sought information from journal articles and other working papers on:

- History and distribution of Jatropha in the country and the rest of the world,
- List and type of by-products from the Jatropha system, and
- Economic evaluation of the Jatropha system.

Questionnaire Survey and Focus Group Discussion

A household questionnaire was designed and administered for this study. It explored information on socio-economic characteristics of the households, their farming systems, land ownership and utilization patterns, farm resource endowments, farmer perceptions on the Jatropha system, and farm management data, among many other things. A total of 120 households were interviewed. Purposive sampling method was employed to capture mainly the characteristics of smallholder farmers in the Jatropha producing areas of Mutoko district. In addition, a focus group discussion (FGD) was conducted with a group of 43 Jatropha producers to get a common position and gain clear understanding of socio-economic issues in the Jatropha system. The FGD was conducted soon after the household questionnaire administration was completed to ensure that individual farmer responses were not influenced by outcomes of the FGD.

Wealth Ranking

Wealth ranking provides a way to group farmers and analyze their preferences (Bellon, 2001). Following the approach suggested in Bellon (2001), the study ranked farmers into high and low resource farmers. The approach entails identification of key informants with thorough knowledge of the research subjects to categorize them according to wealth, in terms of asset ownership. In this study, extension workers resident in the wards were given completed questionnaires from their particular ward and asked to categorize the sampled farmers into either the high resource or low resource wealth category. This was done after discussing with the extension workers on what constituted a high resource or low resource household[1].

Regression Analysis

Regression analysis is a multivariate analysis type which involves examining multiple variables, while at the same time investigating the relationship between dependent variable with variation in one independent variable *ceteris paribus* (Chiputwa, 2006). In this study, two types of regression analysis have been used, namely the binary logistic (logit) and Tobit multiple linear regression models.

The Binary Logistic (Logit) Model

This study uses the binary logistic regression model (logit), which is more or less similar to a linear regression model only that it is applicable to models where the dependent variable is dichotomous. Probit and logit estimations are used when the outcome variable takes two possible states, hence, the name binary models. These models have been used in economic literature to gauge the probability of choosing one option over another (Chiputwa, 2006; Lemchi *et al*, 2005; Jera, 2004, Muhammad and Muhammad, 2003; Bacha *et al*, 2001; Lwayo and Maritim, n.d). The binary logistic regression (logit) model is used because the dependent variable is a dichotomy (e.g. yes or no) and the independent variables are continuous and/or categorical. Following Long (1997), the model is generally presented as:

$$\Pr(y_i = 1 | x_i) = \frac{\exp(x_i \beta)}{1 + \exp(x_i \beta)} = \frac{1}{1 + \exp(-x_i \beta)}$$

Where:

$\Pr(y_i = 1 | x_i)$ represents the probability of an event happening if the dependent variable takes a value of 1, given an independent variable x_i.

x_i represents all vectors of the independent variables and their explanatory power can be explained by the intercept.

[1] A household is often defined as a group of people who live together and eat from the same pot (Bellon, 2001)

The model has the advantage that its regression coefficients can be used to depict odds ratios (the probability of success relative to failure) for each independent variable in the model. An odds ratio that is greater than 1 implies that a unit increase in the continuous variable or discrete change in the categorical variable among the independent variables leads to a decrease in the odds of a household being an adopter versus being a non-adopter. The Logit model is simple to understand and its parameter estimates are asymptotically consistent and efficient (Long, 1997). The other advantage of using the BRM is that it does not necessarily require the variables to be normally distributed. The model's appropriateness to data can be detected using the model Chi-square or F-test, just like the OLS regression model. The model has its limitations in that it cannot analyze the intensity of adoption or utilization of a given practice. It is very sensitive to model specification, thereby requiring larger sample sizes for the estimates to be efficient.

Tobit Regression Model

It is often the case that in adoption studies we do not only want to know probability that a farmer has adopted a technology but also the extent of use of the technology after adoption. To simultaneously explain probability of adoption and intensity of use of the technology, the use of a Tobit model is appropriate (Langyintuo and Mekuria, 2005). Direct application of the Tobit estimation sufficiently provides the needed information on adoption probability and the intensity of use of Jatropha commercialization or subsistence utilization.

The Tobit model can be specified as:

$$t_i = x_i\beta + u_i: \qquad \text{If } x_i\beta + u_i > 0$$

$$= 0 \qquad \text{If } x_i\beta + u_i \leq 0$$

$$i = 1,2,\ldots.n$$

Where:

t_i is the technology (commercial utilization in this case).

X_i represents the vector of independent variables.

u_i: is the disturbance or error term

The model assumes that there is an unobserved latent variable which is positive $(X_i \beta + u_i > 0)$ in that case there is adoption of the technology and negative or zero $(X_i \beta + u_i \leq 0)$ in the case of non-adoption (Baidu-Forson, 1999).

Finding the effect of an independent variable on the expected value of a dependent variable E_t for all cases requires examining the formula for the first-order partial derivative of Tobit model equation, such that:

$$\frac{\delta E_t}{\delta X_k} = F(z) \times \frac{\delta Et^*}{\delta X_k} + E_t^* \times \frac{\delta F(z)}{\delta X_k}$$

Where:

E_t^* is the expected value of *t* for cases above the limit (adopters or commercializers).

$\frac{\delta Et^*}{\delta X_k}$ tells how the intensity of adoption will change due to a change in a specific independent variable.

$\frac{\delta F(z)}{\delta X_k}$ tells the effect of a particular independent variable on the probability of adopting.

RESULTS AND DISCUSSION

Commercial Utilization of Jatropha

Commercialization in the context of this study, refers to derivation of financial benefits from the Jatropha hedges through selling or processing of Jatropha into various consumer products used at home as substitutes of the rest. Commercialization (marketing and value addition) has been encouraged by the introduction of the plant oil and bio-diesel projects in the area, which uses Jatropha seeds in manufacturing bio-fuels, such as diesel and paraffin. The projects have also introduced techniques of processing Jatropha into various household commodities, such as soap, candles, and floor polish as a way of improving rural livelihoods. Most of these products are produced for home consumption, while some are sold on the local market. Either way, households benefit from the extra income generated from Jatropha product marketing or from reducing consumption expenditure on the farm.

Value addition on Jatropha is still a relatively new concept needing extensive promotion through farmer training and education. Only 9.5 percent of the households are involved in processing of Jatropha into household commodities. A greater proportion (55%) of the Jatropha processing households (or 5.3% of Jatropha producers) indicated to have sold some of the commodities they produce, but generally value addition is done on products meant for domestic consumption only since the farmers still lack capacity in terms of working capital, appropriate technology (machinery) and technical know how. Marketing of Jatropha and/or its products is being undertaken by 64.7 percent of the Jatropha producing households to generate supplementary income. This study considers those households that have sold Jatropha and/or processed Jatropha products more than once, as *commercializing*, otherwise, they are *non-commercializers*.

Factors Influencing Jatropha Commercial Utilization

A number of previous studies have analyzed the effects of socio-economic variables on the decision by farmers to adopt agricultural technologies (Chiputwa, 2006; Lemchi *et al*, 2005; Jera, 2004; Muhammad and Muhammad, 2003; Bacha *et al*, 2001; Lwayo and Maritim, n.d.). Variables mainly considered in these studies include, gender, age, marital status, household size, level of education, landholding, and access to agricultural services such as extension and credit. Landholding or farm size has been commonly considered in most adoption studies and it seems that a certain threshold farm size has to be attained for a farmer to consider adopting a new concept. There are also other factors that have been considered in this analysis, such as perception about market conditions (especially commodity price) and purpose for which Jatropha was initially planted to serve.

In analyzing factors influencing the farmers' decision to adopt different concepts of Jatropha utilization, it may not be enough to only know the probability that a farmer will adopt commercial utilization of Jatropha but it is also critical to know the extent of continued commercial utilization after adoption. To simultaneously explain probability of adoption, and intensity of use of the technology, the use of the Tobit model is also appropriate.

The Logit can also be specified as:

$$\ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 X_1 + \dots\dots\dots\dots + \beta_k X_k + e$$

where P_i = probability of adoption, β_i = coefficients, X_i = independent variables, and e = error term.

The dependent variable is the natural log of the probability of a household engaging in commercial utilization of Jatropha (P_i) divided by the probability of not engaging in commercial utilization of Jatropha ($1-P_i$).

Dependant variable: Commercial utilization or non-commercial utilization of Jatropha (If commercialized then 1, otherwise 0).

$$Commercialization = \beta_0 + \beta_1 Sex + \beta_2 Age + \beta_3 Hhsize + \beta_4 Literacy + \beta_5 Landsize + \beta_6 Wealthcat + \beta_7 Incomesorce + \beta_8 Credit + \beta_9 Extension + \beta_{10} Perceptn$$

Where ,

β_0	= denotes the intercept term
β1 - β12	= unknown parameters to be estimated
Commercialization	= commercialization of Jatropha (if commercialized =1, otherwise =0)
Sex	= sex of household head (if male = 1, otherwise = 0)
Age	= age of household head
Hhsize	= size of the household
Literacy	= household head's educational level (None =0, Primary =1, Educated = 2)
Landsize	= size of total arable land
Wealthcat	= wealth category of household
Incomesorce	= major source of income (if on-farm = 1, otherwise = 0)
Credit	= access to agricultural credit (if having access = 1, otherwise = 0)
Extnadvc	= frequency of contact with agricultural extension (none = 0, sometimes =1, always = 2)
JCppltn	= Number of Jatropha trees on the farm
Perceptn	= perception about selling price of Jatropha (if positive = 1, otherwise = 0)

The Logit and Tobit regression models are run first with Commercialization as the dependant variable and then with Subsistence Utilization as the dependant variable to determine the extent of both commercial and subsistence utilization of Jatropha. Table 2 (below) presents the results of Logit and Tobit regression analyses of factors affecting Jatropha commercialization decision (commercialize or not commercialize) by households. The results show that three explanatory variables, namely size of land holding, wealth category, and perception about the selling price of Jatropha are significant in influencing the probability of commercializing (or not commercializing) Jatropha by households. The estimated coefficients of the Logit model represent a change in odds, or the ratio of the probability of adopting over the probability of non-adoption while the marginal effects of the Tobit indicate adoption probability and use intensity in terms of post-harvest utilization of Jatropha.

The size of arable land that a farmer possesses has a negative and significant relationship with the probability of adopting commercial utilization of Jatropha. The probability of adopting any Jatropha utilization option decreases by a factor 0.11 for a unit increase in the size of landholdings.

Table 2: Logit and Tobit Analyses of Jatropha Commercial Utilization

Variable	LOGIT			TOBIT			
	Coefficient (β)	***Odds Ratio (expβ)***	***z*-value**	**Coefficient (β)**	***t*-value**	***Marginal Effects***[2]	
						Adoption Probability	***Use Intensity***
Sex	0.8804784	0.2089403	1.64	0.4931256	1.79	.129578	.1308629
Age	0.0116667	0.0026364	0.71	0.0080159	0.97	.001517	.0017383
Household size	0.0190919	0.0043143	0.16	0.0120703	0.19	.004919	.0056357
Literacy	0.2244359	0.0507174	0.58	0.1483793	0.74	.032470	.037198
Total land size	-0.4960581	-0.1120977	2.83***	-0.2137496	-3.34***	-.076360***	-.08747***
Wealth Category	-1.067497	-0.2412298	1.98**	-0.5546075	-2.04**	-.136448*	-.1563148*
Major source of income	-0.4224473	-0.0954634	0.92	-0.2609535	-1.10	-.057970	-.0664104
Access to credit	1.043865	0.2034409	1.46	0.5469312	1.54	.120998	.1689672*
Frequency of extension contact	0.3283361	0.0741964	0.94	0.1378447	0.79	.038972	.0446472
Number of JC trees on farm	0.0068353	0.0015446	1.45	0.0033629	0.171	.000884	.0010136
Perception about Jatropha price	-1.463154	-0.3502619	1.66*	-0.7616603	-1.81	-.232752*	-.1999436
Cons	1.162787	-	0.58	1.38514	1.38	.289336	.331463
No. of obs	**116**			**116**			
LR Chi^2	**22.75**			**22.32**			
Prob>Chi^2	**0.0192**			**0.0220**			
Pseudo R^2	**0.1487**			**0.1015**			
Log likelihood	**-65.107677**			**-98.735506**			

*significant at 10% level, **significant at 5% level, ***significant at 1% level

[2] Refer to section 3.3.3.2.1 for an explanation of how to derive marginal effects after Tobit.

Since Jatropha was traditionally being planted for the purpose of keeping out animals from crop fields and mainly grown along farm boundaries, it is most likely that farmers with smaller landholdings would choose to fence their plots since it is easier compared to fencing larger plots. In terms of harvesting, it becomes easier for a household to harvest on a smaller perimeter of hedges of a plot than on a larger one. The results from the Tobit model indicate reductions in both use intensity and adoption probability of 0.09 and 0.08, respectively, when the size of land holding is increased by a single acre. Landholding or farm size is, therefore, critical in determining a farmer's decision to adopt or intensify post-harvest commercial utilization in the Jatropha system.

A significant negative relationship also exists between the household's wealth category and the probability of adopting Jatropha commercialization. The odds of adopting Jatropha for commercial utilization increase by a factor of 0.24 for poorer (low resource) households. The adoption probability for non-commercializing households and commercial utilization intensity of use decreases by 14 and 16 percentage points, respectively, when a household's wealth status improves from being poor (low-resource) to being rich (high-resource). This may be explained by the fact that Jatropha marketing is a low capital investment which makes it ideal for low resource farmers to venture into. The picking (harvesting) and selling of Jatropha does not require any machinery, capital, or specialized skills to effect. There may be a possibility that, like most agroforestry options, Jatropha may be perceived by high resource farmers as inferior and a technology for poorer farmers.

The decision to adopt commercial utilization of Jatropha is also significantly influenced by the farmers' perception about the selling price of Jatropha. Results of the Logit analysis show that the perception of a farmer towards the selling price has a negative significant relationship with the probability of commercializing. The odds of adopting post-harvest commercial utilization of Jatropha decrease by a factor of 0.35 when the farmers perceive the selling price of Jatropha as too low and unattractive. This is a common expectation in the (micro) economics of the household or farm. Producer price of a commodity determines the level of supply to the market. Innovations that present desirable attributes and command good perception by the target group are known to command greater chances of adoption by the clientele (Lemchi *et al,* 2005). The adoption probability of non-commercializing households decreases by 23% when the selling price is perceived to be unattractive, while the use intensity by commercializing households increases by 17% when access to credit is there.

Logit and Tobit Analyses of Factors Affecting Subsistence Utilization of Jatropha

Table 3 (below) summarizes the results of Logit and Tobit regression analyses of factors affecting adoption of Jatropha Subsistence Utilization (adopt or not adopt subsistence processing) by households. Also presented are the adoption probability (by non-utilizers) and use intensity (by utilizers for subsistence).

Table 3: Logit and Tobit Analyses of Jatropha Subsistence Utilization

Variable	LOGIT			TOBIT			
	Coefficient (β)	*Odds Ratio (expβ)*	*z*-value	Coefficient (β)	*t*-value	Marginal Effects	
						Adoption Probability	Use Intensity
Sex	-.0737036	-.0058776	-0.09	.0734518	0.13	.0097673	.0123798
Age	.0377056	.0029566	1.35	.0275588	1.35	.0037373	.0046856
Household size	.4791122	.0375691	2.16**	.3067046	2.00**	.0415926**	.052146**
Literacy	.0189021	.0014822	0.979	.1427279	0.28	.0193555	.0242669
Size of arable land	.2389385	.0187361	1.51	.1623009	1.56	.0220098	.0275947
Wealth Category	.2224837	.0174458	0.754	.1973724	0.38	.0267659	.0335576
Major source of income	-.2984093	-.0233994	0.660	-.2003311	-0.43	-.0271671	-.0340607
Access to credit	-2.338266	-.1106502	-1.85***	-1.678844	-1.93*	-.1378044	-.2322786
Frequency of extension contact	.1353176	.0106108	0.794	.176512	0.48	.023937	.0300109
Number of JC trees on farm	-.023559	-.0018473	-2.62***	-.0168204	-2.46**	-.002281**	-.00286**
Perception about Jatropha price	.4458792	.0410292	0.33	.4725537	0.53	.0772831	.0880729
Cons	-4.349814	-	-1.39	-3.340499	-1.42	-.4530089	-.5679583
No. of obs	**102**			**102**			
LR Chi^2	**18.16**			**18.50**			
Prob>Chi^2	**0.0778**			**0.0707**			
Pseudo R^2	**0.2050**			**0.1590**			
Log likelihood	**-35.229674**			**-48.938435**			

*significant at 10% level, **significant at 5% level, ***significant at 1% level

Three explanatory variables, namely size of the household, access to credit, and Jatropha tree population on the farm were found to have significant influence on the probability of subsistence utilization of Jatropha by non-commercializing households. These factors were significant for both models but only differed in terms of level of significance. Size of household and Jatropha tree population on the farm were found significant in influencing intensity of use of subsistence utilization by households. Access to credit has been shown to have no significant influence on both adoption probability and use intensity.

From the results in Table 3, size of the household is positive and significantly related to the probability of the household engaging in subsistence utilization of Jatropha. The probability of adopting Jatropha subsistence utilization increases by 0.38 when the size of household is increased by one person. The adoption probability by non-utilizing households increases by 0.42 and the intensity of use by subsistence utilizers increases by 0.52 when the size of the household is increased by one more person. The size of the household has a bearing on labor availability and level of household expenditure on the farm. Harvesting of Jatropha requires quite a sizable amount of labor force for significant quantities to be realized. A larger household's expenditure on consumption of commodities, such as paraffin and soap, is higher compared to smaller households and this may induce them to engage in Jatropha processing as an expenditure reduction (or cost-cutting) strategy.

A significant negative relationship exists between the household's access to credit and the probability of adopting Jatropha commercialization. The probability of adopting the Jatropha system decreases by a factor of 0.11 when the household has access to agricultural credit. If a household accesses credit it means its capital base has improved and the household can now afford investment in enterprises with higher returns. However, access to credit was not significant in influencing the adoption probability and use intensity in subsistence utilization. This implies that a household's decision to adopt or intensify subsistence utilization of Jatropha is not influenced by whether or not the household has access to credit.

The decision to adopt Jatropha subsistence utilization is also significantly influenced by the size of Jatropha plantation (in terms of tree population) owned by the household. Results of the Logit analysis show that the Jatropha tree population size has a negative significant relationship with the probability of adopting subsistence utilization. The odds of adopting subsistence utilization decrease by a factor of 0.0018 when the Jatropha plant population is increased by one tree. The marginal effects after logit also show decreases of 0.0023 and 0.0029 for adoption probability and use intensity of subsistence utilization by the households.

CONCLUSION AND RECOMMENDATIONS

This paper examined the adoption profile of Jatropha utilization options and factors that have influenced them. Econometric analyses of factors driving the adoption process gave some levels of reliable statistical accuracy in that the factors considered were important in influencing the adoption decisions of the respondents. The strengths of the impacts of the individual variables included in the models, however, differed. The farm size, household size, wealth category, access to credit, Jatropha tree population, and farmer's perception about the selling price of Jatropha are the variables that were found to be significant in shaping the decisions of households on whether to commercialize or not. Statistically, the decision to adopt and intensify use of Jatropha utilization options is based on the wealth category of the farmer. Farmers considered to be poor are in that condition because they have fewer income generating options for improving their livelihoods, hence, they are likely to accept any new option that increases their income base or reduces expenditure.

For successful Jatropha commercialization to be realized and the smallholder farmers' livelihoods improved, there is need for GoZ to put in place a complete package of incentives that will stimulate optimal exploitation of the Jatropha plant. These incentives should include, among others, adjusting the selling price in commensurate with the level of inflation and promoting investment in Jatropha by private players so that there is competition and viability for the farmer. Value addition should also be promoted for the supply of cheaper and cost-saving household products. If, for example, soap production grows in the future, and demand for Jatropha seed along with it, some more plantations may become necessary. At that point, the price for a kilogram of seed will have to be attractive relative to prices of other cash crops. Any increased demand for the output of live hedges will encourage their establishment and increase environmental benefits. Jatropha should not be taken as an alternative to conventional crop production but a necessary complement to it.

ACKNOWLEDGEMENTS

Greatly acknowledged is financial support from the African Network for Agroforestry Education (ANAFE) for necessitating the undertaking and completion of this research. The African Economic Research Consortium (AERC) and RUFORUM are also acknowledged for providing some funding during my undertaking of coursework which gave birth to this research work. My CMAAE colleagues played a very instrumental role in motivating the successful implementation of this study. I also would like to thank Sekuru Katehwe and Mr. Chiwashira of the UZ Department of Agricultural Economics and Extension for their support. Lastly but not least, I thank my supervisor, Dr. R. Mano for his guidance in carrying out activities of this research study. His commitment and hard work immensely contributed to the success of this piece of work.

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