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PRIVATE PARTICIPATION IN AGRICULTURAL EXTENSION IN NIGERIA AND BENIN: DETERMINING THE WILLINGNESS TO PAY FOR INFORMATION

J. Daniela Horna[1], Smale, Melinda[2], von Oppen, Matthias[1]

[1] Institute of Agricultural Economics and Social Sciences for the Tropics and Subtropics, University of Hohenheim
[2] International Institute of Food Policy Research (IFPRI); International Plant Genetic Resources Institute (IPGRI)

Contact Information: J. D. Horna, University Hohenheim, Institute 490B, D-70593 Stuttgart, Germany, Tel: +49 (711) 459-4324, Fax: +49 (711) 459 3762, jdhorna@uni-hohenheim.de

Abstract

A typical private good is defined by its excludability and rivalry characteristics. Information might not generate rivalry among its users. By contrast, excludability is certainly a characteristic of information and its delivery can generate incentives for private participation. This study examines farmers' preferences for seed of new rice varieties and their willingness to pay for related information in villages of Nigeria and Benin. Conjoint analysis is used to estimate the structure of farmers' preferences for rice seed given a set of alternatives. Farmers are considered to be maximizers of utility rather than profit, preferring one variety over another based on the utility they obtain from its attributes, which depends on their own social and economic characteristics. Contingent methods are used to elicit preferences and willingness to pay (WTP) for rice seed. The marginal values of attributes, with and without information about the seed, are estimated with an ordered probit regression. WTP for information is derived from the analysis of WTP for rice seed. The results have implications for the best way to finance research and extension services in the areas of intervention, particularly for new rice varieties.

JEL Classification Code

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Keywords

WTP for information, conjoint analysis, rice attributes, and farmers' preferences

The importance of extension in agricultural systems has been questioned due to its low effectiveness in improving agricultural performance and consequently farmer welfare (Rivera and Gustafson 1991; Carney 1998). Public provision of extension services represents a heavy fiscal burden for governments. Experiences in a number of locations around the world are demonstrating that inefficiencies in resource allocation are unavoidable if a service such as extension is provided free of charge to stakeholders who might be able or willing to contribute in order to obtain appropriate service (Schwartz 1994; Dinar 1996; Carney 1998; Chapman and Tripp 2003; McFeeters 2004).

This study treats information and knowledge as agricultural inputs and the goods that extension services provide. The underlying hypothesis is that as a good, information has a market with incentives for private participation. The objective of the research is to determine the marginal value of information to farmers and estimate their willingness to pay (WTP) for it. Though a hypothetical value, WTP can help to establish boundaries for information supply price and guide the implementation of private participation in extension services.

The project on which the research is based was initiated by the West African Rice Development Association (now Africa Rice Center, WARDA) in 1999 to develop participatory tools to enhance farmer participation in developing new rice varieties and explore alternative ways to increase the efficiency of agricultural extension. The project areas of intervention are villages in Ogun, Kogi and Ebonyi states in Nigeria and Dassa and Glazoue sub-prefectures in Benin (Figure 1). The project identified rice producers in study areas and conducted on-farm trials. The farmers participating in the project represent the population sampled for this research.

Rice is a main staple and cash crop in Nigeria and Benin, and these countries have a comparative advantage to produce it locally (Ahoyo 1996; Akpokoje et al. 2003). Nevertheless, agricultural growth and food production trends have not kept pace with the 3% annual growth in population, leading to increasing dependence on food imports. Although rice production levels and cultivated areas have tended to increase, there is a remarkable decrease in rice yield over the last 20 years, particularly in Nigeria (FAO 2004). A significant proportion of the population in both Nigeria and Benin remains food insecure (IFDC et al. 2000). Over 70% of the population in Nigeria, and 40% of the population in Benin, lives below the poverty line.

Evidence suggests that the rate of adoption of rice technologies in West African countries has stagnated. Despite the importance of rice in the daily diet of the farm households and urban families, rice technologies appear not to have generated better yields or improved quality (FAO 2004). The public delivery of technologies has been inefficient, a problem accentuated by elevated costs (Akpokoje et al. 2003).

Similar situations have been recognized in a number of different countries, where extension services have been handed out to private providers or the funding of this activity has been diversified (Carney 1998; Berdegué and Marchant 2002; Katz 2002; Rivera and Zijp 2002; Chapman and Tripp 2003; Davidson and Ahmad 2003; McFeeters 2004). The conclusion has been the same with either strategy: although there are economic and social reasons that justify public financing of agricultural extension services, not all services need be publicly provided (Sulaiman and Sadamate 2000).

In this study, agricultural extension is viewed as a service that can be publicly funded with additional contributions from farmers, but is delivered in a private way. Farmer contributions have two purposes other than supporting the system. First, they increase the incentives for extension delivery. Second, they enhance the accountability of extension agents to farmers. To assess the level of stakeholder contribution, a methodology is developed to estimate willingness to pay (WTP) for information. The rice seed evaluated includes inter-specific crosses (New Rice for Africa, or NERICA) and other improved rice varieties produced by the West African Rice Development Association (WARDA). The innovative aspect of the research is the use of conjoint analysis to estimate the value of information and its effect on farmers' perceptions and preferences. Findings demonstrate that farmers value information about seed and have a positive WTP for it. As a consequence, there are possibilities for private participation in providing agricultural extension, particularly for new varieties.

Theoretical approach

Demand for seed varieties

In consumer theory, demand functions are derived by considering a model of preference maximizing behaviour coupled with underlying economic constraints. Under normal circumstances, the consumer chooses the good that satisfies better his needs or expectations, or that provides him with a higher utility. The consumer cannot choose a good that he cannot afford because his demand is constrained by his budget. In estimating variety demand equations, the framework of utility maximization is more complete than that of profit maximization. For instance, a farmer deciding over a new rice variety may not necessarily choose the one that offers higher cash return. Farmers seek to maximize utility subject to multiple constraints, and these may be technical, institutional or organizational.

The Lancaster theory of consumer choice (1991) proposes that consumers choose attributes of goods rather than the goods themselves. In other words, utility is provided by the attributes a good possesses instead of the good *per se*. Individual preferences determine the relative weights given to the various attributes when choices are made. The relationship between goods and attributes and as well among attributes is objective and determined by the consumption technology. In this study, the consumption technology is the seed variety, or genotype that is consumed by the farmer as a production input.

Drawing from this theoretic framework, conjoint analysis (CA) methodology allows a utility function to be modeled as the sum of utilities that product attributes generate to a consumer. The methodology is a survey-based valuation technique that relies on individual backgrounds to estimate the marginal contribution of a specific product characteristic to overall preference ratings (Hamath et al. 1997). The underlying premise is that consumers evaluate a product by adding utilities from each attribute (Baidu-Forson1997a). Several studies have employed CA to evaluate farmers' preferences in crops and other technical innovations in West Africa (Adesina and Zinnah 1993; Baidu-Forson, Ntare et al. 1997a; Baidu-Forson, Waliyar et al. 1997b; Ndjeunga and Nelson 2005). Utility is translated into economic benefits through commercial sale or on-farm consumption of the good.

Here, CA was used to decompose the structure of farmers' preferences given his/her overall evaluations of a set of rice seed alternatives that were pre-specified in terms of level of different attributes (Green and Srinivasan 1978). Farmers prefer one variety based on its attributes and how they perceive them. Choices among alternatives depend on the attributes of the variety of rice seed, the characteristics of farmers, and the level of information farmers have about the variety.

Demand for seed-related information

Literature on willingness to pay (WTP) for information provided by extension services is scant. Dinar (1996) estimated demand for and supply of extension visits in Israel, deriving WTP for these services from the per hectare value added by subtracting the production cost (including extension) from the revenue. This approach provides a factual estimate of the extension price, but if the value added is not due exclusively to an increase in the number of extension visits, the extension activity might be overvalued. Where extension services are not strong and structured, as they are in Israel, the validity of the approach is questionable. Application of the method requires detailed information not only about farm production but also about extension performance.

Holloway and Ehui (2001) focused on the cash income constraint in a model of consumer demand, deriving the amount of income that a dairy producer in Ethiopia is willing to forgo to obtain an additional unit of service rendered. The decision the dairy producer has to take is whether or not to participate in the market. Market participation depends on the increased price he can obtain for a better product. The WTP is estimated only for individual extension visits. The suitability of this approach depends on the reliability of market prices and the extent to which production is commercially oriented.

Sulaiman and Sadamate (2000) estimated the WTP for extension services for Indian conditions. Farmers were asked directly about their WTP for extension services and valid agricultural information. The authors used a linear discriminant function to predict farmers' behaviour and evaluate the determinants of their willingness or unwillingness to pay. One caveat of this approach, as in any contingent valuation exercise, is that the WTP is a hypothetical value. Hypothetical values cannot always be correlated with capability or readiness to pay.

When farmers are familiar with fee based extension services and can give a plausible value, as was the case in the Indian study, the methodology is appropriate. By contrast, financial participation for extension is rare in West Africa. In this study, the WTP value for information had to be estimated indirectly. Conjoint analysis, most commonly applied in market research, provides a powerful theoretical basis for doing so.

By treating information about the seed variety as a product attribute, it is possible not only to evaluate how preferences change but also to estimate the marginal value of the information itself. The product delivered by extension services is information about new technologies, which are improved rice varieties. The information variables account for extension activities conducted during the introduction of the new varieties.

Research Design

Site selection

The sites studied were originally selected by the WARDA project based on ecological criteria used to classify the production conditions of upland rice and test varieties. While there is a preference for lowland cultivation in Nigeria as well as Benin, upland production has great potential in both countries. Villages in three states of Nigeria (Ogun, Kogi and Ebonyi) and two sub-prefectures in Benin (Dassa and Glazoue) are included. Each site has unique ecological features, social and economic conditions, summarized in Table 1 (WARDA 1999).

Dassa and Glazoue in Benin, and Kogi in Nigeria are classified as Guinea savannah. Rainfall patterns in these sites varies from 900 to 1200 mm per year in Benin and from 1000 to 1500 mm per year in Kogi, allowing in both cases a crop-growing period of 180 to 210 days. There is a marked dry period in the sub-prefectures of Benin, which as has been extending in length over the last several years. Drought resistant varieties represent an important alternative for rice producers in this area.

Kogi state, located in the central plateau of Nigeria, also has a dry period but the villages under evaluation are close to the Lokoja River, which carries water throughout the year. Lowland rice production is more important than upland production in this state, although upland rice is an alternative for small farmers with limited access to good quality land. Kogi and Benin farmers participating in the project had limited experience in upland rice production.

Ogun state in the Southeast is classified as a rainforest area but it also has some savannah areas. The average annual rainfall in this state varies from 1400 to 1700 mm per year, allowing a crop-growing period of around 270 days. Upland and lowland rice production are important and farmers are organized in an association called ORGA (Ogun State Rice Growers Association). Ogun state is relatively rich with high road density, and with a stronger extension office (OGADEP, Ogun State Agricultural Development Project). Farmers have access to village and regional markets and are quite familiar with rice varieties.

Ebonyi state, located in the Southwestern part of Nigeria, is a secondary savannah as a result of human activities and high population density. The volume of rainfall is greater than in Ebonyi than in the other sites (1500 to 1800 mm per year) and is distributed from April to early November, with a growing period of 230 to 270 days. Traditionally, Ebonyi farmers are rice producers and they are very familiar with rice varieties. The rice produced in Ebonyi is marketed to states around the region, and the rice production and commercialization chain is therefore more developed. Farmers participating in the project take other roles in the rice production chain in addition to farming, including parboiling, milling and trading. This diversity of functions affects the way they perceive and assess rice quality attributes.

Data

The sample of farmers was defined by the WARDA project, since these represent the population with potential willingness to pay for seed and seed-related information. Participating farmers were identified in a two-step process. First, rice-growing villages were located with the help of the agricultural extension officials. Next, farmers were called to community planning meetings and invited to participate in the project. A total of 272 farmers decided to enroll in the project activities, including 176 from Nigeria (57 in Kogi, 49 in Ogun and 70 in Ebonyi), and 96 from Benin (46 in Dassa and 50 in Glazoue).

Three tools generated the primary data. The first tool was a household survey conducted during 2002 – 2003, addressed to each farmer participating in the project. The survey covered general household characteristics, rice production, market information, and farmer perceptions of rice attributes. Survey data provided the explanatory variables for the econometric analysis.

The second tool was an on-farm trial. Each of the 272 participating farmers agreed to implement an on-farm trial during two cropping seasons to test an improved rice variety and compare it to the local variety in use. Farmers were responsible for: a) managing of the plot; b) evaluating rice varieties already available in the area and the new varieties available in stock; c) selecting the most preferred rice varieties to be tested in WARDA experimental fields in each site; d) selecting the improved variety to be tested in their own on-farm trial; and e), providing periodic information to the WARDA technicians about the status of the on-farm trials. WARDA provided the seed and the necessary inputs for the on-farm trials free of charge, most importantly fertilizer and extension assistance. Participation in the on-farm trial is one of the two extension variables included in the analysis.

The third tool was a field day activity where the contingent ranking method (CR) was used to elicit farmers' preferences for rice varieties. The exercise was carried out in the WARDA experimental field in each site in 2002. Only 201 farmers of the 272 participating in the project could attend the field day. The task for farmers was to rank a sample of varieties in order of preference, with and without information about the seed. While the ranking in itself is the dependent variable in the analysis, the information obtained in the field day experience represents the second extension variable.

The ranking system is considered to have estimation efficiency that is superior to the binary preference system (Mackenzie 1993). Unlike rating systems, ranking levels are comparable across respondents. In the study sites, the ability of risk farmers to order or rank varieties and multiple attributes is well developed, although the probability of ranking inconsistency increases when the sample size increases (Baidu-Forson et al. 1997a). For this reason, the number of varieties evaluated was limited to 5 in Kogi, 6 in Ogun, 7 in Ebonyi and 8 in Dassa and Glazoue.

Varieties ranked by farmers correspond to both lowland and upland rice production. They included the most preferred local variety and improved varieties with ITA and WAB prefixes. ITA varieties are relatively old varieties produced by the International Institute of Tropical Agriculture (NCRI 2000). WAB varieties are entirely new varieties bred at WARDA. Among them, WAB 450 P31 and WAB 450 P38 are NERICA (New Rice for Africa) varieties. NERICA varieties are the result of a novel, inter-specific cross between rice originating in Asia (*O. sativa*) and rice originating in Africa (*O. glaberrima*).

Two scenarios were implemented. In the scenario without information, the rice seed samples were presented unidentified to the farmers and they had to base their judgment solely on the characteristics they could see or deduce from the physical appearance of the seed. Observable seed characteristics can provide some genetic information—depending on the farmer's prior knowledge. For example, experienced farmers might recognize seed of a well-known local variety and the variety that they were evaluating in the on-farm trials.

In the scenario with information, seed samples were labeled with their local and WARDA names, and information about variety characteristics was provided orally and on paper, as shown in Table 2. Farmers were guided around the experimental field where the varieties were at the final stage of development and could visually compare the performance, similarities and differences among the varieties.

The contingent valuation method (CV) was used to elicit farmers' willingness to pay for seed of improved varieties in both scenarios, since seed prices were not available in each case. Not all of the improved varieties have been officially released, although several have been used by farmers for some years. Other improved varieties, such as the NERICA varieties, are completely new to farmers. Questions were open-ended because farmers surveyed are accustomed to buying rice seed in the market, even though they were exposed to new varieties in the field day activity.

Econometric Model

Specification

The model states that when a farmer selects rice seed among alternative options, he or she actually compares single attributes (r_i) of the variety (R). The selection process is influenced by the characteristics (f_i) of the farmer (F) and information about the seed (Y). As in a random utility approach, the variety selected is assumed to provide the farmer the highest level of utility. The utility function is therefore defined as:

$$U = U [R (r_1...r_n), F (f_1...f_m), Y] + U [Z] . \qquad (1)$$

The farmer selects the best of the options according to the level of related information, Y. Rice choices are made independent of the consumption of the other goods, Z. Since utility is not directly observable, an indirect utility function (V) is specified. In theory, seed price is an argument in the indirect utility function. Price signals are poor and markets incomplete for rice seed alternatives in the study sites. Instead, farmers were asked to express their WTP for the rice variety of their choice (R). The indirect utility function is then expressed as

$$V = U\,[\,R, F, Y, WTP] \qquad (2)$$

Plausibly, the farmers' best choice could be a variety of seed that is not available. Then the farmer would select the next accessible variety with the attributes that fit his requirements, as his second best choice that attains a lower level of utility. Utility is not amenable to direct estimation. The utility level generated by each variety can be indirectly expressed by a preference ranking, implying that:

$$R^1\,[\,r_1,\ldots r_{n,}\, WTP_1] \geq R^2\,[\,r_1,\ldots r_{n,,}\, WTP_2] \geq \ldots \geq R^n\,[\,r_1,\ldots r_{n,}\, WTP_{n,}] \qquad (3)$$

The indirect utility function can be linearly specified as:

$$V = a + b_{r1}r_1 + b_{r2}r_2 + \ldots + b_{f1}f_1 + b_{f2}f_2 + \ldots + b_{y1}y_1 + b_{y2}y_2 + b_{wtp}WTP \qquad (4)$$

The advantage of the linear model is that the coefficients of the independent variables are marginal utilities: $MU_{ri} = dV/dr_i = b_{ri}$ (Mackenzie 1993). The marginal utility of an independent variable represents the relative change in the value of the independent variable needed to change utility by one unit (keeping the other variables constant). The ratio of marginal utilities of two attributes is the marginal rate of substitution (MRS). The MRS expresses the amount of an attribute the consumer is willing to give up in order to obtain one more unit of another attribute at the same level of utility: $MRS_{r1r2} = MU_{r1} / MU_{r2} = b_{r1} / b_{r2}$. When one of the attributes is price, the equation is the inversed compensated demand for the attribute. The ratio of a given attribute or extension variable coefficient to the WTP coefficient is the inverse compensated demand for the attribute:

$$MWTP_i = b_i / b_{wtp} \quad (5)$$

As specified, the model could be directly calculated using a normal linear probability model (LPM). The LPM model is a simple ordinary least square (OLS) regression that relates the probability of a ranking occurrence to the attributes of the varieties. Due to the discrete nature of the dependent variable the LPM is constrained by its linear definition, heteroskedasticity and non-normality of the disturbances (Gujarati 1995). Logit or probit models can be used to accomplish the same estimation, and these are more appropriate in dealing with discrete dependent variables. Both models adjust better to a probability curve by using a logistic and a normal distribution function to estimate the probability of a certain ranking occurrence. They also have the advantage that the utility function itself remains linear in the parameters. The difference between the output of an ordered probit and logit is minimal (Gujarati 1995; Greene 2003), although probit is preferred when the order value of the dependent variable is important.

The model is built around a latent regression in the same manner as a binomial probit model, where the respondents have their own intensity of opinion that depends on certain measurable factors **x** and certain unobservable factors ε:

$$K^* = x'\hat{a} + \varepsilon \quad (6)$$

K* is unobserved, but what it is observed are threshold values of K:

$K = 0 \qquad \text{if } K^* < 0$

$K = 1 \qquad \text{if } 0 < K^* < \mu_1$

K = 2 if μ_1 < K* < μ_2

…

K = J if $\mu_{J-1} \leq$ K*

Then, for polytomous responses with ranking outcomes K_i = 1, 2, 3, ..., i, the probability p of observing K_i is:

Prob (K=0) = p_1 = Ö (–x'â) (7)

Prob (K=1) = p_2 = Ö (μ_1 – x'â) – Ö (– x'â)

Prob (K=2) = p_3 = Ö (μ_2 – x'â) – Ö (μ_1 – x'â)

…

Prob (K=i) = p_{i*1} = 1 – Ö (μ_{i-1} –x'â)

Where Ö represents a normal cumulative distribution function, x a vector of independent variables, and the μ's are unknown parameters to be estimated with â.

Equation (4) was estimated with a multinomial ordered probit model specified as the probability of ranking K [Pr (K)], where:

K = á + ä R + φ F + γ Y * + ϕ WTP + ε. (8)

The vector of parameter estimates δ, φ, γ and ϕ are embedded in the coefficient vector β' (equation 6), R accounts for variety attributes, F for farmer characteristics, Y for seed-related information from extension activities, WTP for willingness to pay for the rice seed, and á represents the conventional intercept plus the additional intercept dummies or threshold variables (Hamath et al. 1997). In addition, in order to have positive probabilities $0 < \mu_1 < \mu_2 < \ldots < \mu_{j-2}$ (Greene 2003).

Explanatory variables

As compared to Asian or American rice, there are no pre-established market standards for rice grain or agronomic quality properties in Nigeria or Benin. Farmers surveyed identified 5 attributes they consider when selecting varieties of rice seed: potential yield, days to maturity, tillering capacity, plant height, and size of the grain. Each of these is a fundamental agronomic characteristic of importance to farmers who consume seed as a production input, although grain size is also an attribute sought by those who consume the product. Grain size coded as an effect dummy (best option=1; indifferent=0; worst option=-1). The best option corresponds to rice with long, bold grains, while the worst option is represented by small, slender grains.

Attributes omitted from the analysis were grain color, height uniformity and milling capacity. Grain color, although important, was not included because of the sizable difference between the color of the local varieties that were parboiled and milled locally and the color of the improved varieties that were parboiled and milled under experimental conditions. Farmers listed height uniformity only because the latest materials were released unfinished and still demonstrated low field stability and height disparities. Milling attributes reflect a more complex problem concerning processing methods and grain quality. Technical information about the levels of related agronomic characters per variety was insufficient.

In similar studies, an orthogonal array was developed to generate product (seed variety) profiles that consumers then evaluated (Mackenzie 1993; Baidu-Forson et al.1997a; Baidu-Forson et al.1997b). As compared to hypothetical varieties in the research development pipeline, we are dealing with finished varieties. Finished varieties have attribute levels that vary under farmer conditions depending on interactions of the genotype with the environment. Here, expected (in a statistical sense) levels of variety attributes are drawn from multi-year, multi-locational trial data that account statistically for variation in management and growing conditions (Table 2).

Farmer characteristics (**F**) include: age, gender, years in school, marital status, experience in rice production, the size of the household, income from rice production, and whether or not the farmer sells rice (summarized in Table 3). Age, gender and marital status characterize rice producers, and affect variety preferences. Years of school and experience in rice production express farmer knowledge. Farmer knowledge could affect preferences for rice seed and ability to assimilate seed-related information effectively. Income earned from rice sales reflects the extent of commercial orientation and the economic situation of the farmers. In West Africa, household size is also an indicator of better economic status.

Information provided through extension activities (**Y**) was measured by two dummy variables. "On-farm trial experience" took the value of 1 when the farmer evaluated the variety he or she grew in the on-farm trial, and zero otherwise. After observing the variety on the farm, farmers became familiar with its attributes and their judgment was affected by the information acquired with this activity. The value of "field day information" was 1 when the information in Table 2 was provided at the field day activity, and zero if the farmer was presented only with unidentified seed samples.

Results

Descriptive statistics

Farmer characteristics, WTP for rice seed and the farm price of rice are summarized in Table 3, by site. Farmers are considerably older in Dassa and Ogun than in other sites. Women participate more in rice production in Benin, where it is more likely to be a task for which they are responsible. In Nigeria, men's agricultural work is often related to crops like yam or cassava while women undertake production of vegetables and cash crops to meet their own consumption needs, including tomatoes, groundnuts, and pepper. In Nigeria either the husband or wife manages rice plots. Women are often in charge of smaller rice plots for family consumption needs, while men manage the larger rice plots for commercial sales. On the other hand, in Benin, rice production is most likely a task for the wife that explains the difference in gender composition of the sample across countries.

Households in the sites surveyed are often organized around a male household head with several wives. Polygamy is socially accepted and it also provides additional household labor (White 2002). This fact is especially important for rice production since labor is the most expensive variable cost. Female household heads are mainly widows. The average household size of a rice producing family in either country is above 10 members. The household size is particularly large in Ebonyi, which also shows the highest labor cost among the sites.

Rice production is more extensive in Nigeria than in Benin and the production chain is more developed, especially in Ebonyi state. A higher percent of farmers selling rice was reported in the Nigerian sites, which is also linked to a relatively higher quality of the final product sold. Except for Kogi, in the other two states in Nigeria, farmers sell processed rice (parboiled and milled). Survey data also indicate that farmers in the Nigerian states of Ogun and Ebonyi generate a larger percentage of their income from rice production, which is probably due to a greater experience cropping rice in these two states relative to the other sites. Total income is considerably higher in Nigeria than in Benin.

Table 3 also shows that, except for Ebonyi, WTP for the improved seed samples is higher than the actual farm gate price of the local rice. One explanation for this finding could be that Ebonyi is the site with the greatest degree of specialization in rice production and marketing. Farmers in Ebonyi are involved in more than one step of the production chain and almost all of them sell parboiled-milled rice. The milling facilities are organized in a milling company and have developed essential quality standards based on the characteristics of the most important rice types produced in the state. A large percentage of the population in the state is involved in rice production, generating an excess supply that is traded in neighboring states. An improved rice variety must demonstrate similar or better quality characteristics to compete with the local varieties.

Ordered Probit Results

Complete and valid information was gathered for 201 farmers (30 from Kogi, 38 from Ogun, 49 from Ebonyi, 40 from Dassa, and 44 from Glazoue), generating for each case scenario a total of 150 usable rankings in Kogi (30 observations * 5 varieties evaluated), 228 in Ogun (38 * 6), 343 in Ebonyi (49 * 7), 320 in Dassa (40 * 8), and 352 in Glazoue (44 * 8).

The model was estimated for each site and for all respondents. Each site had a different number of varieties evaluated. For the model considering all respondents, rankings were adjusted to include only the four varieties evaluated in every site: the local one, ITA 150, WAB 450 P31 and WAB 450 P38. The transitivity property of the rankings enables recoding. Given the reduction in the number of variety attributes, samples pooled at country levels revealed no additional information and are not reported.

A number of formal approaches can be used for testing for model specification, the most common of which are the Lagrange multiplier (LM) test, the likelihood ratio (LR) test, and the Wald test. In each of these approaches, two models are formulated, a restricted model and an unrestricted model. The likelihood ratio test is preferred when a direct comparison is made between nested hypotheses that can be treated with parameter restrictions (Ramanathan 1998). The test-statistic is defined by the ratio of the maximum value of the likelihood function under the null hypothesis (the restricted model) divided by its maximum value when no restrictions are imposed. The test statistics is asymptotically distributed as chi-squared, with degrees of freedom equal to the difference in estimated parameters (Mazzanti 2001).

Table 4 summarizes the results of six separate probit models representing each site and the pooled sample. The pooled model was compared to an unrestricted model that allows for site-specific marginal and fixed effects. The null hypothesis that separate site effects are equal to zero was rejected with a Swait-Louviere log-likelihood ratio test at the 1% significance level. In other words, data do not support the hypothesis that the underlying population parameters are similar across sites.

The signs of the regression coefficients indicate the direction of effect of each variety attribute, seed-related information, and farmer characteristics. The ranks ranged in value from 0 to 3 for the pooled model, 4 for Kogi, 5 for Ogun, 6 for Ebonyi, or 7 for Dassa and Glazoue. Since a higher rank indicates a stronger preference for the rice variety, utility increases with a positive sign and decreases with a negative sign. The magnitude of the coefficients is more complex to interpret because the probit function uses a normal distribution to adjust the probability curve for the different utility thresholds (rankings). Hamath et al. (1997) explain that since the utility of preference is an ordinal measure, the relative magnitude of the coefficients is more important than their absolute magnitude. The sign and significance of the variables allow inferences to be drawn about: a) the importance of variety attributes to farmers, b) the effects of farmer characteristics on the way they rank varieties; and c) the influence of information in the ranking process.

Farmers in each site stated preferences for a distinct set of variety attributes, as expressed in the divergent combinations of signs and significance of coefficients. The model estimated for all respondents suggests that, in general, farmers prefer varieties with higher potential yield. Still, while a strong preference for yield potential is observable in Ogun, Ebonyi, Dassa and Glazoue, the same cannot be said for Kogi. Yield is typically the primary advantage of improved varieties over local ones, although farmers are not always looking for the single variety with the greatest yield potential but for greater stability, as well as other characteristics. Furthermore, farmers do not generally attain yield potential on their farms, due to a combination of environmental and management factors. Though surprising, these findings coincide with those obtained by Dalton (2004) in his hedonic analysis of the economic value of rice traits.

Days-to-maturity is a significant attribute for farmers in the Nigerian site regressions as well as the pooled regression. In Nigeria, farmers prefer early-maturing varieties. In Ebonyi, China is a short cycle variety that allows farmers to enter the market early in the season, but its yield is still modest and consumers pay a lower market price for its short grain. The indifference of farmers in Dassa and Glazoue to early maturity could be explained by the varieties used as local controls in these sites and their grain size characteristics. In Dassa and Glazoue, Gambiaka is a variety with an extra-long cycle and low drought tolerance, but a good-sized grain that consumers appreciate. The coefficient on grain size has the expected positive sign in Kogi, Ebonyi, and Dassa, as well as the pooled model—demonstrating farmer preference for long-bold grains. Grain size is of statistical significance in all sites except Glazoue, where the local, medium-sized grain is highly demanded by farmers.

The tillering capacity of the plant is an important attribute to rice farmers in all of the sites and in the pooled model. Nonetheless, the highest tillering plants are not the most preferred. For some farmers high tillering capacity is an indicator of higher yield, although a plant that produces more tillers has less vigor to produce bold grains (Myers McClung 2002). Plant height is a statistically significant factor in variety rank for farmers in the all sites except for the pooled sample. Farmers state a clear preference for taller varieties. In Ogun, especially, where only the panicle is cut at harvest, short varieties demand more effort for an activity that already demands a lot of labor.

The set of farmer characteristics that influence how they rank varieties also depends on the site. The extent of formal education is significant only in Ebonyi and Glazoue sites and in the pooled model. Similar results were obtained in India, where analysis of demand for agricultural services revealed a higher WTP among better educated farmers (Sulaiman and Sadamate 2000; Katz 2002). The sample included relatively few cases of single-headed households, and marital status had no effect on variety rank. The gender of the farmer is a statistically significant determinant only in Glazoue, where women participate intensively in rice production. Participation in the market as a rice seller mattered in the Benin sites. The effect of selling rice is negative, indicating that to keep rice for home consumption gives farmers a higher utility. Income generated from rice production is a determining farmer characteristic only in Dassa, which is the site with the lowest total income.

The information provided to farmers during the field day has no significant effect on their variety ranking in any site. Moreover, the coefficient for this variable is negative in all cases, suggesting that the information provided during the field day activity did not increase the utility level of farmers. On the other hand, the second information variable, reflecting farmers' experience in on-farm trials, is statistically significant in Ogun, Glazoue and the pooled sample. Across sites, the willingness to pay (WTP) for seed is a statistically significant and positive factor in a variety's rank. Consistent with consumer theory, these results confirm that the higher the preference for the variety and its attributes, the higher the willingness to pay for seed.

The threshold variables can be interpreted as the numerical linkages between the utility function of respondents and the preference rankings of rice varieties. As shown in table 4 the threshold coefficients obtained are consecutively higher, positive and significant, which implies that the model specification is correct (Hamath, Faminov et al. 1997; Greene 2003).

WTP estimation

In the context of this study, information is understood as a message including data, ideas, or facts that are new and valuable to the person that obtains them. Knowledge is the ability to use information, and the development of this ability involves a learning process. The ratio of a given attribute or extension variable coefficient to the WTP coefficient is the inverse compensated demand for the attribute (Mackenzie 1993) or the WTP value for each attribute. These values are presented in Table 5.

Positive as well as negative WTP values were discovered. The negative values could be interpreted as a lack of farmer interest in field days or on-farm trials unless there is compensation. The on-farm trial experiment included the seed, fertilizer and extension service and the opportunity to observe the variety closely throughout a cropping period. In comparison, the field day activity is a single day of exposure to rice varieties where farmers are told about some characteristics of improved varieties and can visually compare their field performance to that of the local check only at that point in time. In the pooled regression model, WTP is significant and positive for the on-farm experiment (US$ 0.149), but the field day activity does not influence variety rank or increase the utility of farmers. Farmers in Ogun state are willing to pay more for on-farm trials than farmers in other sites. Ogun farmers are willing to pay US$

0.273 for the whole on-farm trial package, as compared to US$ 0.127 in Glazoue. Farmers from Dassa, Kogi and Ebonyi show no interest in paying for the on-farm trial activity. In Dassa, Ebonyi and Kogi the improved varieties tested appear not to have represented a real advantage compared to the local variety included in the trial, or to alternative activities. Rice production is a labor demanding activity and many farmers opt either for other crops like cassava or yam, or for other non-agricultural activities like commerce.

The coefficients for the field day activity suggest a negative WTP for this activity, although they are not statistically significant. Clearly, the information provided to farmers was not enough in quantity or quality to affect their preferences. Nor do improved varieties show a strong technological advantage.

Conclusion

An ordered probit regression was specified to estimate the indirect utility function of rice farmers in selected project sites of Benin and Nigeria, where the ratio of an extension activity coefficient to the WTP coefficient is the inverse compensated demand for the activity. Farmers were asked to rank a sample of rice varieties with and without seed-related information. The rankings represent the relative level of farmer utility. The model was built around a latent regression where the respondents have their own intensity of opinion. Explanatory factors included variety attributes, farmer characteristics, and extension variables in addition to a price, measured as the willingness to pay for the rice seed. The willingness to pay for rice seed was elicited through an open contingent valuation approach.

The variety attributes evaluated in this study (potential yield, tillering capacity, size of the grain, height of the plant and days to maturity) are those that have been addressed specifically by plant breeders. The probit coefficients indicate that these attributes are important determinants of the seed preferences stated by farmers, although in many cases, the sign of coefficient seems to contradict that sought by rice researchers. This is most evident for potential yield and plant height. Finding similar patterns with the application of a hedonic analysis, Dalton (2004)concluded that although yield has served as a defining factor for promoting a new variety for official release, high yield was not a significant determinant of farmer WTP for new rice varieties in West Africa. Most farmers do not obtain yield potential under their growing conditions, and yield stability, as well as other attributes, may also be of concern to them. Plant height is an important indicator for farmers and conventionally, rice breeders tend to select stronger and shorter rice plants to avoid lodging from high winds. Depending on the method they use to harvest and other uses of rice straw, farmers might have a preference for rice plants with medium to tall stature. In the study sites, farmers cut rice panicles and leave the plant on the ground, so that short plants are inconvenient. Tall plants are easier for harvesting, since farmers do not have to bend and the process can be accomplished more effectively. Rice production is already a fundamentally labor-intensive activity.

In general, differences across the regions for preferred attributes express the high degree of physical, social, and economic heterogeneity among the sites. This heterogeneity can help to explain the mixed results obtained with respect to the role of farmer characteristics in predicting rice variety preferences. Education was a significant factor in several sites. In theory, educated farmers can assimilate information and convert it into knowledge more effectively than farmers with limited education, although this is not always the case. The extent of farming experience, expressed as the number of years growing rice, generates relevant knowledge. Surprisingly, this variable was significant only in Glazoue.

The importance of the introduced technology, the content of the activities, and the experience of the farmers regarding specific topics of discussion can influence their WTP for extension activities. Extension activities are usually time-consuming, but if the content is new and valuable to farmers the incentives to participate may be sufficient without a direct financial compensation. In this case, the content is information about improved rice varieties, some of which are already known to farmers. Under these conditions, it is not surprising that the field day information has no strong influence on the preferences of farmers or that the WTP for the field day activity is statistically significant only in one site.

The low WTP values for field day information could also indicate that, in order to provide incentives for private participation in the area, extension efforts should target farmers as groups rather than individuals. This research suggests that rice farmers participating in the project have a positive WTP value for information but mainly for hands-on experience (on-farm trials). Since all farmers evaluated are project participants, there is probably an upward bias in WTP, if any, relative to the general rice-growing population. Clearly, willingness to participate in the project however does not necessarily translate into willingness to pay for extension.

Overall, research findings support the hypothesis that extension activity has potentially positive marginal benefits. The level of marginal benefits may still be too low to encourage the participation of the private sector in extension, at least at the individual level. Even when farmers are willing to pay for a better service, their contribution is limited by their incomes. Group contributions could be a much feasible alternative to increase incentives for private participation. Even when the extension service is not fully paid by farmers, contributions to extension and/or the number of contributors should be high enough to allow the development of the system. If incentives are to be increased, the technology offered with the extension service has to create a technological advantage that is sufficient to make farmers “willing to pay”—or even better—“able to pay”. More research is needed to explore the appropriate institutional arrangement that would suit the specific conditions in the target areas. Outcomes from experiences in other countries can help to guide the process.

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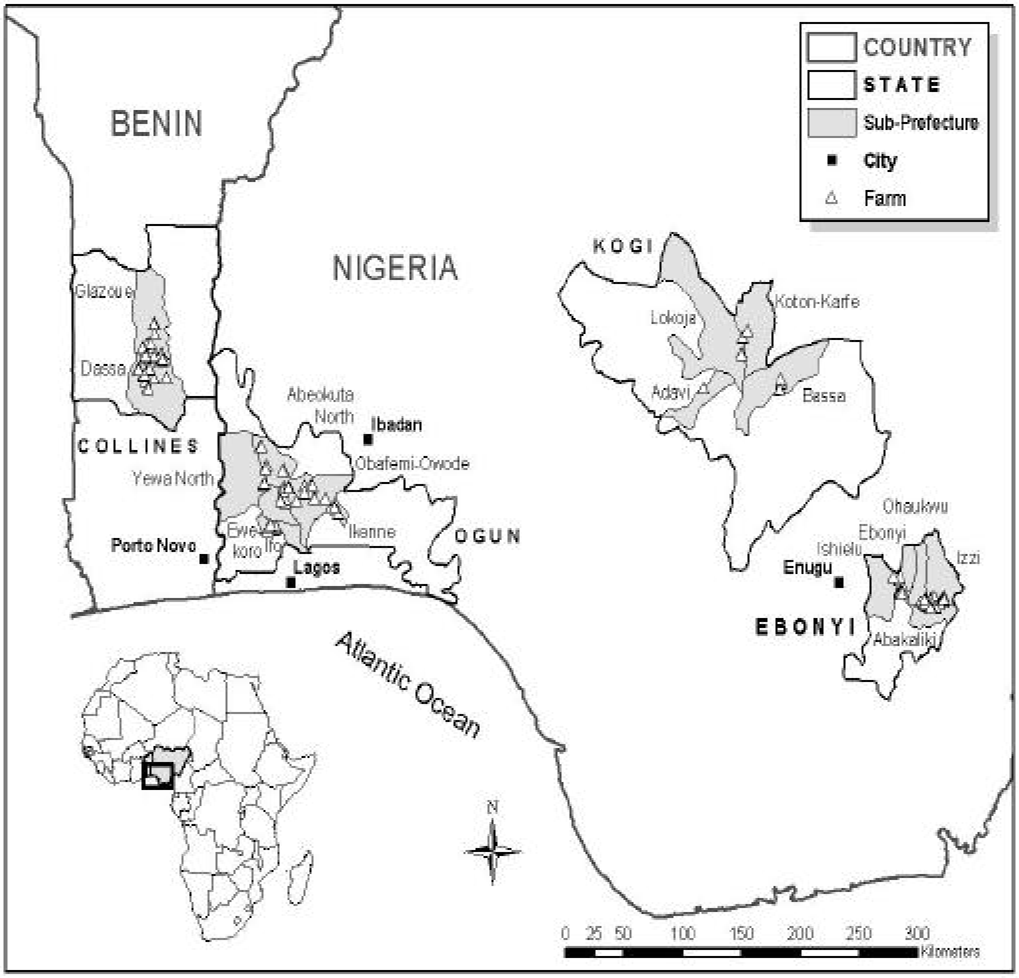
Figure 1. Location of the Study Sites



<u>Data Source:</u> WARDA project and Chris Legg, IITA GIS Lab
<u>Map:</u> Jan Dempewolf, University of Maryland

Table 1. Ecological Characterization of Sites

Variables	Nigeria			Benin
	Ogun State	Kogi State	Ebonyi State	Dassa / Glazoue
Geology	Igneous / metamorphic rocks	Basement complex rocks / alluvial materials	Sedimentary rocks	Gneiss / granites
Relief	Lowland	Undulated plateau and flood plains	Lowland	Mixture of plateau and valley
Ecology	Rainforest	Southern guinea savannah	Derived savannah resulting from human activities	Guinea savannah
Annual rainfall (mm)	1400 - 1700	1000 – 1500	1500 - 1800	900 – 1200
Length of rain season	March – Mid November	May- October	April – Earlier November	May – October
Length of growing period	> 270 days	180 – 210	230 – 270	180 – 210
Annual average temperature	23	25	28	23
Soils	Acrisols / ferrisols (upland) Gleysols (valleys	Ferralitic and alluvial soils	Lateritic clays (upland) Ultisols (valleys)	Ferrigineus tropical (upland) Hydromorphic (lowland)
Population density (persons/Km^2)	139	66	250	50
Ethnic group	Yoruba	Igbira, Igala, Yoruba	Igbo	Idatcha, Mahi, Peuhl
Road density	High	Medium	High	Medium
Market density	Very high both urban and rural	Medium, mainly rural	High, both urban and rural	High
Rural financial systems	Few formal institutions	Few formal institutions	Few formal and informal institutions	Many formal and informal organizations

Source: WARDA (1999)

Table 2. Varieties Evaluated by Farmers and Information Provided at Field Day

Characteristics	Potential yield (mt/ha)	Days to maturity	Number of tillers	Plant height (cm)	Grain size	Evaluated in
Local 1: Atila	1.0 – 2.0	120 – 130	7 – 10	120 – 140	medium, bold	Kogi
Local 2: China	1.0 – 2.0	90 – 100	7 – 9	80 – 100	short, slender	Kogi
Local 3: Ofada	1.5 – 2.5	120 – 130	9 – 12	130 – 150	medium, bold	Ogun
Local 4: China	1.0 – 2.0	90 – 100	7 – 9	80 – 100	short, bold	Ebonyi
Local 5: Gambiaka	2.0 – 3.0	140 – 150	10 –20	110 – 130	medium	Benin
Improved 1: ITA 150	2.5 – 3.0	100 – 105	6	120 – 140	long, bold	Kogi. Ogun, Ebonyi, Benin
Improved 2: WAB 450 P31	2.5 – 3.0	95 – 105	10	100 – 115	medium, slender	Kogi. Ogun, Ebonyi, Benin
Improved 3: WAB 450 P38	2.5 – 3.0	105 – 110	8	110 – 120	medium, slender	Kogi. Ogun, Ebonyi, Benin
Improved 4: ITA 212	3.5 – 7.5	120 – 125	15 – 18	100 – 115	medium	Benin
Improved 5: ITA 128	2.0 – 3.0	120	12	130	medium, bold	Ebonyi, Benin
Improved 6: ITA 306	4.0 – 6.0	125 – 130	15 – 30	100 – 115	long, slender	Benin
Improved 7: ITA 257	1.5 – 3.0	100	10	100	medium, bold	Kogi. Ebonyi, Benin
Improved 8: WAB 189	2.0 – 2.5	105 – 110	6 – 9	110 – 130	medium, bold	Ogun, Ebonyi
Improved 9: WAB 224	2.0 – 2.5	120 – 125	6 –9	110 – 120	long, slender	Ogun

Source: WARDA, Nigeria

Table 3. Descriptive Statistics for Farmers Surveyed

Farmer characteristic	Nigeria						Benin			
	Ogun		Kogi		Ebonyi		Dassa		Glazoue	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (years)	51.1	14.9	38.9	9.6	40.9	8.2	47.5	14.4	41.7	10.2
Female (1=yes, else 0)	0.2	-	0.1	-	0.1	-	0.4	-	0.3	-
Married (1=yes, else 0)	0.9	-	0.8	-	0.9	-	0.9	-	0.9	-
Average education (years)	5.6	4.3	8.5	5.4	7.7	4.3	3.3	4.7	3.0	3.6
Rice experience (years)	18.0	15.4	10.3	6.0	17.6	8.4	11.3	7.3	9.6	7.3
Household size	9.7	3.5	11.2	7.3	13.2	8.4	9.7	5.2	9.8	5.6
Rice income (US$)	244.7	287.9	368.0	788.6	519.9	882.9	155.3	289.4	90.57	150.5
Total income (US$)	910.1	1001.6	1191.4	1729.5	2169.4	3576.6	374.3	376.3	596.2	733.9
Percent selling rice	0.6	-	0.9	-	0.9	-	0,7	-	0.5	-
WTP for seed (US$/Kg)	0.31	0.18	0.35	0.29	0.17	0.14	0.19	0.20	0.30	0.21
Farm price of rice (US$/Kg)	0.27	0.12	0.20	0.05	0.27	0.12	0.17	0.09	0.17	0.05

Table 4. Ordered Probit Results

Variables	All Respondents		Kogi		Ogun		Ebonyi		Dassa		Glazoue	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
Constant	-2.13	-4.13***	8.29	5.77***	43.28	7.44***	0.28	0.29	-3.44	-4.33***	-5.74	-6.40***
Variable Attributes												
Potential yield	0.88	7.46***	-0.51	-1.29	-9.73	-6.25***	0.64	2.39**	0.21	3.79***	0.33	7.67***
Days to maturity	0.02	3.95***	-0.09	-4.24***	-0.22	-7.29***	-0.06	-4.00***	0.00	-0.14	0.00	-0.19
Tillering	-0.19	-7.21***	-0.27	-3.14***	-1.12	-6.97***	-0.03	-0.82	-0.05	-2.73***	-0.04	-3.04***
Height plant	-0.01	-0.86	0.05	2.45***	0.13	5.02***	0.05	4.00***	0.02	3.11***	0.05	7.37***
Grain size	0.52	7.60***	0.01	0.05	-1.81	-3.59***	0.32	4.01***	0.13	1.84*	-0.06	-0.95
Producer Characteristics												
Farmer age	0.00	-1.15	0.00	0.40	0.00	-0.11	0.00	-0.17	0.01	1.54	-0.01	-0.98
Farmer gender	0.08	0.95	0.15	0.42	-0.10	-0.64	-0.02	-0.09	0.07	0.55	0.31	2.44***
Married (1=yes)	-0.11	-1.04	-0.21	-0.85	-0.08	-0.23	-0.17	-0.60	-0.14	-0.71	-0.44	-1.55
Schooling years	0.02	2.35**	0.02	1.23	-0.02	-1.09	0.03	2.64***	0.00	0.01	-0.03	-2.07**
Rice experience	0.01	1.59	0.01	0.95	-0.00	-0.44	0.00	0.23	-0.00	-0.44	-0.01	-2.38**
Household size	0.01	1.76*	-0.00	-0.15	-0.01	-0.37	0.01	1.58	0.01	1.00	0.03	3.01***
Rice income	0.00	2.74***	0.00	0.60	-0.00	-0.24	0.00	1.45	0.00	2.04**	0.00	0.68
Sell rice (1=yes)	0.06	0.88	-0.16	-0.39	0.18	1.52	-0.21	-0.98	-0.34	-2.99***	-0.23	-2.15**
Extension Practices												
On-farm trial	0.31	4.10***	0.03	0.15	0.39	2.08**	0.15	1.21	0.10	0.81	0.48	4.02***
Field day	-0.08	-1.42	-0.03	-0.20	-0.00	-0.01	-0.11	-1.25	-0.05	-0.47	-0.07	-0.85
WTP rice variety	2.07	16.57***	1.03	3.22***	1.43	4.34***	4.12	12.19***	5.76	18.16***	3.81	14.70***
Threshold variables												
γ_1	0.68	19.26***	0.68	8.65***	0.77	9.42***	0.38	8.09***	0.18	4.31***	0.34	6.82***
γ_2	1.54	31.37***	1.33	13.11***	1.51	14.62***	0.77	12.52***	0.38	6.44***	0.67	10.30***
γ_3			2.17	16.93***	2.24	19.90***	1.20	16.70***	0.63	8.71***	1.02	13.35***
γ_4					3.03	23.64***	1.70	20.54***	0.98	11.41***	1.42	17.07***
γ_5							2.44	24.01***	1.47	14.97***	1.89	21.24***
γ_6									2.15	19.01***	2.46	25.14***
Sample size	1608		300		456		686		640		704	
Log Likelihood value	1774.57											
Swait-Louviere test-statistic	19.75***											

Note: *denotes significances at the 10% level, ** at the 5% level, and *** at the 1% level

For the Swait-Louviere test, the chi-squared critical value at 1% with 4 degrees of freedom is 13.2767.

Table 5. WTP for Information Variables

WTP (US$)	All Respondents	Nigeria			Benin	
		Kogi	Ogun	Ebonyi	Dassa	Glazoue
On-farm experience	0.149*	0.032	0.273*	0.036	0.018	0.127*
Field day experience	-0.040	-0.026	-0.001	-0.026	-0.008	-0.019

(*) Significant in the probit analysis