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Determinants of Stevia (stevia rebaudiana) Adoption by Small Scale Farmers in Kericho District, Kenya

Kibet R. Patrick[1] Mutai K. Benjamin [1] Kibet K. Lawrence[2]
1.Department of Agricultural Economics and Agribusiness Management, Egerton University, P.O. Box 536-20115, Egerton, Kenya
2.Department of Economics, Egerton University, P. O. Box 536-20115, Egerton, Kenya

Abstract
The aim of this study was to determine the socio-economic and institutional factors influencing Stevia adoption in Kericho District Kenya. A structured questionnaire was used to collect data from farmers both adopters and non adopters of Stevia through face to face interviews where purposive sampling methods were employed respectively and 150 respondents were contacted in total. Heckman two-step regression analysis was used to determine factors affecting Stevia adoption as well as the extent of adoption. The results showed that group membership, gender, education extension services and individual land ownership significantly and positively affected the adoption of Stevia while age was significant with negative effect. Household size, farm size, revenue from Stevia and access to extension services significantly and positively influenced the extent of adoption. In conclusion, there is need for more effort in terms of extension service so as to encourage farmers to adopt improved crop varieties through demonstrations on farmers' fields, field days, farm visits and agricultural shows and also development of institutional strategies to support farmers. Therefore policy interventions is recommended to enhance access to credit, reduce illiteracy levels among farmers through training and extension services.
Keywords: Stevia, adoption, socioeconomic factors

1.0 Introduction

Agricultural sector has continued to be the backbone of the Kenyan economy contributing directly 24% of Gross Domestic Product (GDP), over 60% of exports, 75% of the total labor force and over 80% of industrial raw materials (Owuor, 2009). Therefore, strengthening of the agricultural sector is a precondition for maintaining economic recovery and growth. The Kenya Vision 2030 and the Strategy for Revitalization of Agriculture have underscored the fact that productivity of farmers can be improved through use of modern technologies (GOK, 2007). Agricultural development has a powerful impact on poverty because it helps poor compared to development of other sectors. Research into new crops varieties for instance high yielding seeds and early maturing has been prompted by need to reduce poverty through agricultural activities (UNCRD, 2003). According to Ministry of finance and planning (2001) growing of high value crops and diversification into cash crops are among the strategies to reduce poverty. It's due to the need to create wealth and reduce poverty that Stevia was introduced in Kericho District.

According to GOK (2003) decline in agricultural productivity in Kenya has been due to poor access to farm credit high cost of farm inputs and absence of appropriate technology. Old and inefficient production technology and long maturity sugar variety are among the problems which has faced sugar industry in Kenya (Kaumbutho *et al*., 1996). The introduction of Stevia in Kericho District can save on importation of sugar, poverty alleviation through job creation by serving as cash crop as well as early maturity complementary crop for sugar production and hence ensure regular flow of income to farmers.

Stevia is a perennial shrub indigenous to Brazil and Paraguay where it has been used as a natural sweetener for hundreds of years. Stevia is also known as "sweet leaf" or "sugar leaf," (Carakostas, 2008). Stevia's leaves have a natural sweetness between 30 to 45 times that of regular sugar while its extracts having up to 400 times the sweetness of white sugar (Elkins, 1997). The sweet tasting components of the Stevia plant are called steviol glycosides which can be isolated and purified from the leaves of the Stevia plant added to some foods, beverages and tabletop sweeteners in the U.S. and elsewhere (Carakostas *et al*, 2008). In recent years, Stevia has been grown commercially and used as natural sweetener in many countries including Brazil, Paraguay, Japan, China, Korea, United States, Canada and parts of Europe (Atteh *et al*, 2007). Stevia products could only be marketed in the U.S. as dietary supplements but with the ruling of new Food and Drug Administration (FDA) has cleared the way for Stevia's expanded use and increased the market potential of this crop (Whitaker, 2010). In Canada, Stevia is being sold as an ingredient in tea but not as a sweetener. The leaves are used for sweetening, as is, or dried and pulverized, or soaked in water; the liquor is used for sweetening beverages. Jan (2002) concluded that Stevia and stevioside are safe when used as a sweetener.

Even though white sugar, turbinado, fructose, honey and corn syrup all qualify as natural sweeteners, all of them are calorie- free nor can they be used by people who suffer from blood sugar disorders. Stevia has been used in several areas of the world, such as in Brazil and Paraguay, as a natural control for diabetes

(Jeppesen *et al*. 2000). Stevia also has been used to help control weight in obese persons (Suttajit *et al.* 1993). Increasing interest in Stevia may be due to the decreasing popularity of artificial sweeteners and the increased consumer interest in natural organic products (Mitchell, 2003). Today, Japan is a major grower and marketer for the sweetener and has approved it for use in many food products, including cereals, teas, and soft drink (Soejarto *et al*. 1982). In China Stevia has been considered a major crop where there is production of more than 2,000 tons per year, but there has been a reduction due to lower demand and price from Japan. Paraguay which is the world's second largest producer currently has around 750 ha dedicated to Stevia and produced more than 500 tons per year. In 2003 Brazil produced 265 tons of Stevia (Midmore *et al*., 2002).

Commercial Stevia cultivation areas in Kenya are relatively minor. Stevia was introduced into Kenya in 2008 and interest in its production in has grown in recent years where currently James Finlay Kenya limited and PureCircle are contracting small-scale farmers where around 2200 farmers have been contracted to grow the cash crop where more than 1500 have been trained. Adoption of Stevia is mainly due to the fact that today more and more farmers are looking for a new alternative ways to improve their incomes that is threatened by various production problems. To improve adoption of Stevia in Kericho District in order to increase the low farm incomes, Ndege Chai Savings and Credit Cooperative (SACCO) and PureCircle Kenya (PCK) have initiated programmes that offer extension services on production and marketing of Stevia. The program operates in Rift Valley. Kericho District has approximately 176033 farmers (KDSP, 2005) and according to pure circle Kenya limited only about 2200 has managed to adopt Stevia.

2.0 Material and methods

2.1 Study area

Kericho District is located in Kericho County the district occupies a total of 2,110 km^2. The mean annual rainfall varies from 1800mm around Kericho town and the whole forest area from 1400mm to 1800mm. Kericho District occupies central section and is mainly a tea zone, and pineapples besides growing pyrethrum, maize and keeping dairy cattle and the newly introduced Stevia crop. The district was selected as the study area because it is accessible and it's where Stevia was first introduced in Kenya and has great number of farmers. It is also where PureCycle in conjunction with Finlays contract farmers to plant the crop.

2.2 Data and sampling design

Multi-stage sampling method was used in obtaining appropriate sample. Purposively sampling was used to select Kericho District. Within Kericho District two Divisions (Ainamoi and Belgut) were purposively selected. In each division, 2 locations were randomly selected to give a total of 4 locations. Each location was stratified into two groups of farmers: Stevia adopters and non-Stevia adopters. From each stratum farmers were randomly selected to give a total sample of 150 farmers (75 adopters and 75 non adopters).

2.3 Analysis framework

The decision to adopt Stevia or not is a binary choice. This is because of the dichotomous nature of the dependent variables, that is, to adopt or not to adopt. The decision on whether or not to adopt is considered under the general framework of utility or profit maximization (Norris and Batie 1987; Pryanishnikov and Katarina 2003). Within this framework, economic agents, in this case, smallholder farmers will decide to adopt Stevia if the perceived utility or net benefit from this option is significantly greater than in the case without adoption. Although utility is not directly observed, the actions of economic agents are observed through the choices they make. Suppose that Uj and U_k represent a household's utility for two choices, which are, correspondingly, denoted by Y_j and Y_k. The linear random utility model could then be specified as in equation 1:

$$U_{ij}(\beta_j X_i + e_j) > U_{ik}(\beta_k X_i + e_k),\ k \neq j\ \forall_i \quad (1)$$

where U_j and U_k are perceived utilities of adoption and non-adoption choices j and k, respectively, X_i is the vector of explanatory variables that influence the perceived desirability of each choice, β_j and β_k utility shifters, and e_j and e_k are error terms assumed to be independently and identically distributed (iid) (Greene 2000). In the case of adoption, if a household decides to use option j, it follows that the perceived utility or benefit from option j is greater than the utility from other options (say k) depicted as in equation 2;

$$U_{ij}(\beta_j X_i + e_j) > U_{ik}(\beta_k X_i + e_k),\ k \neq j\ \forall_i \quad (2)$$

The probability that a household will choose to adopt, i.e., choose method j instead of k could then be defined as:

$$P(Y = 1|X) = P(U_{ij} > U_{ik})$$
$$P(\beta j X_i + e_j - \beta_k X_i - e_k > 0|X)$$
$$P(\beta j X_i - \beta_k X_i + e_j - e_k > 0|X)$$
$$P(X^* X_i + e^* > 0|X = F(\beta^* X_i) \quad (3)$$

Where P is a probability function, U_{ij}, U_{ik}, and X_i are as defined above,
$e^* = e_j - e_k$ a random disturbance term,

$\beta_j^* = (\beta_j - \beta_k)$ a vector of unknown parameters that can be interpreted as a net influence of the vector of independent variables influencing adaptation, and $F(\beta^* X_i)$ cumulative distribution function of e^* evaluated at $\beta^* X_i$. The exact distribution of F depends on the distribution of the random disturbance term, e^*. Depending on the assumed distribution that the random disturbance term follows, several qualitative choice models can be estimated (Greene 2000). Any household decision on the alternative choices is underpinned by this theoretical framework, the realization of which can be implemented by a critically thought out conceptual framework.

To address objective two of this study Heckman two stage selection models were used to determine factors affecting adoption and extent of Stevia adoption in Kericho District. The farmers' behaviour that leads to a particular choice is modeled in a logical sequence, starting with the decision to adopt and then followed by a decision on the extent of adoption. The decision to either adopt or not in this study was built on utility maximization framework so that, the decision to adopt or not depends on whether adoption of Stevia gives the farmer higher utility than not adopting. Based on the nature of these decisions, it is justified to use the Heckman two stage selection models whose estimation involves two stages. This is only possible with two assumptions, first any choice an individual choose depends on his characteristics and secondly household are faced with only two alternative choices.

The expected utility derived by farmers by either adopting or not based on their characteristics were determined as follows;

The probit model used in the first stage is specified as;

Prob $(Y^*_i=1|X) = \int_{-\infty}^{X'\beta} \varphi(t)dt = \varphi(X'\beta)$ ……..……...…… (4)

where Y^* is an indicator variable equal to unity for households that adopt, $\varphi(.)$ the standard normal distribution function, βs the parameters to be estimated and Xs the determinants of the choice.

It follows therefore, that

$Y^*_I = \beta_i X_i + V_i$ ……..…….. (5)

Where Y^*_i is the latent level of utility the household gets from adoption and $V_i \sim N(0,1)$.

Given this assumption, it follows that:

if $Y^*_i > 0$ and $Y_i = 0$

Empirically the model can be represented as

$Y = \beta_j X_i + \varepsilon_i$..... (6)

Where Y *is* the probability of a household adopting given farmer characteristics X_i and ε_i the error term.

In the second step outcome equation involves the extent of adoption per household. Previous studies show that, estimation of such relationships is normally problematic due to sample selection bias. But according to Heckman (1979), Inverse Mills Ratio (IMR) in the Heckman two-step procedure is a correction term for the selectivity bias. To reconcile this problem, the decision to adopt is endogenously in this study will be treated to control for the potential sample selection problem. First the determinants of the decision to adopt will be estimated, and then the IMR from the selected equation will be used as an independent variable in the target equation that will be used to assess the determinants of the extent of adoption as shown

$E(Z_i | Y=1) = f(x_i\beta) + \gamma\lambda' + \mu_i$……..……..……..(7)

where E is the expectation operator, Z_i the (continuous) extent of value measured by the proportion of output from adoption, x a vector of independent variables influencing the extent of adoption and β a vector of the corresponding coefficients to be estimated, λ' the estimated IMR and $U_i \sim .N(0,\delta_u)$ Therefore Zi can be expressed as

$Z_i^* = \beta_i X + \gamma\lambda' + \mu_i$……..…..…...……..... (8)

is observed only if the farmer is adopting (Y=1)

Empirically this can be expressed as

$Z_i^* = \beta_i X + \gamma\lambda' + \mu_i$ ……..……..…..…… (9)

Where Z_i is the extent of adoption given the farm and farmer characteristics, $X_i\lambda'$ the IMR estimated in the Heckman model and u_i the error term.

$E(Z_i | Y=1) = f(x_i\beta) + \gamma\lambda' + \mu_i$……..……..…….. (10)

Where, Y_i is the extent of adoption. Y_i is assumed to have a normal distribution independent error term u, mean zero and constant variance.

Empirical model will be specified as follows,

Selection equation (Probit)

typfrmer = $\beta_0 + \beta_1$* (ageyrs) + β_2* (lnwealth) + β_3* (fbusines) + β_4* (individ) + β_5* (wtrirrig) +β_6* (edulevel) + β_7* (extbfore) + β_8* (gnder) + β_9* (dstmkt) + β_{10}* (creditk) + β_{11}* (hsize) + β_{12}* (farmsize) + β_{13}*(farmonly) ……..…… ……..(11)

Outcome equation (Simple OLS)

extent = α_0 + α_1* (ageyrs) + α_2* (creditk) + α_3* (fbusines) + α_4* (individ) + α_5* (wtrirrig) + α_6* (edulevel) + α_7* (extbfore) + α_8* (pasprice) + α_9* (farmonly)……..……..(12)

3.0 Results and discussion

The results of two tailed t-test of continuous socioeconomic characteristics of Stevia adopters and non adopters are presented in Table 1. These variables include age, household size, farm size, experience in farming contact with extension officers and off farm income and education in years.

Table 1: Summary of continuous socio-economic characteristics of adopter and non-adopters in Kericho District

Characteristics	Mean		overall	t-ratio	Sig
	Adopters	Non-adopters			
Age(years)	42.99	45.25	44.12	1.219	0.225
Household size	5.51	4.96	5.23	-1.787	0.076*
Farm size (ha)	1.83	1.54	1.68	-1.324	0.188
Experience(years)	19.84	20.79	20.31	0.534	0.594
Contact with extension	16.39	8.25	12.32	-13.645	0.000***
Off farm income per year	482098.4	177421.1	365151.5	-1.735	0.086*
Education(Years)	11.55	10.43	10.99	-1.683	0.095*

* Significant at 10%; ** significant at 5%; *** significant at 1%

Table 1 shows that the mean household size of adopters was about 6 members, while that of non-adopters was about 5 members. The overall household size was 5 members which are the same as Kenya's national mean of 5 members per household (CBS, 2005). Household size plays key role in determining decision to adopt new technology. Results of two-tailed test showed that household size was statistically significant indicating that non-adopters had smaller household size than adopters. Larger families may have pressure to create employment opportunities on the farm, and consequently encourage the operator to adopt a land use pattern that utilizes available resources more effectively, including family labor, in an effort to increase income. Raja-Rojas *et al*.(2012) in their study found parameter of house hold size to be positive and significant meaning that likelihood of adopting water conservation practices increases as family labour become more abundant.

The mean number of contact with extension officers for adopters was about 16 times per annum while that of non-adopters was about 8 times per annum. The overall mean was 12 times. The number of contact with extension officers hold plays key role in determining decision to adopt new technology. Results of a two-tailed t-test showed that number of contact with extension officers was statistically significant at 10% indicating that non-adopters of Stevia received less contact with extension officers than adopters per year. The number of contacts with extension officers was a proxy for access to information and thus according to the innovation diffusion theory it contributes to the awareness and subsequent adoption of the innovation (Dolisca, *et al*., 2006).

The mean amount of off farm income per year for adopters was about Kshs 482,098 while that of non-adopters was about Kshs 177,421.Amount of house hold off farm income plays a key role in determining decision to adopt new technologies. Results of two-tailed t-test showed that amount of off farm income was statistically significant at 10% indicating that non-adopters of Stevia have less amount of farm income than adopters. The influence of off-farm income in the adoption of new technologies is derived from the fact that income earned can be used to finance the uptake of new innovation (Amsalu and De Jan 2007).

The mean number of education in years for adopters was about 12 years while that for non-adopters was about 10 years. Education of house hold head in years plays a key role in determining decision to adopt new technologies. The number of years of formal education for adopters was significantly higher that of non adopters and results of two-tailed t-test showed that education in years was statistically significant at 10% indicating that non-adopters of Stevia have less numbers of years of education than adopters.

Table 2 : Categorical household socioeconomic and institutional characteristics of household heads in Kericho District.

Characteristics	Category	Percentages				
		Adopters	Non-adopter	Overall	Chi sq	Sig
Education	**None**	11.33	2.67	2	4.406	0.221
	Primary	37.33	38.67	38		
	Secondary	44	52	48		
	University	17.33	6.67	12		
Occupation	**Farming only**	84	89.33	86.67	2.123	0.346
	Farming with business	8	5.33	5.33		
	Farming with employment	8	8	8		
Gender	**Male**	65.33	78.67	72	3.31*	0.069
	Female	34.67	21.33	28		
Group memb	**Yes**	93.33	25.33	59.33	71.86***	0.000
	No	6.67	74.67	40.67		
Land tenure	**With title deed**	86.67	58.67	72.67	14.02***	0.000
	Otherwise	13.33	41.33	27.33		

* Significant at 10%; ** significant at 5%; *** significant at 1%

The results of the selected characteristics of household are presented in table 2. In terms of gender, the results show that among Stevia adopters 65.33% were men while 34.67% were women. On the other hand non-adopters of Stevia comprised of 78.67% men while women constituted 21.33%. Results of chi square showed that gender was statistically significant at 10% indicating that more adopters of Stevia were men than non-adopters. The household head in most cases was the person in charge of making most of the farming decisions and in overall 72% of the decision makers were men, this portrays that gender equality has not taken roots in Kericho District. This is a cultural problem where the society has put restrictions on opportunities enjoyed by either of the two sexes causing disparities between males and females. This may be due to the fact that male are considered to be the owners of land and other production resources according to the African culture, (Owuor *et al*., 2006).

In terms of group membership 93.33% of adopters of Stevia belong to a farmer group while 6.67% were not in a farmer group. Among the non-adopters of Stevia 25.33% were in farmer group while 74.67% do not belong to a farmer group. Results of chi square showed that group membership was statistically significant at 1% indicating that more adopters of Stevia were in a farmer groups than the non-adopters. According to Shiferaw *et al*. (2006) group membership role in generating support for adopting new innovation is that of information sharing and resource mobilization and higher market bargaining power.

In terms of land tenure 86.67 % of adopters had title deeds while 13.33% did not have title deeds. Among the non-adopters of Stevia 58.67 % had title deeds while 41.33% did not have title deeds. Results of chi square showed that land ownership with title deeds was statistically significant at 1% indicating that more adopters of Stevia owned land with title deeds than non-adopters. Land tenure provides the farmer with ownership and user rights which are necessary in long term projects and collateral which allows the farmer to access credit facilities to fund the investment (Mwirigi *et al*., 2009).

Table 4: Source of information on new technology

Main source of information	Frequency	Percentage
Neighbors	71	47.4
Field days	18	12
Company (PCK)	21	14
Radio	29	19.3
Relatives	11	7.3
	150	**100**

The main information sources of new technology are presented in table 4. The results reveals that the main source of is from neighbors at 47.4% followed by radio at 19.3%. Information from PCK, field days and relatives was 14%, 12% and 7.3% respectively. The implication of the results is that there is a strong social capital among the farmers and thus an approach that can be used to create awareness is to involve the model farmers and the communication can trickle down to the rest of the society.

3.1 Results of Heckman two stage procedure

Heckman two-step procedure was used to determine the factors affecting Stevia adoption and extent of adoption.

The procedure was chosen for estimation to correct the sample selection bias as proposed by Heckman (1979). The variables included in the estimation were age, occupation (variable representing farming as main activity and that for combination of farming and businesses), gender, wealth, distance to market, credit access, access to extension services, individual land tenure, farm size, household size, education level, Stevia price and access to irrigation water. Post estimation of the selection equation results was done to determine marginal effects of variables for use in interpretation. The reason is that coefficients have no direct interpretation because they are just values that maximize the likelihood function. On the other hand, marginal effects have direct interpretation and hence facilitate discussion of the results.

3.1.1 Factors influencing Stevia adoption

To identify the socio-economic and institutional factors affecting a farmer's decision to adopt Stevia, a probit model was estimated (Heckman selection equation) and the results are presented in Table5. Six variables Gender, Age, Group membership, Education in years, Land tenure and a number of visits by extension officers were found to significantly affect a farmer's decision to adopt Stevia. The coefficient of IMR was also significant and positive (0.009) indicating that there were unobserved variables that both increased the probability of selection and a higher than average score on the dependent variable. The results reveal that three coefficients are significant at 1%, one coefficient is significant at 5% and one coefficient at 10%.

Table 4: Selection equation results

Variable	dy/dx	Coef.	Std. Err.	z	P>|z|
Group membership	0.6806	1.9980	0.0974	6.99	0.0000***
Gender	-0.4046	-1.1296	0.1324	-3.06	0.0020***
Age in years	-0.0296	-0.0745	0.0101	-2.92	0.0040***
Education in years	0.0425	-0.1071	0.0192	-2.21	0.0270**
Household size	0.0024	0.0062	0.0372	0.07	0.9470
Farm size in ha	-0.0534	-0.1345	0.0595	-0.90	0.3690
Farming in years	0.0120	0.0303	0.0129	0.93	0.3520
Individual Land tenure	0.2660	0.6804	0.1482	1.79	0.0730*
Number of visits by extension officers	0.1056	0.2662	0.0211	5.02	0.0000***
Mills lambda	-0.0698	0.0631	-1.11		0.009***
Rho	-0.6008				
Sigma	0.1162				
Lambda	-0.0698				

* **indicates significance at 1%, ** significance at 5% and * significance at 10%

Group membership significantly and positively influenced Stevia adoption with a 1% increase in group membership increases the probability of adopting Stevia farming by 0.6806 %. This can be explained by the fact that awareness is critical factor in adoption of innovation. Individuals in groups are easily influenced by their associates than those in isolation. Social groups enable easy communication between farmers. Farmers get to exchange ideas and learn about the benefits of Stevia adoption and are thus willing to take the extra step of adoption. Members of groups also receive training on diverse issues among them the importance of Stevia and are therefore willing to take up Stevia as a means of improving their farm income hence poverty status. Social capital (in this case group membership) is a key instrument for exchange of ideas and in essence, farmers benefit both economically and socially if they belong to groups. Furthermore, members of farmer groups are in a better position to pull their resources together and take advantage of economies of scale. They access wider markets and higher prices unlike their colleagues who are not members of groups. This was consistent with the findings by Adesina *et al.* (2000) who found that belonging to a farmers group significantly influence the probability of adoption of alley cropping. Menale *et al.* (2011) found group membership to be statistically significantly associated with adoption of improved groundnuts.

In terms of gender, male members of the society tend not to adopt Stevia farming. Being male farmer decreases the conditional probability of adopting Stevia farming by 0.4046% at 1% confidence level. This is consistent with the findings by Murage *et al*. (2011) who observed that hazard ratio of gender was less than one and corresponding marginal effect indicated that being a male farmer delayed the conditional probability of adoption of technology by 0.77years. This is because women spend more time in farms than male farmers.

The coefficient of age is significant and negatively affects adoption of Stevia. An increase in age of household head by 1% leads to a decline in the probability of adopting Stevia farming by 0.0296%. The older the household head, the less likely that a household will adopt Stevia. This arises from the fact that as the decision maker grows older, they become risk averse and are not willing to venture into new fields or take part in activities that they are not certain about. Young farmers are better disposed to trying new innovations and are less risk averse and have longer planning horizons. Kaguongo *et al.* (2012) observed that age of the household head had a negative sign meaning that as age of household increase by one year the odds in favour of not adopting increase. However, according to Mignouno e*t al.* (2010) they observed age of household head to be

positive and significant meaning that older farmers adopt *imazypyr*-resistant maize than young farmers.

The coefficient of educational status is positive and significant. The positive coefficient of educational status means that there is a direct relationship between adoption of Stevia and educational status, whereby as educational status increases, adoption level also increases among farmers. An increase in year's education by 1% leads to an increase in the probability of Stevia farming by 0.0425%. This can be explained by the fact that as an individual gets more educated, he/she tends to acquire more information and skills that will help him/her in adopting new technologies. This is consistent with the findings by Mariano *et al.* (2012) who found education to be significantly and positively influencing adoption of certified seeds. This is also consistent with the findings by Lapar *et al.* (2004) who found farmers education as significant positive factor in adoption of forage species. The findings corroborate those of Murage *et al.* (2011) who observed that farmers with high level of education tend to adopt new technology than those with low level. These findings concur with those by Ndiema *et al*. (2007) who observed significant relationship between farmers' level of education and technology awareness in wheat production It is believed farmers with better education have greater ability to process information and search for technologies suitable to production constraints than those who are less educated .Vink and VIlijoen (1993) concluded that low education level is the most limiting factor in the uptake of innovation among small scale farmers.

As expected individual land tenure system had a positive significant effect with having land rights increasing the probability of Stevia adoption by 0.2660%. This means that security in land use enables farmers to adopt agricultural technologies. Those farmers who privately owned land were more able to adopt Stevia than those who were under leasehold and community land tenure systems due to security of tenure and thus creating an incentive for farmers to adopt new, long term and even riskier agricultural technologies. This indicates that those with title deeds have absolute rights over the parcel of land and usage thus influences decision to adopting and planting new crops. Ayuya *et al*. (2011) found out that security in land tenure significantly and positively affects adoption of clean development mechanism projects.

The coefficient of contact with extension agents is positive and significant at 1% level. This agrees with the expectation that there is a positive significant relationship between extension contact and adoption of Stevia in the study area. The positive relationship suggests that, adoption of Stevia increases as extension contact between the extension Agents and farmers become more frequent. Therefore an increase in the number of visits by extension officers by 1% leads to an increase in the probability of Stevia adoption by 0.1056%. This indicates that the extension workers provide useful information on the benefits of Stevia production therefore influencing the farmers' decision to adopt Stevia production. The findings concur with that of Mignouna *et al.* (2010) who found out that contact with extension agents significantly influenced decision to adopt *Imazapyr*-resistant maize (IRM). The findings are consistent with those by Adesina *et al*. (2000) who found out that contact with extension officers to be positive and significant in adoption of alley farming.

3.1.2 Factors influencing extent of Stevia adoption

Table 6 presents Heckman two-step outcome equation results. The extent of Stevia adoption is influenced by many factors among them household size Revenues from Stevia, number of visits by extension officers, total land owned. The results reveal that one coefficient is significant at 1%, one coefficient is significant at 5% and two coefficients are significant at 10%.

Table 6: Outcome equation results

Variable	Coef.	Std. Err.	Z	P>|z|
Group membership	-0.1053	0.0724	-1.46	0.146
Age	-0.0028	0.0024	-1.19	0.235
Education in years	-0.0021	0.0044	-0.47	0.636
Household size	0.0129	0.0071	-1.81	0.070*
Farm size in Hectares	0.0169	0.0096	1.77	0.078*
Farming years	0.0029	0.0024	1.21	0.228
Nonfarm income	0.0044	0.0033	1.32	0.185
Individ Land tenure	-0.0368	0.0489	-0.75	0.451
Number of visits by extension officers	0.0150	0.0060	2.49	0.013**
Revenue from Stevia	0.0185	0.0145	1.27	0.003***

*** indicates significance at 1%, ** significance at 5% and * significance at 10%

House hold size significantly and positively influence the expansion of Stevia .As the Household size increases by 1%, it raises the probability of increasing the extent of stevia farming by 0.0129%. This is because bigger household provide extra labour required to increase land under Stevia. This is consistent with the findings by Jara-rojas *et al*. (2012) who observed house hold size to be positive and significant in influencing extent of water adoption. However Amaza *et al*. (2008) found that household size coefficient to be negative and significant suggesting that larger the household the lower the intensity of adoption of improved varieties.

The effect of farm size was found to be positive and significant .As the farm size increases by 1% the extent of

stevia production increases by a probability of 0.0169%. This means that the larger the land the more room for expansion of Stevia enterprise. This suggests that the larger the farms the more likely the farmer is willing to extend land under Stevia. The interpretation for this is that the larger the farm the more the farmer flexibility in their decision making, more opportunity to use new practices on a trial basis and more ability to deal with risk. This also offers the farmer greater access to discretionary resources. However Amaza *et al*. (2008) found coefficient of farm size to be negative and significant. The negative coefficient implies an inverse relationship that as farm size increases adoption of improved maize varieties decreases. In other words the larger the farm sizes the lower the potential of the intensity of adoption.

The number of visits by extension services significantly and positively affected the expansion of Stevia production with increase in the number of visits by extension providers by 1% enhances an increase in the probability of increasing the extend of Stevia production by 0.0150%. This means that extension providers have a positive influence on farmer's decisions to increase the land under stevia production. Extension agents supply farmers with important information and skills on production, management and marketing. The availability of relevant and adequate information reduces the risk associated with crop production. The reduction in the risk therefore provided an incentive to the farmers to expand production of Stevia. Omonona, *et al.* (2005) found contact with extension agents significant and positively affecting adopting improved cassava varieties. They concluded that contact with the extension agents were the major factors for the adoption of improved cassava varieties. Chitere and Van Doorne (1985) also found agricultural education and extension services to be significant and positively affecting adoption of new agricultural technologies. The argument is that the education and extension service facilitates awareness among farmers. Some studies however have revealed the contrary, for example Tshiunza *et al*. (2001) found a negative relationship between extension visits and adoption of bananas.

Revenue from Stevia significantly and positively influence Stevia adoption .An increase in revenue accruing from stevia production by 1% leads to an increase in the probability of extending stevia production by 0.0185%. Greater returns from Stevia motivate farmers to increase land under Stevia. This is because farmers want to maximize on their returns.

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4.0 CONCLUSION AND RECOMMENDATION

4.1 Conclusion

Different socio-economic characteristics of both categories of farmers (Stevia adopters and non-adopters) were determined. It is clear that crucial factors like gender, age education in years, group membership, land tenure and extension visits positively affected the decision to adoption Stevia. Age was significant but negative meaning that more of young people adopted Stevia than the old. Reason for this is that older people are less receptive to new ideas and are less willing to take risk. This implies that there may be need to review method of technology dissemination used in intervention programme to ensure they are attractive to both young and older farmers. Group membership plays a key role in Stevia adoption. This is because farmers in groups are able to learn from each other on current issues and new technology. Accesses to title deeds also play a key role in Stevia adoption. Land title deeds provide security of using land and act as collateral in securing agricultural credit. Security in land ownership and usage is crucial as it increases the ability of the farmer to adopt Stevia. Extension visits also played a key role in adoption of Stevia. This is because extension workers provide useful information on the benefits of Stevia production therefore influencing the farmers' decision to adopt Stevia production. Education in years positively and significantly plays a major role in adoption of Stevia. All areas dealing with farmer education such as farmer field schools add value to the knowledge already acquired in formal schooling and increases the adoption of innovation. It is therefore evident from this study that capacity building plays a major role in adoption of Stevia .This can be explained by the fact that as an individual gets more educated, he/she tends to acquire more information and skills that will help him/her in adopting new technologies.

Four factors were found to be significant in influencing the extent of Stevia adoption. Household size, farm size, number of visits by extension officers and Revenue from Stevia had positive influence on extent of adoption. Famers with larger house hold size find it easier to increase land under Stevia than those with small family size due to availability of own farm labour. Farm size had a positive influence on extent of adoption of Stevia because it offers farmers with flexibility during decision making.

4.2 Recommendation.

Based on the results of this study, education of a farmer, group membership, age, extension services, and individual land ownership are the factors that influence Stevia adoption. Farmers need to take full advantage of the benefits of cultivating Stevia which usually translates into increased income. This will only be possible with an effective network of extension agents who deliver their services to these farmers more frequently. The government and other policy makers therefore need to increase knowledge and skills of farmers through avenues such as field days and schools, increase extension contact with farmers or any other means of building capacity.

However, to ensure widely adoption of Stevia, it is important that government should formulated policies which will enhance adoption.

The government should also ensure that farmers access land title deeds so as to create an incentive for adoption of Stevia and other new agricultural technologies. Extension services also played a key role in the expansion of Stevia production and therefore government should deploy more agricultural extension officers to rural areas to facilitate dissemination of new agricultural knowledge, skills and other new agricultural technologies. Extension services improve the knowledge base of farmers through a variety of means, such as demonstrations, model plots, specific training and group meetings. The exposure to such activities is solely intended to increase the ability of farmers to optimize the use of their resources and ultimately leading to increase of land under Stevia.

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