Farmers' Indigenous Knowledge in Managing and Using Jatropha Curcas in Bati District, Oromiya Zone, Amhara Region, Ethiopia

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Abstract
Farmers' indigenous knowledge is locally available, economically affordable, and sustainable encourages participatory decision-making and information. Farmer's indigenous knowledge of how to manage and use natural resources has made significant contributions to global knowledge. Farmers have accumulated IK about natural resources but this knowledge is not assessed, analyzed and documented Therefore, the study investigates the experience of farmers in growing Jatropha and how their immense knowledge of Jatropha cultivation practices can be captured and incorporated into development programmes to improve such practices. Indigenous knowledge must be documented, valued and integrated into development planning to maximize its usefulness for decision-making. Thus, this study assessed the general status of farmers' indigenous knowledge in managing and using Jatropha and the factors affecting the cultivation of Jatropha. The study was conducted in Bati District, Oromiya Zone, Amhara Region. A multistage sampling technique was used for the selection of the peasant association and sample respondents. A total of 150 farmers were interviewed to obtain primary data for the study. Both primary and secondary data were used. In this study, qualitative and quantitative data were collected and analyzed. Quantitative data analysis methods employed in this study were minimum and maximum values, mean, standard deviation, percentage, cross-tabulation, t-test and chi-square (x^2), and binary logit model using SPSS computer software program. The qualitative aspect of the study was conducted through group discussions and informal discussions with farmers and experts. The survey result shows that about 99.3% of the sample respondents were familiar with the plant and 90.7% know that the plant was introduced by farmers from another area. The survey results revealed that farmers have experience in and knowledge of Jatropha cultivation and use for a maximum of 36 years. A binary logistic regression model was fitted to analyze the potential variables affecting farmers' decision to grow Jatropha in the study area. Among 9 explanatory variables included in the logistic model, 5 of them were significant at less than 5 percent probability levels. These were the sex of the household, family size, education level of the household, total landholding size, and distance to the main marketplace. The model estimate correctly predicted 87.3% of the sample cases, 96% growers and 70% non- growers. To enhance the probability that farmers grow Jatropha encouraging the farmers by incentive and creating awareness of the positive characteristics of the plant should get a serious consideration.

Keywords: Indigenous Knowledge, Jatropha, Decision to Grow, Logit Model

Introduction

Background of the study

Indigenous knowledge (IK) is widely applied for different purposes, particularly within traditional communities. In the emerging global knowledge economy, a country's ability to build and mobilize knowledge capital is essential to sustainable development as the availability of physical and financial capital. The basic component of any country's knowledge system is its local knowledge (Warren). The fact that farmers' IK and practices are based on generations of experiences, and are constantly tested, evaluated and adapted through a continuous process of experimentation and innovation makes them the best fit under 'complex, diverse, and risk-prone' circumstances.

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 indoor smoke pollution from cooking using inefficient fuel and stoves in poorly ventilated spaces. This positive attribute of Jatropha, if fully tapped, may help save time for rural women 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 (Mujeyi).

The Indian experience shows that Jatropha curcas has the highest oil yield per hectare of tree-borne oil seeds. Apart from its potential as a substitute for diesel, it grows on marginal soils/lands of gravel, sandy or saline soils and also on the poorest stony soils and rock crevices. Its water and nutrient requirements are extremely low and withstands long periods of drought by shedding most of its leaves to reduce transpiration loss. It retains soil moisture and improves land capability and the environment. It is easy to establish and grows relatively faster.

The experience of Jatropha plantations in Ethiopia comes from the Amhara and Oromiya National Regional States where few investors have attempted to expand. Jatropha curcas plantation on concessions or enhance the Jatropha curcas seeds/kernel collection activities using out-growers schemes, although out-sourcing can ensure seeds collected from the right type species.

Jatropha curcas presently covers remarkable areas in some parts of Ethiopia. The expansion of this species is fast, especially in the northern part, where the availability of vast areas of marginal and abandoned lands is extensive. Plantation of this species expands in a large area of the Amhara Region, particularly the Bati district, where it is used mainly as a source of seed and cutting of the plant. Nevertheless, its potential was not explored widely. In addition, farmers who have been using and cultivating the plant in the district have currently started to develop and modify some of the cultivation practices using their IK. It is, therefore, in the effort of building on this emerging opportunity that this study, attempts to assess farmers' local or IK as well as factors limiting its adaptive.

Objectives

The Specific objectives of the study are to explore farmers' IK of the management and use of Jatropha curcas and to identify the factors affecting farmers' decision to grow Jatropha curcas.

Literature Review

Botanical Description of Jatropha curcas

Jatropha curcas L., commonly known as Jatropha or physic nut, is a succulent shrub or small tree, which belongs to the large Euphorbiaceae family. It originated in Central America but has been naturalized in most tropical and subtropical countries from South America to Africa and Asia (Wahl et al.). The genus name Jatropha derives from the Greek Jatros (doctor), and trophe (food), which implies medicinal uses. Curcas is the common name for physic nut in Malabar, India.

Jatropha curcas is a large shrub or small tree up to 5m tall and has a life expectancy of about 50 years. The plant develops a deep taproot and initially four shallow lateral roots. Normally, Jatropha flowers only once a year during the rainy season. In permanently humid regions or under irrigated conditions Jatropha flowers almost throughout the year. The seeds become mature when the capsule changes from green to yellow. Jatropha has a deciduous nature, shedding its leaves during the dry season. All plant components contain toxic elements, mainly phorbol esters.

Cultivation of Jatropha Curcas

Nowadays Jatropha curcas has attracted particular attention as a tropical energy plant. Cultivation of it assumes utmost importance to meet the large-scale demand and ensure a continuous supply of the resource material. Traditional propagation through stem cuttings is possible, but low seed yield and easy uprooting of established plants on poor and marginal soils hamper the practical utility of this method. Evaluation of tissue-culture-propagated plants of non-toxic Jatropha curcas was compared to seed-propagated plants. Normally five roots are formed from the plant seeds: one tap root and four lateral roots. Plants from cuttings do not develop the tap root, only the laterals (FACT).

In the tropics, the plant is widely used as a hedge in fields and settlements. It protects plants against wind erosion and keeps animals out. Jatropha is chosen mainly because it can easily be propagated by cuttings, densely planted for this purpose, and as the species is not browsed by cattle. The roots also form a protection against soil erosion by runoff if planted with Vetiver grass or lemon grass (FACT).

Indigenous Knowledge

Definition of Indigenous knowledge

According to Haverkort et al., the term indigenous is defined as local, tribal, and native. The word indigenous knowledge has many meanings and a distinction is made between local, traditional and indigenous knowledge. The term local or indigenous knowledge (IK) is used to distinguish the knowledge developed by a given community from international knowledge systems or scientific knowledge (Kolawole). However, the term indigenous knowledge has a broader and more flexible scope of meaning (Haverkort et al.). Some believe that such a definition is too narrow, in that it excludes people who may have lived in an area for a long period but are not necessarily the original inhabitants. This has led to a widespread use of the term local knowledge, a broader concept, which refers to the knowledge possessed by any group living off the land in a particular area for a long period. Many scholars consider it is not necessary to know if the people in question are the original inhabitants of an area; the important thing is to learn how the people, aboriginal or non-aboriginal, in a particular area view and interact with their environment so that their knowledge can be mobilized for the design of appropriate interventions".

'Knowledge is regarded as the body of mental inferences and conclusions that people build from different elements of information, and which allows them to take action in a given context' (Leeuwis and den Ban). According to (Joshi et al.), knowledge is defined as an output of learning, reasoning and perception and a basis for predictions of future events; it is people's understanding and interpretation based on some explainable logic of supposedly general validity. The term indigenous knowledge denotes a type of knowledge that has evolved within the community and has been passed on from one generation to another (Tripathi and Bhattarya).

(Beshah) puts indigenous knowledge as the result of social learning. "It is generated through social interaction as a person tries to make his/her environment suitable for living. A piece of knowledge on a given social phenomenon is developed, tested, improved upon and stored through utilization in the community of origin: thus, the knowledge is socially constructed" (Leeuwis and den Ban). Due to this fact, the knowledge becomes indigenous to the locality and its subsequent generation, he further adds that when knowledge developed in this manner is handed down from generation to generation it is called traditional knowledge. Nowadays, due to the ease of communication, people's knowledge tends to bring together useful components from different sources, changing its indigenous nature. For this reason, some practitioners prefer to use rural peoples' knowledge instead of Indigenous or traditional (Beshah).

In this study, the terms 'indigenous', 'local', and 'traditional' knowledge are used interchangeably and they will be used in the same manner.

Factors Influencing Jatropha Cultivation

Several previous studies have analyzed the effects of socioeconomic variables on the decision by farmers to adopt agricultural technologies (Chiputwa; Lemchi et al.; Sarwar and Goheer). Variables mainly considered in these studies include gender, age, 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 of farm size has to be attained for a farmer to consider adopting a new concept. Other factors have been considered in this analysis, such as the perception of Jatropha and the purpose for which Jatropha was initially planted.

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 Jatropha, but it is also critical to know the extent of farmers' knowledge about Jatropha. To simultaneously explain the probability of adoption, the use of the binary Logit model is also appropriate.

Analytical Framework

Adoption of innovation is the outcome of behavioural change processes which in turn involves decision-making (Koch). In addition, (Rogers) indicated that adoption is a mental process of deciding whether to adopt a given technology or not. The literature reviewed in the previous section also proved that adoption is not an instantaneous act, rather it is a process. It involves a series of decision-making stages implying a cognitive engagement in the process.

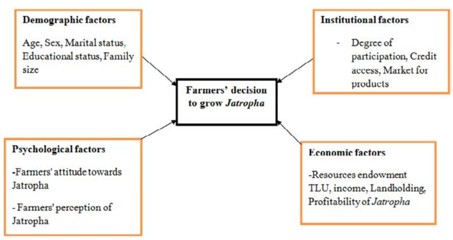

Figure 1 Analytical Framework for the Study

Methodology

Description of the Study Area

Location

Oromiya Zone of the Amhara National Regional State (ANRS) with its' capital town Kemissie, which is located 325 km away from Addis Ababa on the way to Dessie road. Bati district, the study area, is one of the food-insecure districts in the ANRS and it is one of the seven districts of the Oromiya Zone. Bati district is situated 420 km northeast of the capital city of the country, Addis Ababa, and 545 km from the capital city of ANRS, Bahir Dar. The capital of Bati district is Bati town. It is about 97 km away from Kemissie town. The district has 32 PAs out of which 23 are rural PAs and 9 are urban PAs. The geographical location of Bati district is $10^0 55'$ and $11^0 30'$ N latitudes and $39^0 50'$ and $40^0 15'$E longitude.

The total area of the district or the study area is 124,696 ha; it is 34.6% of the Oromiya Zone. It has an altitude range of 1001-2500 m.a.s.l. The district shares boundaries with Afar National Regional State in the east, Kalu district (South Wollo Zone) in the west, Werebabu (South Wollo Zone) and Dawa Chefa district (Oroimiya Zone) in the south. The study area is agro-ecologically classified as mid-altitude (Weyna dega) 19% and lowland (Kola) 81%.

Climate

Rainfall is bi-modal and the short rainy season (Belge) starts in January and extends to April. The long rainy season (Meher) starts in June and extends to September. The rainfall distribution in the study area is erratic in nature and from 500 to 1000 mm annually while the temperature ranges from 18 to 36^oC annually.

Topography and Soil Type

The landscape of the study district is classified as rugged terrain (42%), mountainous (20%), gorge (28%) and plane (10%). Even though a large part of the land is covered with scattered bushes or shrubs, the soil is very shallow and consists of highly weathered and fractured volcanic rocks. Most of the farm plots are found in the hillsides and at the bottom of mountains, following the valley, where the degree of vulnerability to erosion is very high. Type of soil found in the study district are black, red, sandy and grey soils and the makeup is about 23%, 12%, 11% and 54%, respectively.

Sampling Technique

The sampling technique employed to draw these 150 sample respondents' household heads was multistage sampling. First, among the 23 rural PAs in the district, five PAs were selected randomly namely Kurkura, Ournguo, Mumed, Mutuma and Jeldity. In the second step, 150 households were randomly selected from the household list and in each sample PAs were taken from the office of development agents and PA administrations (Table 1). Then the farm household stratified and identified evenly for each PA into 100 growers and 50 non-growers.

The stratification of sample household heads into growers and non-growers was done before data collection for the purpose of comparison to ensure that one-third of each sample PA belongs to the non-growers because, in the study area, almost all farmers grow Jatropha as a fence.

Table 1 Distribution of Sampled Household Heads by PAs

Peasant Association	Total number of HH	Percentage of each PA to total	Number of household heads in the sample
Ourngou	755	18	27
Kurkura	710	17	23
Mumed	1040	25	37
Mutuma	730	17	26
Jeldayti	980	23	37
Total	4215	100	150

Source: Agricultural Development Agent Office

Sample Size Determination

There are several approaches to determine the sample size. These include using a census for small populations, imitating a sample size of similar studies, using published tables, and applying formulas to calculate a sample size. This study applied a simplified formula provided by Yamane to determine the required sample size at 95% confidence level, degree of variability=0.5 and level of precision= 9% (0.09)

$n=N/\{1+N(l)^2\}$

Where n is the sample size, N is the population size (total household heads size), and e is the level of precision. The above formula required a minimum of 123 responses but this study was carried out on 150 respondents.

Type and Source of Data

For this study, both primary and secondary were collected and used, which are qualitative or quantitative. Primary data sources such as interviews with respondents and informal discussions with relevant key informants were used. Informal discussions were also conducted with key informants who have vested interest, knowledge, and experience in the Jatropha to generate both socio-economic and other information on economic, technical, and social aspects of the Jatropha. The key informants included local community leaders (e.g. village head) and Agricultural or Environmental experts. The community leaders were asked to provide information on issues of farmers' knowledge, and access to resources. The extension personnel were asked to inform on current technologies and practices in the Jatropha system; its production and utilization, and the level of adoption of these technologies in the area. Whereas, such data as coverage of plant population in the study area, and economic and environmental importance of the plant were collected from secondary sources such as district line department, NGOs, and other sources.

Method of Data Collection

Primary data were collected through various data collection methods or techniques. The researcher employed PRA methodology to gather general and specific qualitative information and data from focus groups and key informants; ranking, informal discussion and observation on the socio-economic and institutional situation of the area based on Jatropha production. To gather this information, two focus group discussions were held in Kurkura and Eila PAs with 5-6 persons per focus group discussion. Totally 11 persons for the focus group were approached, out of which four were women. Participants were selected based on a combination of sex, age, leadership position and Jatropha's growers and non-growers. The purpose of the focus group discussion was to collect information on the history of Jatropha, how it is shared, and who uses it.

Primary data on household socio-economic and culture were collected using a structured interview schedule. The interview schedule involved close-ended questions that were constructed and pre-tested and from the result of the pre-test, the schedule was revised and administered under the researcher's supervision. A structured interview schedule was used as an instrument to conduct a field survey on sample households.

Before commencing the primary data collection, five enumerators with at least secondary education who know the area, language, and culture were recruited to conduct the interviews. They were oriented on the objectives of the study and trained before commencing the work. They were trained on how to approach farmers, how to ask questions and how to apply other survey interview techniques for the field survey.

Data Analysis

Data was analyzed using both descriptive statistics and econometrics model, to draw meaningful inferences about the problem under investigation. Qualitative data analysis methods were also been employed starting from data collection from individual and group respondents, through interview schedules and group discussion. Quantitative data were also analyzed using descriptive statistics such as frequency, cross tabulation (chi-square test), descriptive (minimum and maximum values, mean, standard deviation, and percentage) and independent sample t-test (for comparison of group means) were applied with the use of statistical package for social science (SPSS). Moreover, a binary logistic regression model was used to see the relation between the dependent and the independent variables related to farmers' indigenous knowledge in managing and using to grow Jatropha.

Rationale for Choosing the Logit Model

Studies with a binary dependent variable (i.e. yes or no) can employ models, such as the Linear Probability Model (LPM), Probit and Logit models to see the relationship between the dummy response variable and the explanatory variables. However, the logit model has superiority over and is more frequently used by researchers than LPM and Probit models on the following grounds:

The conventional model, LPM, though having citable advantages, has meaningful limitations, such as the generation of predicted values outside the 0-1 intervals (which violets the basic principles of probability), the heteroscedastic nature of the variance of the disturbance term, and the non-reasonability of assumption of normality in the disturbance term (Greene). With such drawbacks of LPM, non-linear probability models (logit and probit), are suggested to satisfy the limitations of the former (Amemiya; Maddala). However, the choice of the logit model over the probit is that the former is easy and extremely flexible to manipulate, leads to meaningful interpretation (Hosmer et al.), and is simpler in estimation than the probit model (Pindyck and Rubinfeld). As a result, a binary logistic regression model was used to analyze farmers' indigenous knowledge in managing and using Jatropha in the study area.

Following Gujarati, the logistic distribution function for the decision to use the farmers' Indigenous knowledge can be specified as

$$p(i)=1/\{1+e^{-z(i)}\} \quad (1)$$

Where p (i) is the probability of deciding to grow Jatropha for the ith farmer and Z(i) is a function of m explanatory variables (Xi) and is expressed as:

$$Z(i)=\beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_m x_m \quad (2)$$

Where β_0 is the intercept and β_i is the slope parameter in the intercept in the model. The slopes tell how the log odds in favour of deciding to grow Jatropha change as the independent variables change by a unit.

The stimulus index Z_i also referred to as the log of the odds ratio in favor of deciding to grow Jatropha. The odds ratio is defined as the ratio of the probability that a farmer to grow Jatropha (p_i) to the probability that he/she will not ($1-P_i$)

But $(1-p_i) = 1/\{1+e^{z(i)}\}$ (3)

Therefore, $(p_i/\{1-p_i\}) = \{1+e^{z(i)}\}/\{1+e^{-z(i)}\} = e^{z(i)}$ (4)

and $\{p_{(i)}/(1-p_i)\} = \{1+e^{z(i)}\}/\{1+e^{-z(i)}\} = e^{\beta 0} + \Sigma^{m}_{i-1} \beta_i X_i$ (5)

Taking the natural logarithms of the odds ratio of equation (5) will result in what is known as the logit model as indicated below.

$$\ln \{p_{(i)}/(1-p_i)\} = \ln \{e^{\beta 0} + \Sigma^{m}_{i-1} \beta_i X_i\} = Z_i \quad (6)$$

If the disturbance term U_i is taken into account, the logit model becomes:

$$Z_i = \beta_0 + \Sigma \beta_i X_i + U_i \quad (7)$$

Hence, the above logit model was used and treated against potential variables assumed to determine farmers' decision to grow Jatropha.

Before including the hypothesized variable and running the model analyses the existence of a serious multicollinearity or high degree of association problem among independent variables for all continuous and dummy/discrete variables were checked. Contingency coefficients were computed from survey data to check the existence of a high degree of association problem among dummy independent variables. The contingency coefficient is a chi-square-based measure of association. A value of 0.75 or more indicates a stronger relationship (Maddala and Lahiri).

The decision rule for contingency coefficients says that when its value approaches 1, there is a problem of association between independent dummy variables. As indicated in Appendix Table 2 there is no problem of a high degree of association among independent dummy variables.

Variance Inflation Factor (VIF) was also checked for continuous variables using a statistical package known as SPSS.

According to Maddala and Lahiri, VIF can be defined as: $VIF(x_i) = 1/(1-R_i^2)$

The larger the value of VIF, the more will be the collinear of variable xi as a rule of thumb, if the VIF of a variable exceeds 10, there is multicollinearity. The VIF values displayed in Annex 3 have shown that all the continuous independent variables have no multicollinearity problem.

Definition of Variables and Working Hypotheses

Farmers' decision to grow Jatropha dependent variable for the logit model has a dichotomous nature that takes a value of 1 if the household decides to grow Jatropha to use their indigenous knowledge; and 0, otherwise. It is to identify the potential explanatory variables and to formulate hypotheses regarding their possible effects on the dependent variable.

Results and Discussion

Farmers' Knowledge about Jatropha

In this part, knowledge of the farmers refers to their understanding of the biophysical and socio-economic roles of the plant. Jatropha curcas exist in large amounts along roads and as live fences in the area. It's locally called "Gullo" and "Ayderke" The name implies that it is drought-resistant and evergreen during the dry season. According to the group discussion, Jatropha is commonly grown for 50 to 60 years in the area and was first introduced by farmers from other areas. The district BoARD indicated that Jatropha covered a total of 892.015 ha out of this 100.103 ha of land is planted by the Organization for Rehabilitation and Development in Amhara (ORDA) as communal land. As compared to other agroforestry trees like Acacia Senegal and Grevillea Robusta the survival rate of Jatropha is high. Farmers reported that pruning management practices are used for Jatropha if the plant's height increases since the collection of seed and shade will be difficult. The plant can easily be grown in any area, locally called "mongetekle". Farmers also mentioned in the group discussion that management practices such as irrigation and fertilizer application are not required for Jatropha. On the other hand, one of the non-grower participants has explained Jatropha ``the plant can easily grow in any area but it is not a good plant and we think of it as "gefi" thus we are not growing it'. The word "gift" means that it loses the wealth of the farmers or migrates to other areas and loses the person or something bad things will happen.

Table 2 Farmers' Response on this Knowledge of Jatropha and its Time of Introduction

Item	Household response		%	Mean	SD	Min	Max
	No	Yes					
Do you know Jatropha?	1	149	99.3				
How many years ago did you learn of Jatropha?				14.69	7.66	2	36
Did you get to know Jatropha from farmers in another area?	14	136	90.7				

SD=Standard deviation; **Source**: Own survey result

The survey result revealed that almost all the interviewed sample household heads (149 that is 99.3%) know or are familiar with the plant. Also, 136 (90.7%) of the respondents have introduced the plant through farmers from another area. The mean year when respondents heard about the plant was 14.7 years ago and it ranges from 2 to 36 years with a standard deviation of 7.7 years (Table 2).

The group discussion held with farmers revealed that they grow Jatropha for: (a) multipurpose uses such as live fences and soil conservation purposes. (b) Leaves are used to treat open wounds and medication for children's head wounds locally called "quakucha". (c) Jatropha is utilised for pest control and management. The leaves are packed in a jug filled with water for 5-6 days and then squeezed. Then the pressed juice is sprayed on the plant at a minimum amount. The farmers also acknowledge the poisonous nature of it by saying that if the water from the soaked leaves comes in contact with an eye can cause serious disaster to the extent of leading to blindness. (d) Jatropha seed lube oil is used for baking injera (Ethiopian traditional pancake) so it does not stick to the plate. (e) Is an income generation activity by women who are selling the seeds to cover expenses for children, pens and exercise books.

Insights into the History, Advantages and Disadvantages of Jatropha Curcas

The community has their insights which were built as indigenous knowledge through centuries. Hence, the researcher decided to explore the indigenous knowledge that they have about the history, advantages and disadvantages of Jatropha curcas through FGDs (focus group discussions) and discussions held with key informant interviews. In their view, Jatropha curcas (locally called Gullo) was said to have been brought into the surveyed community 50 to 60 years ago by a man called Hussien Dema who used to live in Kukura Mumechi Kebele of Bati district now he is dead. Farmers mentioned that Hussien brought the seed from Chefa, (Neighboring lowland district) and initially used the plant as fences around homesteads, livestock ranches and for protection from soil erosion. Afterwards, cognizant of the enormous use and benefits the plant has in terms of erosion protection, easiness of growing and other values; its cultivation was practised widely by other community members.

In addition to its use as a fence for livestock ranch, Jatropha is also been used as good farmland demarcation locally known as "Yedinber Astaraki" and for lightning purposes. Ten seeds of Jatropha curcas are said to be sufficient to give light for more than two hours. With regards to the mechanism of generating light, it was said that the seed will be put wire mesh will be used to generate light. Besides protection against soil erosion, accumulated pods and dropped leaves of Jatropha curcas are mentioned as a good source of fertilizer.

Having said this on the advantage of Jatropha curcas FGD participants mentioned the negative aspects of the plant as follows: due to its large and dense leaves Jatropha curcas can act as the canopy and prevent sunlight for the nearby crops by being a physical barrier and also compete with plant feed (nutrients), it is convenient to serve as a hiding place for harmful birds and animals, and the plant has watery milky liquid which is very harmful and toxic if it comes in contact into subcutaneous tissues of a human being.

Regarding purpose and motivation to grow Jatropha within (100) growers category respondents reported that the main purpose of growing the plant is for rehabilitating degraded land (79 that is 79%), hedges (98 that is 98%), and income generation (66 that is 66%) (Table 3). On the other hand, 67 (67%) of the respondents mentioned that they grow Jatropha because they were motivated by other farmers who have started growing in the area and because it's good as a fence. In the survey, 100 (100%) growers category of respondents reported sources of planting material were from farmers within the area (Table 3).

Table 3 Household Responses on the uses and Motivation to Grow Jatropha

Item	Household responses %	
	Yes	No
1. Motivation to grow		
Other farmer started	67	33
Extension worker advice	33	67
Government encouraged	30	70
NGO's encouraged	11	89
A biofuel company proposed	8	92

2. Purpose of planting		
Rehabilitating degraded land	79	21
Own energy supply	3	97
Hedge	98	2
Diversify income sources	66	34
3. Source of planting material		
Farmer	100	-
Market	-	100
Agricultural office	-	100
NGO's	1	99

Source: Own survey result

Almost all farmers reported that they were planting Jatropha by cutting. The findings of the survey within (100) growers category of respondents revealed that 5 (3.3%) and 95 (63.3%) were propagating by seeds and cuttings respectively and also 86 (57.3%) of the same respondents grow Jatropha as a fence/hedge, the rest 14 (9.3%) are growing it as monoculture (Table 4).

Table 4 Household Response on Propagation Method and Form of Planting

Item	Yes	No
1. Propagation method		
Seeds	5	3.3
Cutting	95	63.3
2. Form of planting		
Hedge/fence	86	57.3
Monoculture	14	9.3

Source: Own survey result

Farmers' Experience of Planting Jatropha

Farm experience of 100 growers sample households ranged from a minimum of 2 to a maximum of 36 years of starting to grow Jatropha. The average years of farm experience was 10.3 with a standard deviation of 6.61 years. About 100 (66.7%) growers of the respondents have more than 10 years of experience with farming Jatropha. To determine farmers' knowledge the number of years of farm experience of the household is important.

The result is in conformity with a prior expectation that those with longer years of experience in farming can acquire more knowledge and skills which enable them to be confident in their knowledge and to continue with it.

Households' Demographic Characteristics

Sex: Out of the total 150 sample household heads, 126 (84%) were male and 24 (16%) were female. More specifically, out of the 100 grower and 50 non-grower categories 91 (72.2%) were male and 9 (37.5%) were female, and 35 (27.8%) were male and 15 (62.5%) were female, respectively (Table 6).

A chi-square analysis was run to see the relationship between the sex of the household heads within each category of respondents to see whether it influenced the decision to grow Jatropha. The result indicated that it was significantly influenced at x^2=10.938 at $p<0.01$ (Table 6).

Age: The mean age of the respondents was 39.31 years with a standard deviation of 9.916 and it ranges from 19 up to 70 years. Within the category of respondents, 40.75 and 36.44 were the mean ages of growers and non-growers, respectively (Table 5). The result showed that the difference in mean age between growers and non-growers was significant at $p<0.01$. This result shows a positive relationship between the age of the household and the use of local knowledge. The implication is that the older the household heads are, the higher the probability of conserving and using indigenous knowledge.

Family size: Large family size may be an indicator of the availability of labour provided that there are more people within the age range of the active labour force. The availability of labour in the household is one of the important resources in agricultural activities. Based on this assumption, the variable was hypothesized to have a positive and significant relationship with the growers and non-growers category of the decision to grow Jatropha.

The overall mean family size was 5.4 persons, while it was 5.95 and 4.16 persons for growers and non-growers, respectively (Table 5). A large proportion of respondents, 46 (70.8%) of the growers had a family size of between 4-6 persons. This implies that household family size within the category is significant at $p<0.01$ probability level.

Education: Out of 150 sample respondents, 78 (52%) of them cannot read and write, 43 (28.7%) were able to read and write. In terms of schooling 19 (12.7%), 8 (5.3%), and 2 (1.3%) had 1-4, 5-8 and 9-12 grades, respectively (Table 5). The educational status of the respondents by farmer group shows that out of the sample grower and non-grower farmers, the highest proportion 44 (44%) and 34 (68%) cannot read and write, respectively. An independent sample t-test was conducted to see whether there is a difference between growers and non-growers in years of schooling for deciding to grow Jatropha. Therefore, the study showed that there is a significant difference in education status between growers and non- growers; with significance at p<0.01.

As was expected previously, education had a negative influence on conserving and using IK to manage and use Jatropha. Thus, those who are illiterate have stayed and prolonged with the IK acquired from their ancestors compared to those who were educated. But, in this study education has a positive influence on to growth of Jatropha.

Economic Factor

Landholding: The average landholding size of all respondents was 1.1 ha per household with a minimum of 0.25 ha and a maximum of 2.75 ha. The average land holding size was 0.85 ha for non-growers and 1.22 ha for growers (Table 5). However, a considerable proportion of respondents 42 growers and 28 non-growers had a total landholding size between 0.5-1.00 ha. The average landholding size for growers was significantly higher (p=0.00) than that of non-growers. This result is inconsistent with the prior assumption that landholding will positively influence farmers' decision to grow Jatropha. The assumption was that as farm size becomes large, it can be more laborious for farmers to apply the indigenous practices.

Livestock Holding: For several applications, there is a need to use a common unit to describe livestock numbers of various species as a single figure to express the total amount of livestock irrespective of the specific composition. To do this, the concept of an 'exchange ratio' has been developed, whereby different species of different average sizes can be compared and described about a common unit. This unit is the Tropical Livestock Unit (TLU).

To indicate the livestock holding of each household head in terms of total livestock unit (TLU), the TLU per household was calculated. The total TLU owned varied from 0 to 20.1 with an average of 4.0 and a standard deviation of 3.02. In this study, it was revealed that the average livestock ownership of growers and non-growers in TLU were 4.31 and 3.39, respectively (Table 5).

To know whether there is a variation in average livestock ownership between growers and non-growers and as a result, if there is any significant difference due to resource position, a t-test was applied. The result of the t-test showed that there is a significant variation in average livestock ownership between growers and non-growers at (p<0.01) probability level as indicated in Table 5. The previous assumption stated that livestock holding will have a positive and negative influence on farmers to grow Jatropha. The assumption was that those household heads having a large number of livestock tend to cultivate more Jatropha to protect their agricultural plots. On the other hand, if the land is covered by Jatropha, then the area of land remaining for cattle grazing will decrease hence discouraging livestock.

Institutional Factor

Market Access: Market accessibility is an important factor for farmers to adopt improved agricultural inputs. If farmers are closer- and have access to credit services will be able to easily purchase improved agricultural inputs and sell their agricultural output without moving for long distances. Out of the total respondents, 121 (80.7%) had access to the markets. On the other hand, distance from the main market varied from 4 up to 25 km with an average of 11.22 km and the standard deviation was 5.584. From the respondent category of growers and non-growers average distance from the main market was 11.99 and 9.69 km respectively. An independent sample t-test was conducted to see whether there is a mean difference between growers and non-growers by the distance from the main market. The result of the t-test showed that there is a significant mean difference between the farmers category at p<0.01 (Table 5). The result contradicts the prior assumptions the far the distance from the market places, has the least likelihood of adopting the technology. In this case, the distance from the main marketplace is not a factor in determining the farmer's decision to grow Jatropha because in this study the nearest market distance was covered by non-grower respondents.

Psychological Factor

Farmers' Perception: The characteristics of a technology such as its relative advantage and compatibility with farmers' situational circumstances an important factors in determining the decision to a specific technology. The relative superiority of the technology in terms of its advantage will enable farmers to have a favourable perception of the technology, which in turn enhances decisions in favour of the adoption of the technology. According to Duvel, perception is a key dimension in the behavioural change process. Hence, a favourable perception of the relative advantage of the innovation is an important prerequisite for the adoption of an innovation. Based on this fact, the perceived relative advantage of the plant was supposed to have a positive effect on the decision to grow Jatropha.

Farmers' Opinion about the Importance of Jatropha: Among the total respondents, 128 (85.3%) knew the importance of the plant. More specifically, within the farmers category 100 (78.1%) and 28 (21.9%) knew the importance of Jatropha to growers and non-growers respectively (Table 6). The remaining 22 (100%) of non-growers farmers were not aware of the importance of Jatropha. This shows that over half of the non-growers knew the importance of the plant thus farmers have a positive attitude about the plant.

A chi-square analysis was conducted to see the association between farmers' category and answers about the importance of the plant indicating that there was a significant association (x^2=51.56) at p=0.01 probability level.

Farmers' Perception of Soil Quality on Jatropha Plots as Compared to Other Farm Plot: Only grower farmers have responded to the comparison of soil quality of the Jatropha plot to other farm plots. This is mainly because of a lack of awareness by non-growers farmers regarding the issue. Of 100 growers respondents, 89 (89%) and 11 (11%) were good and same soil fertility respectively.

Summary of Result of Descriptive Analysis

Before passing to the econometric part of the analysis it is probably important to summarize the results of the descriptive statistics. In general about 12 explanatory variables were considered out of which, 8 of them had shown significant association with the farmer's decision to grow Jatropha.

Table 5 Results of Continuous/Discrete Explanatory Variables Mean Across Farmers Category

Variable	Mean across farmers categories		T-test	Expected	Observed
	Growers	Non-growers		Sign	Sign
Age of HH	40.75	36.44	-2.556***	+ve	+ve
Family size	5.95	4.16	-4.781***	+ve	+ve
Education of HH	1.92	1.42	-3.491***	-ve	+ve
TLU	4.3143	3.3982	-1.761*	+/-ve	+ve
Landholding	1.22	0.85	-4.275***	+ve	+ve
Total income	7139.76	5917.72	-1.032 NS	+ve	-ve
Distance of market	11.99	9.69	-3.056***	+ve	+ve

Source: Own survey result; *, *** = significant at 10% & 1% probability level; NS=Non significant

Table 6 Results of Dummy Explanatory Variables Percentage Proportion Across Farmers Category

Variable	Percentage proportion across farmers categories		p- value	Expected	Observed
	Growers	Non-growers		sign	sign
Sex of HH (Female=1)	37.5	62.5	0.001***	+ve	+ve
Marital status (Married=1)	67.7	32.3	0.497 NS	+ve	-ve
Access to credit (Yes=1)	66.7	33.3	1.000 NS	+ve	-ve
Degree of participation (Yes=1)	67.8	32.2	0.073 NS	+ve	-ve
Perception about Jatropha (Important=1)	78.1	21.9	0.000***	+ve	+ve

Source: Own survey result, ***= significant at 1% probability level, NS=Non-significant

Results of the Econometric Model

In the previous section, we dealt mainly with a description of the sample population and tested the existence of an association between the dependent and explanatory variables to identify factors affecting farmers' decision to grow Jatropha. Identification of these factors alone is however not enough to stimulate policy actions unless the relative influence of each factor is known for priority-based intervention. In this section, the Binary logistic regression model was used to estimate the effects of explanatory variables on farmers' decision to grow Jatropha. A detailed description of the hypothesized variables is indicated in Table 7.

Several variables which had shown a significant relationship with the dependent variable were tried to be included in the model. But, regardless of their importance and their significant relationship, some of them were excluded from the model. Finally, nine explanatory variables were considered to be included in the econometric model out of which five variables were found to be statistically significant (Table 8)

Table 7 List of Variables to be included in the Econometric Model

Variables	Description	Variable type	Value
AGEHH	Age of HH	Continuous	Measured in years
SEXHH	Sex of HH	Dummy	Takes a value of 1 is females and 0 for male
EDUHH	Education of HH	discrete	Measured in years of schooling
FAMILY	Family size of HH	Continuous	Measured in the number of HH member
MARISA	Marital status of HH	Dummy	Takes a value of 1 is married and 0 for the other
TOTLLIVSTO	Total TLU owned	Continuous	Measured in tropical livestock unit
TOFAINC	Total annual farm income	Continuous	Measured in Birr
LANDHOLDER	Total land holding of HH	Continuous	Measured in ha
DISMRKT	Distance of the main market	Continuous	Measured in km

Table 8 Logistic Regression Estimates of Factors Affecting Farmers' Decision to Grow

Variable	B	S.E	Sig.	M.E	Mean of X
SEX	-1.3938	.7076	.0489**	-.3118	.1600
AGE	.0237	.0241	.3249	.0046	39.3133
FAMSIZE	.3022	.1269	.0173**	.0582	5.3533
EDULEV	.7101	.2940	.0157**	.1367	1.7533
MARISTA	.3303	.3381	.3286	.0636	1.2800
TLU	-.0510	.0953	.5927	-.0098	4.0089
LANDHOLDER	1.2287	.5694	.0309**	.2365	1.1000
TOINCO	-.5236D-04	.4026D-04	.1934	-.0000	6732.4133
DISTMRK	.1082	.0515	.0357**	.0208	11.2233
Constant	-4.9588	1.3382	.0002	-.9544	
Number of observations 150, Chi-squared 50.41920, Log-likelihood function -70.26753, Degrees of freedom 8, Restricted log-likelihood -95.47713, Prob[ChiSqd > value] = .0000000, Hosmer-Lemeshow chi-squared = 5.32416, ** at 5% Significant level, M.E= Marginal effect					

The result shows that the sex of the HH (SEX), family size of the HH (FAMSIZE), education level (EDULEV), total size of land holding (LANDHOLDER), and distance of market (DISTMRK) were significantly related to farmers' decision to grow Jatropha (Table 8).

Sex of the HH: The sex of the household head influenced farmers' decision to grow Jatropha negatively and significantly at $p < 0.05$ significant level. Keeping all other factors constant, the sex of the household head decreases the probability of the decision to grow Jatropha by 0.3118 when the household head is female. This could be because females have less access to information than males. Likewise, the finding of Ellis and Mudhara showed that females have less access to any improved agricultural technologies and extension services which contributes to lower adoption of technologies.

Family size of the HH: The household family size positively influenced farmers' decision to grow Jatropha at $p< 0.05$ significant level. This implies that large families diversify their incomes to improve their livelihoods. The model results indicated that with all the other factors being kept constant an increase in household family number by one increases the probability of farmers' decision to grow Jatropha by 0.058. The result is consistent with the findings of Tizale.

Education level: The result of the study shows that education level positively influenced farmers' decisions at $p<0.05$ significance level. The model result shows that an increase in the education level of the household head by one year will increase the probability of growing Jatropha by 0.137. Farmer's education level also increases their understanding of the information and their use of practical knowledge.

Landholding: Total landholding size is one of the important variables that affected the decision to grow Jatropha at a $p< 0.05$ probability level. The decision to grow Jatropha was positively related to indigenous knowledge, proving the working hypothesis true. As many studies support it, farmers with larger land sizes are expected to adopt improved and new agricultural technologies in larger proportions than those with less farmland. The model result indicates that an increase of land holding by one hectare increases the probability of growing by 0.236.

Distance of market: Distance from the market has a positive and significant impact on the probability of growing Jatropha. This result may be because, in the study area, farmers grow Jatropha mainly as a fence and for soil and water conservation practices and not for sale. The model result indicated that an increase of the market distance by 1 km leads to an increased probability of growing Jatropha by 0.021 and is significant at $p < 0.05$ probability level.

Conclusions

This research examined the farmer's decision to grow Jatropha by using their indigenous knowledge and the factors that have influenced them. Econometric analysis of the factors driving the decision gave some levels of reliable statistical accuracy in that the factors considered were important in influencing the decision of the respondents. The strength of the independent variable included in the model, however, differs. Family size, education status, land holding size and distance to market were highly and positively significant in the model result. The other variable like the sex of the household when the household head is female was found to be negative and significant to the decision. Therefore, the majority of female household respondents (62.5%) were found to be in the category of non-growers. This may be because female households had less access to information which Jatropha production demands as a result of better access to production and marketing information to decision to grow than males.

The farmers recognized such positive attributes of the plant as soil fertility improvement, and the intermediate benefit found from the plant thereof. However, for successful Jatropha plantation farmers' indigenous knowledge is also playing an indispensable role. Therefore, exploring, identifying, documenting and preserving it will help significantly in the development process. Hence, to improve the livelihoods of smallholder farmers, there is a need to introduce an agricultural policy promoting a complete package of incentives that will stimulate optimal exploitation and create awareness of the Jatropha plant by the government. These incentives should include, among others, adjusting the selling price to improve farmer's livelihood. This means the price of Jatropha product for sale makes it attractive relative to other cash crops which leads to initiating farmers to grow Jatropha.

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Conflict of Interests

The author have declared that they have no conflict of interest

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