The Effect of Agricultural Extension Services Incentives as Dose Response Experiment on Local Farmers for Increasing Productivity

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Abstract
In recent time, Farmers are increasingly asked to pay for agricultural extension services (AES) in many developing countries. As a result of the rapid changing situation of agriculture, inability of public extension services to be responsive to the needs of farmers and changing of policy environment, new paradigm is emerging...Farmers have been involved in AES, their participation has not been sustainable; AES officers should go a next step on farmers motivation. The sincerity and ingenuity of AES officers in extension services towards farmers, offering financial incentives through a rebate scheme and lifecycle monitoring of their projects, would go a long way in sustaining farmers interest. This paper therefore focus on the aspect of financial incentives A simulated demonstrative data scheme has been used to assist AES officials on how to go about making farmers involvement sustainable noting also that farmers commitment is a strong factor . Farmers were classified into three categories: The traditional local farmers (TLF), the micro scale farmers (MSF) and small scale farmers (SSF). Probit analysis model was used to evaluate the strength of AES on education, orientation, incentives and compliance by the categories of local farmers; this is referred to as the local farmers' potency. Findings revealed that about 6.7 percent of the farmers are aware of the value of AES and had voluntarily requested for it. The traditional local farmers responded better than others. When the observed response is correlated with the expected responses, there is a significant relationship at 0.01 levels. It has been recommended that government should do everything possible to encourage local farmers and make agricultural extension services and management free for farmers.

Keywords: *Agricultural Research Extension Services, Probit Analysis, Local Farmers' Potency" ARE Services Compliance*

INTRODUCTION

Agriculture is a critical sector for sustainable development and poverty reduction in developing countries (Olaitan & Omonia, 2006). The achievement of using agriculture for sustainable development is the establishment of agricultural extension services (AES) in most developing countries like Nigeria. Agricultural extension services are already being acknowledged as information and knowledge sharing where by innovations and improved methods and techniques of planting crops and rearing animals are made available to the farmers in their settlements through services in form of advice and assistance given to them to help them improve their methods of production, marketing and processing activities (Olaitan and Omomia, 2006). Globally, the objective of agricultural extension services remains the development of rural populace and raising the standard of living of the farmers through increased farm production and income. Regrettably the AES that is considered as representing the synapses that bring information from research to the end users, namely farmers, suffer in

many developing countries from chronic understaffing, limited operational funds and weak linkages to other players, such as research. Evidence from Africa, for example, shows that the numbers of farmers served by each extension worker is 950 in Kenya, 2 500 in Uganda, and 3420 in Nigeria (Sones, Odour, Watiti & Rommey, 2015). This situation leads to underperformance of extension systems, limited reach and impact, and presents the main challenges or the main underlying principles of the advice (e.g. organic production, integrated production) is not absolute. The AES according to Bouroncle Imbach, Läderach, Rodríguez, et al (2015) has its plan consisted of several components: food assistance (rations) for the households willing to adopt soil and water conservation practices aimed at increasing agricultural system's resilience to future climate threats, the establishment of community markets, as well as long-term investments in conservation strategies This section of agriculture is not without its challenges. The lack of appreciation of the role of agricultural extension especially by policy makers that are involved in resource allocation leads to limited allocation of resources to agricultural extension. (Ilukor1, Isoto, Turinawe, & Muwanika, 2019). According to Timmer and Akkus (2008), no country can sustain a rapid transition out of poverty without raising agricultural productivity. The question is therefore, what can be done to increase agricultural productivity in developing countries like Nigeria? Availing improved technologies such as high yielding varieties that are unique to our soils and condition by AES and reducing post-harvest losses (McNamara & Tata 2015) is an option. It is estimated that a third of food produced worldwide is lost and or wasted (Affognon, Mutungi, Sanginga, Borgemeister, (2015). Post-harvest loss is an important threat to food security, loss in farmer incomes, and inefficiency in the global food system. Factors that lead to increasing agricultural productivity include use of disease resistant varieties, increasing fertilizer use, improving market access, and making better use of the technology (Bah *et al.*, 2015). A recent multi country study in selected African countries revealed that the use of modern inputs is no longer universally low in Africa especially for inorganic fertilizers (Christiaensen, 2017). How to reach these conservative local farmers to market AES products to them is the focus of this study

Objectives of the Study

This study is designed to assist agricultural extension services officials in marketing their services and therefore increasing productivity among the local farmers. Specifically to:

1. analyze the rate of local farmers that voluntarily request and pay for agricultural extension services
2. assess the response rate of the local farmers to agricultural extension services incentives
3. evaluate the pattern of the observed (actual) responses when compared with expected responses

Research Questions

The following research questions were formulated for the purpose of achieving the study objectives

1. What is the rate of local farmers that are voluntarily interested and requested for agricultural extension services?
2. What is the response rate of the local farmers to agricultural extension services incentives?
3. What is the pattern of the observed (actual) responses when compared with expected responses?

Research Hypotheses

The following research hypotheses were formulated using 5 % level of significance.

1. There will be no significant effect of agricultural extension services incentives on different categories of local farmers.
2. There will be no significant difference in the relative potency within the categories of local farmers.

Scope of the Study

This study will be limited to local farmer segmented into three categories as traditional (cutlass and hoe) micro, and small scale farmers in a replica of any developing country especially in the Sub-Saharan Africa (SSA)

REVIEW OF RELATED LITERATURE

The issue of food security and poverty reduction in many parts of developing world, are linked with agricultural growth. The availability of agricultural extension services crucial to the propagation of modern technology, improved seedlings, irrigation systems and environmentally sustainable agricultural practices because developing countries are mostly agrarian and majority of people derive their livelihood from agricultural activities. Thus, the means of boosting agricultural production is widely acknowledged as the core strategy for escaping poverty trap (Otsuka, & Larson, 2013). The submission of (Elias, Nohmi, Yasunobu, & Ishida, 2013) was in tandem with the improvement of agricultural production, as in the case of Sub-Saharan Africa (SSA), strategy for overcoming this challenge mainly lies with improvement of agricultural production since 62% of the total population, excluding the population in South Africa, work in the agricultural sector for their livelihoods. Accordingly, Sumner (2012). Have also documented that 83 percent of the population who are extremely poor in SSA dwell in rural areas and Sub-Saharan region accounts for approximately 26 percent of the 1.2 billion people in extreme poverty who live on less than $ 1.25 a day. Meanwhile, one of the severe problems rising in this region is that productivity has not significantly increased over the decades, and its output is not in correlation with the rate of population growth (Morris, 2007) In other words, the low adoption rates of technologies caused by lack of information, resistance to change, proper education and other difficulties resulted in poor outcomes. Previous studies describe that a knowledge and skill delivery could be an integral part in farmers' capacity to generate higher growth in agricultural yield (Anderson, & Feder, 2003). The importance of agricultural extension service cannot be over-emphasized as one of the most common mechanisms of transferring knowledge skills to farmers and as support to apply them to the real world for food self-sufficiency. It is interesting to note that food self-sufficiency is achievable. Pan (2014) has credited China that over the past 50 years, China has successfully achieved food self-sufficiency for its rapidly growing population. China is now feeding approximately 22% of the global population with only 7% of the global arable land area.

Agricultural Extension Services Incentives and Increasing Productivity among the Local Farmers

Various incentives doses can be applied to entice farmers to pay extension services charges as at when due. In other words it is indirectly a bait for adopting agricultural extension services aimed at increasing farmer's productivity through compliance. Agricultural extension services incentives range from rate reduction (in the case of extension services charges), non-tax payment/tax holiday, and access to special government policies, the rebate off services charges is in form of a percentage. It is not obligatory for the farmers to key in into the incentives. This study centers its discussions on ***a rebate off (****representing a dose-response) on* the extension services charges expected to be paid. The major target is to increase productivity and reduce post-harvest losses.

Agric-Extension Services Incentives and Potency

Generally potency means the power that something has to influence people. In marketing and incentive dose parlance, potency is the ability of enticing local farmers to pay the cost of agricultural services with less rebate offer. It is the strength of the responsiveness of the local farmers to pay for extension services a result of cost rebate/ incentives.

Local Farmers Potency and Relative Potency

This is the value offer (rebate off) necessary to achieve a desired probability of extension services payment. For example, a 9.670% rebate offer would entice Farmer A to make extension service payment, while 11.818% rebate offer would raise the probability of extension service payment would entice Farmer B, then Farmer A' has extension services potency more than Farmer B. The relative median potency of these two farmers is the ratio of the rebate values needed to obtain a 50% probability of extension services payment, or 9.670/ 11.818 = 0.818. At a 100% performance of Farmer A in payment, Farmer B;s performance under the same condition is 81.8%.

Increasing Compliance

It is highly imperative that the government make the use of tested and trusted Extension Services Officials Tested and trusted officials are very obligatory to guarantee the farmers compliance. The officials must also have zero tolerance for corruption. Corruption is the root of all economic evils. It is an obstacle to economic growth and development of a country, ensures continuation of poverty, decay life expectancy and improved livelihood of a country to mention a few.

Extension services officials in some cases had been found to perpetrate collusion with farmers to sell improved seedlings freely provided by the government. According to Asher (2001), corrupt practices are likely to impact the local farmers more severely than the large firms in the formal sector

Natural Response Rate

The natural response rate is the probability of getting a response with no dose. In the extension charges example, the natural response rate is the proportion of local farmers who would request for AES and pay without an incentive or a rebate. A natural response rate of 0 means the response is due only to the stimulus, that is, voluntary compliance. The officials can specify the value of the voluntary compliance or natural response rate (if known), or allow it to be estimated from the data. The natural response rate is a measure of credibility status of the government from the local farmers.

3. METHODOLOGY

2.1. Data Collection

The data collected for this study has been carefully simulated and hypothetically presented as much as possible to reflect natural setting. Local farmers are segmented into uneducated core traditional farmers of 17004 (referred to as cutlass & hoe) micro farmers of 10168 small scale farmers of 1896 to be a replica of any developing economy. An orientation/sensitization is organized for all farmers and those who are interested responded. The expected and actual responses are in Table 1.The sustainable agricultural practices (SAP) among others are, for the purpose of this study, six practices such as (1) farmers participation in orientation, education and training (2) use of improved seedlings/ disease resistant high yielding varieties, (3) soil management (use of organic fertilizer, crop rotation, water irrigation reject bush burning), (4) post-harvest loss avoidance through improved processing and marketing of outputs, (5) making

better use of the technology and (6) mitigating climate change/making farmers climate change smart.

Table 1 Sustainable Agricultural Practices (SAP) Compliance and Rebates % of Charges

Sustainable Agricultural Practices Compliance	6	5	4	3	2	1
Rebate on charges [%]	40	33	26	19	12	5

If a farmer adopts the six SAPs, there is a rebate of 40% but only 5% if farmer takes just one SAP. No incentives if a farmer is indifference to any of the SAPs. The responses are as in Table 2 and 3 below.

Table 2 Orientation Attendants and the Respondents taking up the Rebate Offer.

Various Categories of Farmers	Codes (Size)	Rebate offer on [%](reb off)	Local Farmers who opted for various rebates (subj)	Local Farmes who Eventually Resp(resp)
Traditional Local Farmers (TLF)	1	5	2640	144
	1	12	2784	504
	1	19	2568	648
	1	26	2364	1356
	1	33	3216	2424
	1	40	3432	2928
Micro Scale Farmers (MSF)	2	5	1900	132
	2	12	1632	84
	2	19	1716	432
	2	26	1920	876
	2	33	1416	684
	2	40	1584	1152
Small Scale Farmers (SSF)	3	5	1056	60
	3	12	1356	144
	3	19	1272	144
	3	26	924	276
	3	33	1440	624
	3	40	1068	648

Source: A Pilot (Demonstrative) Study

Table 3. Farmers' Response Rate

Categories of Farmers	Farmers available for Orientation	Farmers that actually Responded to rebate off.	Percent of Responses
Traditional local Farmers	(17004)	8004	47
Micro Scale Farmers	(10168)	3360	33
Small Scale Farmers	(7116)	1896	27

Model Specification

The Probit Analysis Model

This study applies the SPSS 21 probit analysis model (IBM 2011, SPSS 21). Probit Analysis is designed to model the probability of response to a stimulus. Since the probability of an event must lie between 0 and 1, it is impractical to model probabilities with linear regression techniques, because the linear regression model allows the dependent variable to take values greater than 1 or less than 0. The probit analysis model is a type of generalized linear model that extends the linear regression model by linking the range of real numbers to the 0-1 range

$\pi_i = c+(1-c)F(zi)$

where

π_i = the probability the ith case experiences the event of interest

Zi = the value of the unobserved continuous variable for the ith case

F = a link function.

C = the natural response rate..

The model also assumes that Z is linearly related to the predictors.

$Zi = c+ (1-c) F (b_0+b_1x_{i1}+b_2x_{i2}+...+bpxip)$

where

x_{ij} is simply the jth predictor for the i^{th} case when there is no grouping variable. When there is a grouping variable, indicator variables are constructed to represent the levelsof the grouping variable and added to the list of predictors.

bj is the j^{th} coefficient

p is the number of predictors

If Z were observable, you would simply fit a linear regression to Z and be done. However, since Z is unobserved, you must relate the predictors to the probability of interest by substituting for Z.

$Pi = c + (I \sim c) F (b_0 + b_i x_{il} + b_2 x_{i2} + \ldots + b_p x_{ip})$

The model coefficients are estimated through an iterative maximum likelihood method.

4. Results and Discussion.

The results of the statistical outputs from Table A-1 to Table A-6 have been fully discussed in a table by table approach under each relevant table in the appendix.

Further discussion of the results is to provide answers to research questions and the testing of the respective research hypotheses. The results and discussion would toe the line of the research questions and the research hypotheses.

Research Question 1- What is the rate of voluntary tax compliance in the informal sector study area?

Table A-2 shows the rate of voluntary tax compliance in the study area. The estimated rate was 0.066 (or 6.6%) with standard error of 0.003. This is a highly reliable estimate because 0.003/0.066 is 0.045 (or 4.5%) signifying voluntary compliance of 0.066 (31280). This is 2064 out of 31280 farmers. The importance of voluntary compliance is that it measures the credibility status of the AES officials.

Research Question 2 - What is the response rate of farmers to extension services education, orientation and incentives?

Categories of Farmers	Farmers available for Orientation	Farmers that actually Responded to rebate off.	Percent of Responses	Rank
Traditional local Farmers	(17004)	8004	47	1st
Micro Scale Farmers	(10168)	3360	33	2nd
Small Scale Farmers	(7116)	1896	27	3rd

The above Table shows the response rate category by category without recourse to value of rebate offer TLF rate = 47.%; MSF rate = 33%; and SSF rate = 26.%... The response rate is generally low since no categories of the farmers could manage up to 50% average. The response rate of all farmers is 56.6, (47+ 33 + 27 = 107/3)

Research Question 3- How was the pattern of comparing expected responses of the local farmers for AES displayed when compared with the observed (or actual) responses?
A correlation analysis reveal that there is significant relationship with r =.995 sig at 0.001level (two tail) in table

Descriptive Statistics

	Mean	Std. Deviation	N
obs responses	736.6667	801.40025	18
exp responses	737.5852	790.11146	18

Correlations

		obs responses	exp responses
obs responses	Pearson Correlation	1	.995**
	Sig. (2-tailed)		.000
	N	18	18
exp responses	Pearson Correlation	.995**	1
	Sig. (2-tailed)	.000	
	N	18	18

**. Correlation is significant at the 0.01 level (2-tailed).

Research Hypothesis 1- Ho_1: Extension services education, orientation and incentives have approximately the same effects on the different categories of farmers.
Table A-6 is the confidence limit table. The analysis shows the rebate offer that would be able to achieve a 50% desired probability of AES payment. The analysis shows 24.868% rebate offer to attract 50% from TLF. In the case of MSF it is 30.969% rebate offer and also 37.215% for SSF. Hypothesis 1 is rejected and the alternative hypothesis is accepted.

Research Hypothesis 2 - Ho2: The relative median potency estimates of one category/size of the local farmers is not significantly different from other categories/sizes of the farmers

The issue of potency is very important when a dose, incentives or an empowerment is entrenched in a reform especially of in the case of local farmers. Table A-6 is still used to compare 50% probability of rebate offer. 24.868 of TLF ÷ 30.969 of MSF = 0.803. 24.868 of TLF ÷ 37.215 of SSF =0.668. Lastly 30.969 of MSF ÷ 37.215 of SSF =0.832. Since none of the relative median potency of the categories/sizes of the farmers are same, there is a significant difference in the relative potency of the categories of farmers. The null hypothesis is rejected.

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APPENDIX*

Table A-1 Data Information

		N of Cases
Valid		18
	Out of Range[a]	0
	Missing	0
Rejected	LOG Transform Cannot be Done	0
	Number of Responses > Number of Subjects	0
Control Group		0
	1. Traditional local farmers	6
Size[b]	2.. Micro scale farmers	6
	3.Small scale farmers	6

a. Cases rejected because of out of range group values.
This model validity is 100% with reliable as rejection cases is null.

b. The various sizes represent the categories (or control group) of farmers.

Table A-2 Natural Response Rate Estimate[a]

	Estimate	Std. Error
PROBIT	.066	.003

a. Control group is not provided.

About 6.6% of all taxpayers would pay taxes without rebate offer. This signifies voluntary compliance of 2158 out of 31280 taxpayers.

Table A-3 Chi-Square Tests

		Chi-Square	df[b]	Sig
PROBIT	Pearson Goodness-of-Fit Test	3182324	18	.000[a]
	Parallelism Test	16.559	2	.000

a. Since the significance level is less than 0.150, a heterogeneity factor is used in the calculation of confidence limits. That is, the performance of the group of farmers are significantly different. The parameter estimates in Table A-4 has further revealed difference based on category of farmers sizes intercept.

b. Statistics based on individual cases differ from statistics based on aggregated cases. The probit analysis produces two chi-square test of different aspects of the model.

The Pearson goodness-of-fit chi-square statistics is used to test the null hypothesis that the model adequately fits the data.

If the null hypotheses of these tests are true, the statistics have chi-square distributions with the displayed degrees of freedom. If the significance value of a given test is small (less than 0.05), then the model does not adequately fit the data. In this case, the data do not violate the model assumptions

Table – A4 Parameter Estimates

	Parameter		Estimate	Std. Error	Z	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
PROBIT[a]	reb off		2.043	.037	55.471	.000	1.971	2.115
	Intercept[b]	traditional local F	-6.565	.126	-52.065	.000	-6.691	-6.438
		micro scale farm	-7.013	.128	-54.832	.000	-7.141	-6.885
		small scale farm	-7.388	.133	-55.508	.000	-7.521	-7.255

a. PROBIT model: PROBIT (p) = Intercept + BX (Covariates X are transformed using the base 2.718 logarithm.)
b. Corresponds to the grouping variable codes.

Probit Analysis estimates a common slope, common natural response rate, and separate intercepts for each factor level
A common slope means that increasing the value of the rebate offer has the same effect as increasing the value of the rebate offer for *Micro scale farmers and small scale farmers on the transformed scale*. The traditional local farmer (TLF) have great slope than others. The effect of the incentives is more on the TLF than others
The estimates of the intercepts give the relative orderings of the sizes. The exact quantification of the differences in terms of probabilities varies over the range of values of rebate offers.
The ordering of the sizes therefore is -6.565; -7.013; and -7.388.

Table A-5 Cell Counts and Residuals

Cell Counts and Residuals

	Number	codes	reb off	Number of Subjects	Observed Responses	Expected Responses	Residual
PROBIT	1	1	1.609	2640	144	175.632	-31.632
	2	1	2.485	2784	504	361.464	142.536
	3	1	2.944	2568	648	868.077	-220.077
	4	1	3.258	2364	1356	1340.037	15.963
	5	1	3.497	3216	2424	2370.021	53.979
	6	1	3.689	3432	2928	2900.557	27.443
	7	2	1.609	1900	132	125.644	6.356
	8	2	2.485	1632	84	148.001	-64.001
	9	2	2.944	1716	432	368.382	63.618
	10	2	3.258	1920	876	773.158	102.842
	11	2	3.497	1416	684	823.024	-139.024
	12	2	3.689	1584	1152	1139.319	12.681
	13	3	1.609	1056	60	69.755	-9.755
	14	3	2.485	1356	144	102.704	41.296

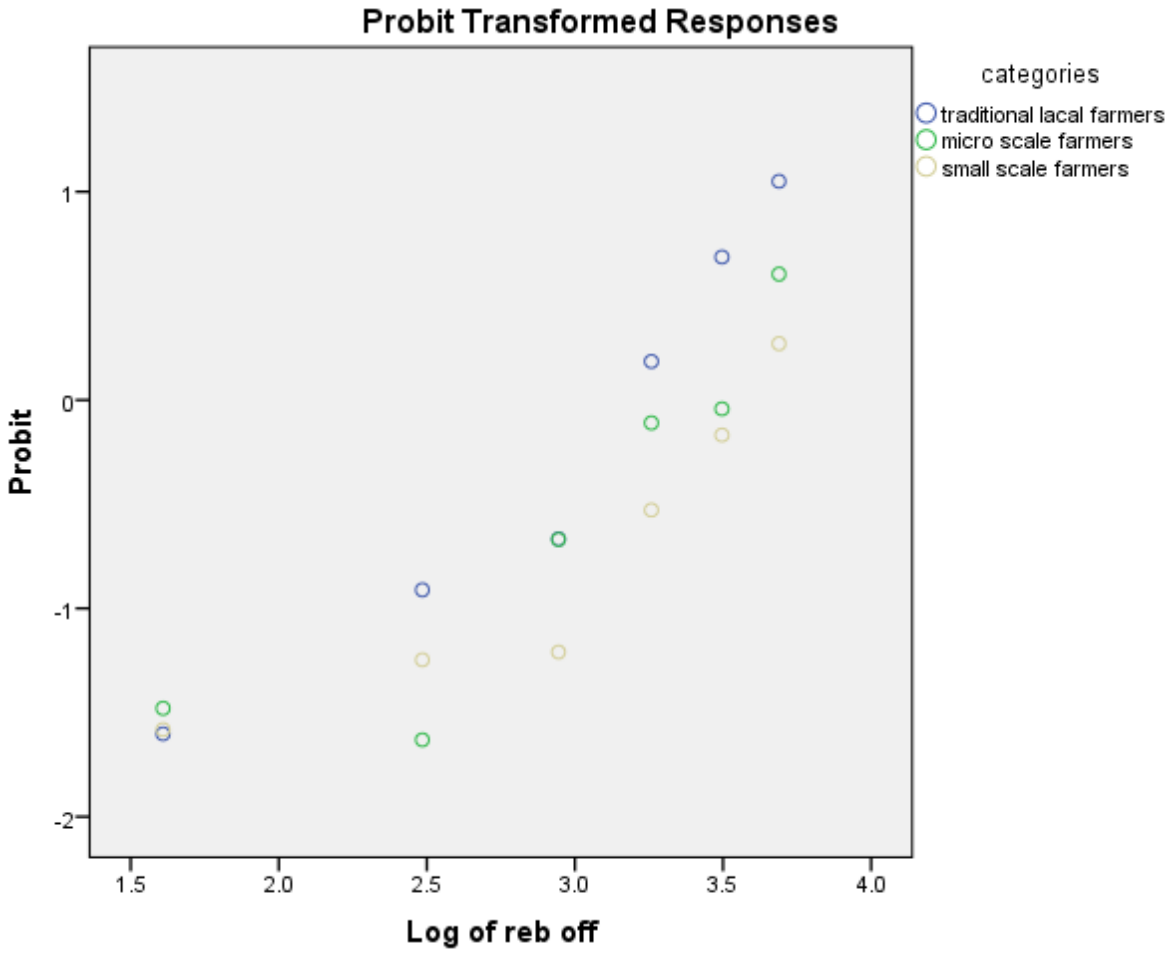
	15	3	2.944	1272	144	184.780	-40.780
	16	3	3.258	924	276	261.155	14.845
	17	3	3.497	1440	624	637.111	-13.111
	18	3	3.689	1068	648	627.713	20.287

Table- A6 Confidence Limits

Categories of Farmers	Probability	95% Confidence Limits for reb off			95% Confidence Limits for log(reb off)[b]		
		Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Traditional local farmers (TLF)	.350	20.593	18.253	22.564	3.025	2.904	3.116
	.400	21.967	19.693	23.918	3.090	2.980	3.175
	.450	23.384	21.174	25.329	3.152	3.053	3.232
	.500	24.868	22.713	26.831	3.214	3.123	3.290
	.550	26.446	24.330	28.463	3.275	3.192	3.349
	.600	28.152	26.044	30.277	3.338	3.260	3.410
	.650	30.030	27.883	32.341	3.402	3.328	3.476
Micro scale farmrs (MSF)	.350	25.645	22.907	28.286	3.244	3.131	3.342
	.400	27.357	24.595	30.128	3.309	3.203	3.405
	.450	29.121	26.309	32.071	3.371	3.270	3.468
	.500	30.969	28.069	34.158	3.433	3.335	3.531
	.550	32.934	29.901	36.436	3.495	3.398	3.596
	.600	35.058	31.836	38.967	3.557	3.461	3.663
	.650	37.398	33.915	41.832	3.622	3.524	3.734
Small scale farmrs (SSF)	.350	30.818	26.967	34.868	3.428	3.295	3.552
	.400	32.874	28.896	37.214	3.493	3.364	3.617
	.450	34.995	30.854	39.684	3.555	3.429	3.681
	.500	37.215	32.872	42.327	3.617	3.493	3.745
	.550	39.576	34.979	45.198	3.678	3.555	3.811
	.600	42.129	37.216	48.373	3.741	3.617	3.879
	.650	44.941	39.632	51.948	3.805	3.680	3.950

a. A heterogeneity factor is used.
b. Logarithm base = 2.718.

The confidence limits table (shown here for probabilities from .350 to .6650) displays the value offer necessary to achieve a desired probability of local farmers' incentives. For example, a 24.868% rebate offer would entice 50% of TLF to make a AES payment, while 30.969% rebate offer would raise the probability of 50% for MSF.


Probit Transformed Responses
categories
traditional lacal farmers
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Probit
1
0
-1
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1.5
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