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Farmer Perception of Technology and its Impact on Technology Uptake: The Case of Fodder Legume in Central Kenya Highlands.

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Abstract: Technology adoption by farmers is crucial to increasing agricultural productivity hence meeting food and nutrition challenges in Africa. Economists investigating consumer demand have accumulated considerable evidence showing that consumers generally have subjective preferences for product attributes. However, when investigating adoption of new agricultural technologies, economists have lagged behind in analysing how farmers' (the consumer of agricultural technologies) subjective perceptions of technology characteristics affect their adoption decisions. Focusing on farmer perceptions of technologies may provide a better understanding of technology adoption since they deal with the technologies and probably perceive technologies differently from researchers and extension agents. The objective of this paper is to investigate farmers' perception of technology and its impact on adoption using a case study of legume forages in central Kenya highlands. Data from a random sample of 131 farm households in four districts in central Kenya was used. Using participatory techniques, four most important fodder legume attributes to farmers in their adoption decision were identified. These were then used in conjoint analysis. An ordered probit model was estimated to assess relative importance of each attribute to the farmer. A tobit model was also estimated to show the effect of farmers' perception of calliandra and desmodium on probability and intensity of adoption. Results showed that dry season tolerance and economy on land are most important characteristics of fodder legumes to the farmers. It was also found that Calliandra and desmodium were more relevant to the farmers in the area than other fodders. Farmers' perception of the two fodders had a significant impact on their adoption. Consequently, it was recommended that before introducing a technology in an area, it is necessary that the farmers' perception of the technology be analysed
Conjoint analysis, ordered probit and tobit estimates, fodder legume adoption.

1.0. Introduction

Technology adoption is a complex and a dynamic process that is determined by many factors such as perceived characteristics of the technologies, farmer circumstances and conditions. The adopter perception model suggests that the perceived attributes of innovations condition adoption behaviour (Adesina and Zinnah, 1993; Adesina and Baidu-Forson, 1995). Thus adoption depends on users' judgement of the value of the technology to them. Users' judgement depends on many factors some personal, others reflecting on utility and efficiency of the technology. Adoption or rejection of technologies by users may reflect rational decision characteristics of the technologies under investigation. Users will reject a technology that is not relevant to their needs, not suited to their work environment and one that may interfere with other activities that are considered to be important. These subjective technology attributes have shown to significantly condition technology adoption decisions (Farrington and Martin, 1988; Tripp, 1989; Ashby et at., 1989). Their omissions in adoption model may bias the results of the factors determining adoption decision of users (Adesina and Baidu-Forson, 1995).
Economists investigating consumer demand have accumulated considerable evidence showing that consumers generally have subjective preferences for characteristics of products attributes (Engel and Blakwell, 1982; Steenkamp, 1989). However, when investigating adoption of new agricultural technologies, economists have lagged behind investigating how users' (the consumer of agricultural technologies) subjective perceptions of technology characteristics affect their adoption decisions. Focusing on the perceptions of farmers towards technologies may provide the answers since they deal with the technologies and they probably perceive technologies differently than researchers and extension agents.

As a matter of fact, researchers in the tropics are increasingly recognizing the farmer as a partner, not just as a client or a customer, in developing new agricultural technologies. The farming system approach in the 1990s helped researchers to focus on smallholder farmers' needs and circumstances (Byerlee and Collinson, 1980; Caldwell, 1987). In the 1990s, the participatory research paradigm helped scientists to understand how farmers experiment on their own and to seek partnerships with them in developing technologies (Chambers, *et al*., 1989).

In reality, a decision that a new technology is a workable alternative to customary ways of farming is more than purely technical, for it requires a holistic grasp of the human needs which farming is intended to meet. The small farmer knows this decision- making approach, because she/he has used it ever since childhood. An effective farmer evaluation enables researchers to map these perceptions with systematic data, so that they can readily communicate this information to technology designers, who need to understand the farmers' point of view about the usefulness of a new technology.

Other benefits accruing to research stem from the fact that users are active innovators, experimenters and seekers of research knowledge in their own right. They play different roles when they work with researchers and can at one time be colleagues, students, advisors or even extension agents (Tripp, 1989; Biggs, 1980). By working with them, researchers can build on their knowledge while at the same time being more sensitive and responsive to the needs of their clients and hence enhancing the probability of adoption of future technologies

1.1. Fodder legumes adoption studies

Elbasha et al. (1999) reviewed the literature and assembled a list of the factors, which have been cited as constraining adoption of forage legumes in West Africa. These included: lack of fencing materials; shortage of labour; inappropriate land tenure; land scarcity; livestock diseases; invasion of grasses and weeds; and damage by fire. Some other factors cited such as lack of extension, information and limited availability of credit and seed reflect institutional failures and presumably are, at least in theory, amenable to correction. But others such as shortage of labour, 'inappropriate' land tenure and land scarcity surely must be seen as more fundamental system properties: rather than being constraints to adoption of fodder legumes they simply define the legumes as inappropriate (i.e not useful). It is interesting that among the constraints listed by Elbasha *et al* (1999), there is no reference to the performance or reliability of the legume technologies themselves. The assumption seems to be that under highly diverse farm conditions these technologies will consistently, and cost-effectively deliver meaningful improvements to soil fertility and animal performance.

It is not acceptable to suggest that what must surely be considered fundamental system properties are constraining the adoption of fodder legume technologies. Those very properties- agro-climatic, social, economic and cultural – should define the context of technology design and development, and should be fully integrated into the process of design specification. Livestock and forage scientists have generally been less willing than crop agronomists to embrace the more client-oriented approaches such as farming systems and farmer-participatory research (Sumberg, 2002). Much of their research is still driven by a macro-level, constraint oriented analysis that assumes a set of objectives that is not necessarily shared by any livestock producers. While there may be some producers in certain situations who would be interested in benefits from existing forage legume technology, forage researchers have seldom developed the detailed site and system-specific analyses that would enable these situations to be identified. The more micro-oriented analyses that follow a client-oriented or participatory approach would highlight new opportunities for research.

The objective of this paper is to show farmers' perception of fodder legume attributes and its effect on adoption of fodder legume technologies (Desmodium and Calliandra) and therefore define the kind of fodder legumes suitable to the Kenyan highlands and examine whether those introduced to the farmers were suitable to them. This study improves on the approach of analyzing farmers' perception in technology adoption. In light of what the other researchers (Adesina et, 1993 and 1995) have done by including attributes whose perception by the farmer is thought by the researchers or extension agent to be important in their decision to adopt the technology, in this paper the attributes considered are suggested by the farmers' themselves through participatory techniques and are subjected to conjoint analysis to accurately rank them in relative importance then they are used in the adoption model to confirm their significance . They are also used to rank the fodders that were introduced to the farmers to determine which ones were more appropriate.

2.0 Materials and Methods

2.1. Study area

The study was conducted in the highlands of central Kenya. Central Kenya is characterized by high human population, and although it is only 18% of the land area in the country, it has about 64% of the population. Population density ranges from about 100 persons per Km^2 in the dry lowlands to 1,000 persons per Km^2 in areas with high agricultural potential (CBS, 1999). Agriculture is the main activity in the area with coffee (medium to low) and tea (high altitude) as the main cash crops. Dairy production is an important farm enterprise and is second only to the cash crops in economic importance (Staal et al., 1997). In terms of cash flow, dairying is more important to the farmers than the cash crop as they have to wait a long time for payment from their cash crops, while that coming from milk is generally monthly and occasionally daily.

Due to the high human population, farm sizes in central Kenya are small with average holdings being 0.9 ha to 2 ha per household (Gitau et al., 1994; Mwangi, 1994; Staal et al., 1997) and are decreasing rapidly because of subdivision. Animals are therefore confined in stalls and various types of feeds are cut and carried to them, including fodder crops; weeds gathered from cropping areas, crop by-products and residues, agro-industrial by-products and purchased concentrates. The importance and nutritive value of these feed sources vary seasonally. In both of the wet seasons in the predominantly bimodal regions, the bulk of the feed consists of fodder crops and weeds, while in the dry season; these are supplemented by crop residues (Abate et al., 1992). Napier grass or hybrids of Pennisetum purpureum with P. glaucum (formerly known as P. typhoides) are the most important fodder crops. Pasture grasses include Kikuyu (Pennisetum clandestinum), Star grass (Cynodon spp.) and Nandi setaria (Setaria anceps), while maize stover and bean haulms are the most abundant crops residues. These feeds are low in Nitrogen hence the animals need nitrogen supplements.

2.2. Sample selection

The data used in this study were collected from a sample of 131 farm households in 4 districts of central Kenya highlands. These farm households were randomly selected from farmer groups that were given desmodium by smallholder dairy project in the year 2000 and Calliandra by ICRAF in the years 1999. The sample consists of 60% of those with and 60% without desmodium on their farms., which corresponds to 107 farm households with and 24 farm households without desmodium. In this sample 115 farm house holds had calliandra and 16 farm households did not have calliandra on their farms. 25 farmers in this sample were from Nyeri district and these are farmers that did not receive the fodders from SDP project or SLP but from other sources e.g. NDDP way back in 1994 etc.

2.3. Survey instrument

The data was collected in the year 2003 using a formal household questionnaire at the household level. Farmer group discussions were first held in which farmers identified 4 most important fodder legume attributes that were used to develop the conjoint part of the questionnaire and the matrix scoring of the fodders. The conjoint part of the questionnaire was administered in terms of cards for the farmer to rank. The 4 attributes i.e. economy on land, dry season tolerance, cost of planting material and disease resistance was combined at 3 levels in each card. These levels were low, medium and high. 27 combinations were selected using orthogonal array in SPSS version 8 program. Each farmer was randomly given 5 cards to rank in order of preference (1 best and 5 worst). Each group of 5 cards had a reference card that was similar in all. In other word other cards were ranked in reference to this card (Green, 1974). Data collected in the formal household questionnaire was on farmer, farm and institutional factors hypothesized to influence adoption decision. Farm and farmer characteristics were age, education, resource endowment, size of plot farmed, labor availability, institutional factors including access to market, extension etc. The amount of the fodder on the farm per household was also recorded. In the questionnaire, farmers were asked to give scores to desmodium and calliandra on the basis of their performance in the four attributes used in the conjoint analysis. Score were 1 to 5 and the higher the score the better the performance of that fodder in that particular attribute.

2.4. Model specification

2.4.1. Ordered probit model

Farmer preference was analysed using ordered probit model. The rank 1-5 given to attribute combinations was taken as the dependent variables and the levels present in the combinations as the independent variables. Since rankings and ratings all yield bounded discrete indices, the empirical utility function can be estimated via probit or logit (Mackenzie, 1993, pg 597). For multi-level response with outcomes *i,* for *i*=1,2,….,c, the probability, p_j , or of observing l_i is:

p_j=R + (1- R) Z(x*b*)

p_2= (1-R) (Z(a2 = x' *b*) – Z(x' *b*)

p_j= (1-R) (Z(a_j = x' *b*) – Z(a_{j-1} – x' *b*)

p_c= (1-R) (1-Z(a_{c-1} + x' *b*) (1)

Where = vector of parameter estimates; Z= normal cumulative distribution function of response; R= response rank.
The c-level response produces c-2 additional parameters, a's, denoted 'inter' (SAS Institute Inc., 1989).

The ordered probit model was specified as: PREF=Pr [Z] (2)

Where:

Z=I + δ_1 Disease resistance (high=1 and otherwise=0; medium=1 and otherwise =0)

δ_2 Dry season tolerance (high=1 and otherwise=0; medium=1 and otherwise =0)

δ_3 Cost of planting material (high=1 and otherwise=0; medium=1 and otherwise =0)

δ_4 Economy on land (high=1 and otherwise=0; medium=1 and otherwise =0)

δ_1 , δ_2 , δ_3 δ_4, are parameter estimates (embed in the vector *b*); and *I* represents the conventional intercepts and appropriate interval dummies.

To examine the value of disaggregated conjoint analysis across location, farm sizes and income groups, 8 models were estimated for: All respondents, respondents in Kirinyaga district, respondents in Embu district, respondents in Maragua district, respondents in Nyeri districts, respondents with below 1 acre of land, respondents with more than 1 acre of land, respondents with off farm income and respondents without off farm income (Daidu-Forson, 1997 and 1996).

The relative importance of each attribute to respondents can be computed by using estimates from equation (1), (for example, how important is one attribute relative to all other characteristic?) The formula for the relative importance is:

$$\Psi_a = [\ (\max(v^{*}_{ga}) - \min(v^{*}_{ga})\ )] / \Sigma\ \omega_a \qquad (3)$$

Where v^{*}_{ga} is the marginal value of the g^{th} level of the a^{th} attribute; Ψ_a represents the relative importance for the a^{th} attribute; $\Sigma\ \omega_a$ is the sum of the ranges, $[\ (\max(v^{*}_{ga}) - \min(v^{*}_{ga})\ )]$ across all attributes (Tano et al 2003). Jain *et al*., (1979) argue that Ψ_a for a consumer may be normalized to ascertain its relative importance with regard to the other attributes and across consumers.

2.4.2. Weighted matrix scoring

This analysis was used to analyse the data collected from matrix scoring of desmodium and calliandra in the four attributes used in conjoint analysis. This was done by weighting every score given for a particular attribute by the relative importance calculated in the conjoint analysis. Weighted score given to a particular attribute for a particular fodder = the relative importance of the attribute X Score given to the attribute.
The importance of a fodder = Sum of the weighted scores the fodder received for every attribute from all the farmers.

2.4.3. Tobit model

The tobit model was used to estimate the probability and extend of adoption of the two fodders; calliandra and desmodium. Independent variables are as shown in the table 2. The dependent variable was the amount of either desmodium or calliandra on the farm. Two tobit models were estimated, one for desmodium and another for calliandra.

This analysis uses the same broad approach as used by many. But emphasis here is on introducing technology attributes that were found to be important to farmers from farmers' point of view.

3.0. Results and Discussions

3.1. Ordered probit estimates

Table 4 summarizes the ordered probit results across the entire sample, and for several subgroups of respondents, identified on the basis of variables that could be reasonably used as segmenting variables that are likely to influence farmer preferences of fodder attributes. The signs are negative on the level of each attribute that influences the farmer to rank the fodder towards rank 1 (most preferred) and is positive for the levels that influence the farmer to rank the fodder towards rank 5 (least preferred). The relative importance of each attribute is also indicated in table 5, which is derived from table 4 using equation 3.

In the whole sample, high dry season resistance has about twice as much effect on improving the rank than high economy on land, even though both are the more desirable level of their own attributes. The most preferred attribute for the general sample is dry season resistance (0.43) followed by economy on land (0.26). Disease resistance and cost of planting material were similarly of much lower importance with no significant differences between levels for the former and only at the highest level for the latter.

Results for the different categories of farmers show that these attributes do not greatly influence part worth. The trend is the same as for the whole sample. However, there are differences in magnitude placed on each attribute by each segment of farmers. As might be expected, farmers with smaller farms placed more importance on economy on land while those with no off farm income, placed greater importance on cost of planting materials, which may be because they cannot easily access ready cash. The slightly lower importance placed on drought tolerance in Kirinyaga may reflect higher rainfall in this district as compared to the other two districts. Farmers in Nyeri district were indifferent to the four fodder attributes as far as their importances are concerned. This is most likely because some of the fodder like desmodium was growing wildly on their farms without being cared for. Most of the desmodium was desmodium intordium unlike desmodium uniciturm in the other districts. The farmers had very few calliandra trees on their farms. It seemed like the technology was introduced by some projects much earlier and the farmers had abandoned it.

Table 4: Ordered probit estimates of farmer preferences of fodder attributes.

Variable	All farmers	Off far income		Size of farm		Districts		
		With	Without	< 1 acre	> 1 acre	Embu	Maragua	Kirinyaga
Disease resistance								
High	-0.50(14)***	-0.69(0.22)***	-0.14(0.15)	-0.18(0.25)	-0.30(0.14)**	0.09(0.34)	-0.58(0.21)***	-0.67(0.24)***
Moderate	-0.42(15)***	-0.71(0.23)***	-0.17(0.16)	-0.13(0.27)	-0.39(0.15)***	0.07(0.34)	-0.37(0.22)*	-0.76(0.27)**
Tolerance to dry season								
High	-1.62(14)***	-1.52(0.20)***	-1.21(0.15)***	-1.40(0.26)***	-1.27(0.13)***	-1.67(0.34)***	-1.58(0.20)***	-1.79(0.24)***
Moderate	-1.14(15)***	-0.81(0.22)***	-0.93(0.17)***	-0.89(0.27)***	-0.88(0.16)***	-1.66(0.36)***	-1.27(0.23)***	-0.75(0.26)***
Cost of planting material								
High	0.81(15)***	0.56(0.22)***	0.71(0.16)***	0.50(0.26)*	0.72(0.15)***	1.03(0.36)***	0.81(0.22)***	0.85(0.25)***
Medium	0.05(15)	0.05(0.23)	-0.02(0.17)	-0.12(0.30)	0.05(0.15)	0.17(0.34)	-0.01(0.22)	0.21(0.27)
Economy on land								
High	-0.91(13)***	-1.05(0.20)***	-0.46(0.14)***	-0.62(0.23)***	-0.67(0.15)***	-0.94(0.29)***	-0.86(0.20)***	-0.97(0.23)***
Moderate	-0.78(16)***	-0.80(0.25)***	-0.49(0.18)***	-0.84(0.36)**	-0.55(0.16)***	-0.80(0.36)**	-0.69(0.24)***	-0.95(0.29)***
Number of observations	510	235	400	145	490	100	235	175

$^{***}P<0.01$, $^{**}P<0.05$, $^{*}P<0.1$: Values in parentheses are standard errors.

Source: Survey data 2003

Table 5: Relative importance of each fodder legumes attributes for all farmers in the sample and for the different categories.

Attribute	All farmers	Off farm income		Area of land owned		District		
		With	Without	=>1 acre	<1 cre	Embu	Maragua	Kirinyaga
Disease resistance	0.14	0.21	0.07	0.07	0.14	0.02	0.15	0.19
Dry season tolerance	0.43	0.38	0.50	0.50	0.43	0.49	0.44	0.38
Cost of planting material	0.17	0.12	0.21	0.12	0.19	0.22	0.16	0.17
Economy on land	0.26	0.29	0.22	0.31	0.24	0.26	0.24	0.26

Source: Computed from table 4 above.

3.2. Farmer perception of Desmodium and Calliandra

The 4 attributes analysed above were used to compare *Desmodium* and *Calliandra* using matrix scoring at household level this needs to be in the methods and you need to analyse and describe the analysis!. The results are as shown in table 3. The last two columns are weighted scores estimated using the relative importance of the attributes inform the conjoint analysis (table 5). *Calliandra* had a high score in dry season resistance and economy on land than *Desmodium*, which are the most important attributes to farmers. Calliandra's economy on land can be because farmers were using boundaries and other places that have no opportunity cost to plant it unlike desmodium where there were quite a number of farmers planting it as a pure stand claiming that when it is planted with napier it "spoils" it. Farmers also said in our informal interviews that desmodium had low herbage productivity per area as compared to calliandra. In general the difference between the two fodders from the farmers' perception of their performance in the important attributes is very small hence we can if there are any significant differences is that there is no difference between farmers perception of the 2 different forages.

Table 4: armers' scores for desmodium and calliandra in important fodder attributes.

Attribute	Desmodium	Calliandra	Desmodium l score X relative importance	Calliandra l score X relative importance
Dry season tolerance	235	251	33.15	35.41
Disease resistance	263	240	114.35	104.35
Economy on land	212	235	35.36	39.19
Availability of planting material	237	191	61.00	49.16
Total Score	-	-	243.85	228.11

3.3. Tobit estimates

Out of the total number of farmers interviewed from the groups given the fodders, there were 65% and 74% with *Desmodium* and *Calliandra* on their farms respectively. The greater number of farmers with calliandra observed were perhaps due to the fact that Calliandra was introduced to the farmers earlier than desmodium. It may also be because there was more sustained follow up after calliandra was introduced, as stated by the farmers themselves. The results of the tobit model are as shown in tables 4.

The coefficients on the variables indicate the effect of the variables on probability and intensity of having the fodder on the farm. A negative sign on the coefficient means that for an increase in that variable the probability and intensity of a farmer having the fodders on the farm is reduced. The opposite is true for a positive sign. The column of change in intensity of adoption indicates the change in metres squared for desmodium and number of trees for calliandra expected for one unit change in the specific variable. Change in probability of adoption indicates percentage change in probability of the farmer taking up the fodder with one unit change in the variable. For example a change in years of education of the household head by one year increases intensity of adoption of desmodium by 22 square metres and the probability of adoption by 2.3%. For dummy variables, a marginal change indicates a discrete change of the variable from 0 to 1.

The results show that farm size has a strong positive influence on the probability of having the fodder on the farm and the increase of the fodder amounts being significant at 1% level. This concurs with the results of the conjoint analysis, which showed that economy on land was one of the most important attributes to farmers in the decision to adopt a fodder. This is also in line with the fact that farmers in the study area have very small plots of land with a mean of 3.6 acres with a standard deviation of 3.5 hence it is a limiting factor. Wanyoike, (2004) also found similar results that farm size had a significant influence on adoption of Calliandra trees in male managed farms in Embu district.

Farmer training also had a strong positive significant influence on uptake of desmodium although not significant for Calliandra. It is likely that farmers reported formal training which as expected enables the farmer to understand and perceive technologies better in terms of management and benefits. Hence the probability of technology uptake is high. Credit had a negative influence on adoption of desmodium perhaps because the technology is a low cost option that is not preferred by farmers who can use credit to pursue other income generation.

Table5: Tobit estimates of effects of farm and farmer attributes on the probability and intensity of adoption of desmodium. Values in parentheses are standard errors.

	Desmodium (D)			Calliandra (C)		
Variable	Coefficient	Change in extend of adoption	Change in probability of adoption	Coefficient	Change in extend of adoption	Change in probability of adoption
Age of household head	5.72(8.18)	2.67	0	-0.92(5.21)	-0.46	0.00
Years of education of household head	33(29.1)	15.2	0.01	3.99(17.22)	2.01	0.00
Group official	148(195.2)	69.5	0.06	54.90(125.62)	27.63	0.04
Community responsibility	46.01(197.20)	21.54	0.02	120.75(125.29)	61.97	0.08
Off farm income	-322.96(200.87)	-146	-0.14	-52.26(129.28)	-26.1	-0.03
Farmer training	590.93(213.31)***	265.02	0.26	-48.58(131.05)	-24.62	-0.03
Credit	-432.51(227.13)*	-187.49	-0.19	-59.89(146.38)	-29.59	-0.04
Total labour available	-4.26(8.84)	-1.99	0	12.03(5.89)**	6.05	0.01
Number of cattle (TLU)	145.47(90.30)	67.84	0.06	-52.97(53.31)	-26.62	-0.03
Number of goats (TLU)	-3.26(70.55)	-1.52	0	-29.88(46.20)	-15.02	-0.02
Farm size	114.57(30.18)***	53.42	0.05	80.27(22.51)***	40.34	0.05
Market distance	-71.39(40.02)	-33.29	-0.03	-18.00(22.34)	-9.05	-0.01
D/C high dry season tolerance	462.14(243.84)*	214.06	0.2	-111.47(147.74)	-57.54	-0.07
D/C low dry season tolerance	215.37(273.48)	104.99	0.09	-360.32(365.35)	-151.64	-0.26
D/C high in economy on land	-210.61(230.74)	-96.08	-0.09	463.09(238.60)*	280.26	0.23
D/C low in economy on land	127.33(240.83)	60.8	0.05	62.83(140.14)	31.27	0.04
Constant	1044.65(678.92)	487.13	10.45	89.68(410.22)	45.08	0.06

*****P< 0.01, **P<0.05, *P<0.1:**

Values in parenthesis are standard deviations.

Numbers of cattle and goats did not have a significance influence on uptake of both fodders may be because the numbers have changed. The numbers are now not the same as they were when they making the decision about the amount of fodder legume to grow on their farms.

Total labour available to the farmer had a positive significant influence on Calliandra uptake most likely because Calliandra is labour intensive as stated by farmers matrix scoring of fodder attributes during focus group discussions. This result is consistent with other studies where labour availability significantly influences adoption of labour intensive technologies (Wanjiku, (2004) and Wanyoike, (2004).

Perception was found to be significant in uptake of both calliandra and desmodium although in different attributes of the fodders. For calliandra, the farmers' perception that the fodder economizes on land significantly enhanced the probability and intensity of having the fodder on the farm. For desmodium it was farmers' perception that the fodder is dry season tolerance significantly enhanced the probability and intensity of the farmer having the fodder on the farm. This agrees very well with the results in the conjoint analysis that the two fodder attributes are important in the farmers' decision to adopt fodders legumes. Farmers' perception of technology attributes significant effect on adoption has also been found in other studies (Negatu et al, (1999); Adesina et al, (1995); and Adesina et al, (1993)).

4.0. Conclusion

Since farmer perception about the performance of the technologies significantly affects both the probability and the intensity of having the fodder on the farm, it is important that for any new technology to be introduced to the farmers, farmers should be involved in its evaluation to find its suitability to the farmers' circumstances, especially screening fodder legume varieties to be introduced to farmers.

It also follows that in adoption studies, researchers should analyze those factors that farmers themselves state as important in their decision to adopt the technologies as was addressed by the conjoint analysis method in this study. Otherwise researchers, when they rely only on literature and extension staff, as has been the habit, they may end up considering factors that are irrelevant to the farmers in a particular region. This has been shown by the study when factors least considered by farmers in their decision to adopt fodder legumes have been found insignificant on the technology uptake and vice versa.

Farmers in central Kenya value dry season tolerance and economy on land highly fodder legumes attributes. It is important that when screening fodder legumes for regions where land is a limiting factor and there is dry season feed deficiency like in central Kenya, researchers should value highly those fodders that are dry season tolerant and economizes on land. By giving different weights to different fodder legume attributes and valuing the different fodders for different regions the researchers can come up with specific fodders of each region. In central Kenya, desmodium seems to have the highest value to them. Emphasis should be that the important attributes should originate from the farmers themselves.

Certain constraints to adoption of fodder legumes that can be alleviated by extension information to The government and other stakeholders should invest in farmer training since it enables farmers to understand well technologies and perceive their benefits increasing their probability to adopt as shown in the survey as it was shown in the study that farmers who had received some formal training in agricultural.

This study was limited in terms of fodder legumes that were considered at the household level. Only desmodium and calliandra were examined yet many other fodder legumes have been introduced in the study area. In future research, it is recommended that more fodder legumes introduced to farmers in a particular area be examined using the same criteria used in this study, in which case they can be ranked in terms of suitability using both conjoint results and farmer scoring of the fodders in the particular attributes.

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References

Adesina, A.A. and Zinnah, M., 1992. Technology Characteristics, Farmers' Perception and Adoption Decision: A Tobit model Application in Sierra Leone. Agricultural Economics. Elsevier Science Publishers, Amsterdam.

Adesina, A., Baidu-Forson, J., 1995. Farmers' perception of new agricultural technology- evidence from analysis in Burkina Faso and Guinea, West Africa. Agricultural Economics 13, 1-9.

Adesina, A., Zinnah, M., 1993. Technology characteristics, farmers' perception and adoption decision: a tobit model application in Sierra Leone. Agricultural Economics 9, 297-311.

Ashby, J.A., Quirose, C.A. and Rivers, Y.M., 1989: Farmer participation in technology development: Work with crop varieties. Chabers, R., Pacey, A. and Thrupp, L.A. (Eds), Farmer first. Farmer innovations and agricultural research. Intermediate technology publications, London, UK.

Biggs, S., 1980: Informal R&D. Ceres 13. (4): 23-26.

Byerlee, D. and Hesse de Polanco, E., 1986: Farmers' stepwise adoption of technological packages: evidence from the Mexican Altipalno. Aerican Journal of Agricultural Economics 68: 519-527.

CBS (1994). Kenya population census 1989 Volume 1. Office of the vice-President and Ministry of planning and National Development, Nairobi, Kenya.

Chambers, R., Pacey, A., and Thrupp, L.A., 1989: Farmer first: Farer innovations and agricultural research. Intermediate technology publications, London.

Ferrington,J., and Martin, A., 1988: Farmer participation in agricultural research: A review of concepts and practices. Agricultural Administration Occasional Paper 9. ODI, London.

Gitau, G.K., and O'Callaghan, C. J., McDermott, Omore, A.O., Odima, P.A., Mulei, C., and Kilungo, J.K., (1994). Description of smallholder dairy farms in Kiambu district, Kenya. Preventive Veterinary Medicine 21, 155-166.

Green, P.E., (1974). On the design of choice experiments involving multifactor alternatives. Journal of consumer research, Volume 1 page 64.

Mwangi, D. (1994). Survey on feeds, feeding and livestock management in Central Kenya. In Proceedings of the 2nd Kenya Agricultural Research Institute (KARI) Scientific conference. Kenya Agricultural Research Institute, Nairobi, Kenya.

Negatu, W.,Parkikh,A. 1999. The impact of perception and other factors on the adoption of agricultural technology in Moret and Jiru Woreda (district) of Ethiopia. Agricultural Economics 21, 205-216

Tripp, R., 1989: Farmer participation in agricultural research: new directions or old problems? Agriculture and rural probles. Institute of Development Studies.

Staal, S., Chege, l., Kenyanjui, K., Kiari, A., Lukuyu, B., Njubi, D., Owango, M., Tanner, J., Thorpe, W., and Wabugu, M., (1997). " A cross-sectional survey of Kiambu district for the identification of target groups of smallholder dairy producers". KARI/ILRI collaborative project research report, Nairobi, Kenya.

Wanjiku, J., (2004). Social-Economic factors influencing the intensity of use of improved tree fallows, indigenous rock phosphate and biomass transfer in food production in Western Kenya. Msc. Thesis. University of Nairobi, Department of Agricultural Economics, Nairobi, Kenya.

Wanyoike, F. G., (2004). Dissemination and adoption of improved fodder tree: The case of Calliandra Calothyrsus in Embu district, Kenya. Msc. Thesis, University of Nairobi. Department of Agricultural Economics, Kenya.