Preliminary Draft – Please do not cite without permission

Activity Choices and Livelihoods in Tropical Forests: Can Reservation Price Data Guide Conservation and Development Efforts?

Bradford L. Barham*+,
Oliver T. Coomes,**
Yoshito Takasaki*,**
and Suzanne Loney**

* University of Wisconsin-Madison, ** McGill University, and ***Tsukuba University
+ contact person: barham@aae.wisc.edu, 608-265-3090 (o), 608-262-4376 (fax)

Paper Prepared for the NEUDC 2002 Conference in Williamstown, Massachusetts

October 9, 2002

Notes:

1. Introduction

In tropical rain forests, where ecosystems are diverse and opportunities vary seasonally, peasant households generally pursue a wide array of economic activities, including agriculture, fishing, hunting, forest product gathering, and other forms of aquatic extraction. Understanding the micro-foundations of household participation and reliance on the full range of rain forest resources is vital to the success of the myriad of tropical conservation and development initiatives. At the heart of these initiatives is a search to find ways to work with local people to help protect ecological resources, especially biodiversity, while advancing people's prospects for healthier and economically productive lives.

Three features of life in tropical forest areas make the design of conservation-development initiatives challenging. First, local benefits of biodiversity conservation are generally not sufficient, compared either to the global benefits or to the opportunity costs of foregoing certain activities, to make conservation activities attractive without direct subsidies or the successful promotion of alternative activities (Barrett et al.). Second, local residents often pursue quite heterogeneous livelihood strategies -- within villages or across quite proximate villages -- based on differences in physical wealth endowments, human capital, family demographic or lifecycle factors, and access to key environmental resources (Riordan and Vosti). This heterogeneity can give rise to a high concentration of certain activities, often the most environmentally damaging ones, among just a few people in a village or even a region (Coomes et al.). As a result, effective conservation and development work is likely to hinge on careful targeting of policies and programs aimed at working with specific local residents. This need for careful targeting is reinforced further by the fact that the logistics of program design and implementation in tropical areas are often very demanding because of the high transaction and transportation costs involved in serving remote and highly disperse forest populations. Combined, these features create

major program design challenges for conservation and development practitioners because they can only be addressed with the help of high quality information and analyses in locales where both are generally in short supply.

Social scientists are striving to fill these information gaps by exploring the factors that influence the degree and level of participation as well as the reliance of forest people on different economic activities (Godoy, Pattanayak and Sills, Byron and Arnold, Coomes et al.). In conjunction with these detailed studies of heterogeneous livelihood practices, considerable emphasis has been placed on attempting to develop approaches that might elicit key information from local residents in a parsimonious manner, so that practitioners might be able to rely more confidently on rapid appraisal techniques that are both more timely and less costly than the types of studies being undertaken by academics (Barrett and Clay, Chambers, Takasaki et al.,). One major challenge, however, stems from the evidence that just as in the broader research on rural livelihoods and diversification in developing countries (Barrett and Riordan; Ellis), heterogeneity in household activity choice in tropical forests arises from a combination of factors including imperfect markets and differences in physical and human capital asset holdings, family demographics, household objectives, and environmental endowments. In effect, this means that these households face quite distinctive shadow prices or reservation wages with respect to similar activities. Thus, while shadow values of key assets or skills can be estimated in activity choice regressions, typically these efforts cast no direct light on predicting the likely response of local people to programs or policies that change relative prices to stimulate certain activities and discourage others. This information gap makes it difficult to evaluate the impacts on activity choice of price policies, input subsidies, alternative technologies, local tax measures, and any other interventions that might affect relative prices and returns across activities.

One method currently being explored for obtaining information on supply responsiveness is through the use of household survey questions on "reservation prices or wages" for participation in key activities (Barrett and Clay, others), especially those that are critical to conservation concerns. These reservation price questions are akin to contingent valuation efforts in the environmental economics literature or games in experimental economics, except that in this case respondents are asked to consider hypothetical situations of varying prices and then to discuss what they would do in response to those prices. These individual reservation price (or wage) responses can then potentially be combined to generate notional supply curves, elasticities, or other aggregated response measures of use in identifying effective policy and program interventions. Also, by providing a concise measure of the attractiveness of different activities, reservation price data have the potential to substitute for detailed information on and analyses of the actual patterns of activity choice among local residents that could be used to identify target households and tailor interventions. Thus, if the reservation price data are reliable, then they can become a core element of a rapid rural appraisal approach, perhaps in combination with some basic information on household wealth holdings, demographics, and local activity choices. But, are reservation prices likely to be reliable in contexts with multiple activity options whose relative returns within and across households can vary substantially due to the factors mentioned above?

This paper develops a mostly cautionary view on the reliability of reservation price information gathered from forest peasant households. While conceptually the reservation price measure is shown to provide an attractive means for predicting participation, practically a number of confounding factors arise in efforts to measure reservation prices of households facing diverse activity choices in an imperfect market setting. The empirical portion of the paper considers a series of reservation price questions that were asked of peasant households in the Pacaya-Samiria National Reserve, a biodiverse rain forest area in the lowlands of the Peruvian Amazon. The reliability of these measures as predictors

of participation is examined in several ways by comparing it with data on actual participation levels. Overall, these comparisons raise serious concerns over the reliability of a simple battery of reservation price questions. The conclusion reviews the reasons for caution in using reservation price data in tropical forest contexts and closes with suggestions that might potentially improve the reliability of reservation price questions at the cost of more intensive data collection.

2. Reservation Prices, Shadow Wages, and Activity Choices

Reservation prices are meant to capture the threshold at which a respondent, in our case a peasant household, becomes willing to undertake an activity, presumably because the shadow wage they assign to their labor will be less than or equal to the marginal returns received from the activity in question. Equation (1) offers a simple form of a reservation price ($p^A_{i,j}$) comparison that is consistent with a static agricultural household model in a context of imperfect factor markets where no stigma or disutility is associated with the activity A relative to other labor choices.[1]

(1) $L^A_{i,j} > 0$ if, $p^A_{i,j} dA_{i,j}/dL \geq w^*_{ij}$,

Specifically, equation (1) says that the i^{th} household in the j^{th} community will participate ($L^A_{i,j} > 0$) in the given activity as long as its shadow measure of the marginal value product in activity A is greater than or equal to the shadow wage (w^*_{ij}) it can earn applying labor elsewhere. Note that the reservation price, the marginal product of labor, and the shadow wage are all household-specific measures that could vary depending on the underlying wealth and labor endowments, environmental conditions, risk preferences, and other factors.

By adding $R^A_{i,j}$ to the left hand side of equation (1), equation (2) provides a stylized version of an agricultural model that incorporates consumption risk associated with price volatility (Barrett) or price

bands associated with transaction costs (de Janvry et al.), either of which might add a premium to a given activity for the role it plays in ensuring consumption of key staples.[2]

(2) $L^{A}_{i,j} > 0$ if, $p^{A}_{i,j} dA_{i,j}/dL + R^{A}_{i,j} \geq w^{*}_{ij}$,

These two equations can be used to illustrate the apparent potential of using reservation prices as a means to draw inferences about the participation of peasant households in distinctive activities.

2.1 The Attractiveness of the Reservation Price Comparison - Take 1

If all households have the same marginal product with respect to labor in activity A ($dA_{i,j}/dL$ = dA/dL for all i in village j),* then households with high opportunity costs of labor (w^{*}_{ij}) should report high reservation prices and visa versa. Accordingly, if a household reports a high reservation price relative to the going market price, it would seem reasonable to expect them to be non-participants in a given activity, because presumably the household's labor will be more valuable allocated elsewhere. Conversely, reservation prices that are less than (or equal to) actual prices should predict high rates of participation in the given activity. Thus, at a village level, these comparisons would presumably provide a solid basis for predicting participation versus non-participation.

Extending this logic to multiple activities, one might construct a measure of the hierarchy of household activity choices by ordering them from the largest negative gap to the largest positive gap in terms of the difference between reservation price and actual price. This ordering of negative to positive would then be predicted to be associated with a participation ranking that would go from highest likelihood to lowest. Moreover, one can imagine that the larger the negative gap between reservation

[1] If participation in certain activities are viewed as either negatively, such as joining in a food-for-work program (Barrett and Cook), or positively, then there would be an additional term on the right-hand side of equation 1 to capture the disutility or utility of the activity.

[2] The risk premium could be a penalty if the risk to income is greater than the risk to consumption of staple, and thus a substitution toward leisure is encouraged by volatility.

price and actual price, the more likely the household is to rely heavily on that income generating activity unless there is some resource constraint blocking its intensive pursuit of that activity.

Notice that this reservation price measure in equation 1 is robust to potential differences in the marginal product across households. If one household has a relatively high marginal product in activity A, then they may have a lower reservation price than other households (assuming similar opportunity costs of labor), reflecting their higher productivity in that activity. Thus, if a certain activity requires special skills or other factors of production that might not be easily secured, some households could be anticipated to have higher marginal products in that activity than other households that lack those skills or access to key factors of production. In that case, the reservation price schedule for a given activity might reflect highest to lowest marginal product across households, but in a way that is still consistent with the low reservation price measure reflecting a higher probability of participation.

While these initial illustrations hold fixed across households either the marginal product of labor in the given activity, or the opportunity cost of labor, the comparison of reservation price to market price as a predictor of participation remains robust when both of the other variables are allowed to vary across households. For example, it is quite possible that the less productive households in a given activity could express lower reservation prices than more productive households if they also face lower opportunity costs to labor in alternative activities. Thus, while this means that estimates of reservation prices do not necessarily provide a clean signal about either the opportunity costs of labor or the productivity of a household in a given activity, it does not mean that a comparison of reservation price and market price for a given household would not still be a good predictor of its participation. In this example, the low productivity household might be willing to undertake the specific activity, because it remains a good choice given their low opportunity costs in alternative activities.

2.2 The Attractiveness of the Reservation Price Comparison - Take 2

As express in equation (2) above, reservation price estimates from households may capture more than just production comparisons when they are obtained for activities that are a key component of their consumption bundle. They may also reflect the household's need to insure their consumption of food and/or other basic goods in a context with imperfect insurance alternatives and/or one with significant price bands between producers and consumers for key goods. Thus, a low reservation price could also reflect the significant role a commodity plays in the consumption bundle of a household that it cannot be assured of securing by other means. This shadow price premium for consumption risk can certainly vary across villages with differential access to the commodity in question as well as across households within a village because of their different exposures to and preferences regarding consumption risk. This risk-premium component of the reservation price measure may confound efforts to predict actual changes in household supply responses from reservation price comparisons and changes in corresponding opportunity, if the activity in question cannot be readily pursued in a given locale because of environmental constraints. Nonetheless, the reservation price measure remains attractive as a measure of the importance of this particular activity to the households in question if reservation prices are widely expressed as being much lower than the going market price.

Risk can also enter in on the production side with respect to reservation price responses. Equation (2) is flexible enough to capture this possibility, if the premium is potentially considered as a discount that might lower the attractiveness of a given activity and thus give rise to a higher reservation price for the respondent. In other words, high reservation prices for certain activities may in part be a reflection of the risks entailed in their production relative to the alternatives. It is important to note that these risk considerations could well be household specific, too, depending both on their skills and experience in a given activity and their capacity to insure themselves against the downside of risky

activity. Overall, at a conceptual level, the reservation price measure compared with actual prices holds considerable promise as an indicator for participation.

3. Implementing Reservation Price Questions in a Multiple Activity Context

Reservation price questions are supposed to reflect "on the margin" activity choices that households would make with an additional unit of labor, comparing them with the opportunity costs of that labor time. In practice, asking these hypothetical questions about activities that may or may not currently be part of the activity mix of the household is a non-trivial undertaking. One challenge comes from the differences in environmental endowments across villages and what this means for how respondents view the activities in question, and hence how the reservation price question can be asked in a meaningful manner. Another stems from the inherent variation in what "on the margin" actually means with respect to labor utilized in different activities. A third challenge arises from the way in which the reservation price question effectively matches up against current activities and constraints on choices. A fourth concerns the potential effects of seasonality and contingent events on reservation prices. These challenges are explored further below, first with a brief statement of the problem, and then in the empirical analysis of data from the Peruvian Amazon.

3.1. Environmental Variations and the Construction of Relevant Hypothetical Questions

In tropical forest regions, major variations often occur in the quantity and quality of resource endowments across relatively proximate locales, especially in lowland, riverine environments. An oxbow lake might offer one village tremendous fishing opportunities, while elsewhere a major stand of palm trees might provide a village with rich forest extraction possibilities. A third village might have much more prime agricultural land than the previous two. A fourth village might be nearer a region of the forest where hunting opportunities are better. At the same time, the village near the oxbow lake might be distant from good agricultural lands and hunting options, while the village near the palm tree

stands might have relatively limited access to productive fisheries and agricultural lands but decent hunting options. In other words, the diversity in environmental endowments makes for a wide range of potential combinations of strongly and weakly relevant activity options across villages.

This variation complicates the construction of workable reservation price questions on similar activities. For example, a reservation price question that simply asks at what market price would you go hunting to households in the village near the oxbow lake may be received with 'blank stares' because that activity is uncommon or perhaps not even pursued at all in the village at the current time. If the hypothetical is made more "feasible" by asking the question in a way that presumes ready access to reasonable hunting opportunities, then one can elicit a set of reservation price responses from those households that reflect their subjective evaluation of their opportunity costs, marginal product of labor in hunting, and consumption considerations but not the actual options they face. One challenge arises then is how to handle reservation price questions for activities that are not common to a locale but might become so following major changes in market conditions. The "feasible" hypothetical may elicit answers where the actual one may not, but the two may not be closely related in terms of reliability. One potential solution is to come at these questions from two angles, one based on a "feasible hypothetical (that helps the respondents to become more comfortable with the exercise), followed by one that one is based on actual conditions (and that elicits perceived marginal products of labor and perhaps information on relevant consumption/production premia).

3.2 Variation in Labor Effort Exerted "On the Margin"

In the activity examples mentioned above, very different quantities of labor are likely to be exerted on the margin. Fishing is a daily activity that is frequently pursued for even part of a day, allowing time for other labor activities. Palm tree extraction may take a whole day or even two, one to get to and fell the trees, a second to harvest and haul out the fruits. Hunting expeditions can take several

days. Agriculture involves a season with various stages of the labor process. These variations in labor efforts "on the margin" suggest that when a household is asked its reservation price for a given activity, they may have very different time commitments in mind for distinct activities, and these could affect the reservation prices they report. *Ceteris paribus*, activities with shorter time periods would have lower reservation prices, because they require less of a commitment and afford the respondent more flexibility in their time allocation. Thus, the hierarchy of activity choices that might emerge from reservation price comparisons could reflect the distinctive commitments of labor required "on the margin."

3.3. Reservation Prices, Current Activities, and Key Constraints

Reservation price questions are meant to capture the willingness of a respondent household to participate in an activity "on the margin", but if they are being asked of households with respect to activities that they already pursue, then the issue arises about which "margin" is under consideration. Their response will be, as requested, about labor "on the margin" rather than in the main, or not as if they were making decisions across all activities about where to begin allocating their labor. Thus, while "on the margin" they may have a high reservation price for allocating further labor to a given activity, this measure could reflect mostly a high opportunity cost to any further allocation of labor to new activities, even though they could be currently participating (perhaps intensively) in the given activity. As a result, some high reservation prices "on the margin" may reflect the respondents' high opportunity cost of time rather than their current propensity to participate in those activities. This outcome would seem to be even more likely for those activities that require substantial additional labor "on the margin" such as agriculture or hunting in the examples given above. Similarly, respondents may also report high reservation prices for activities that have a consumption insurance value that are being pursued currently but would not be the focus of any additional labor allocation "on the margin." The main recourse would appear to be a set of questions that elicit information on current participation in the activity and at what

price they would cease participation. This approach would be consistent with the approach taken in the Food-For-Work study done by Barrett and Clay in Ethopia.

3.4. Reservation Prices, Seasonality, and Contingent Events

In locales where households pursue multiple activities, seasonality often plays a critical role in shaping labor allocation choices. The same can be said for contingent events, such as natural shocks, illnesses, or market and policy events that affect relative prices and returns. These considerations suggest that reservation price responses are likely to be quite dependent on the context that the respondent has in mind when they are considering the price at which they would pursue a given activity. For example, hunting in lowland areas is often easier in high water periods when animals are more likely to be concentrated on the relatively scarce high ground and hunters can get around more readily by boat. At the same time, fishing will generally be less productive, because the fish are now dispersed over a much wider body of water. Reservation price responses should thus clearly depend on what season the respondent has in mind. This concern means that unless the question makes clear the season, or more generally, the context for comparison, respondents might be comparing very different moments. One might be weighing the reservation price for hunting in the high water period when her household pursues that activity, while the other might be comparing it with, say, the current low water period when that activity is likely to be less productive.

3.5 The Challenge of Gathering Parsimonious and Reliable Reservation Price Data

In all of these examples, the reliability of the reservation price as a predictor of participation is undercut by factors related to the quality of information that can be extracted from individual questions about reservation prices for participation in multiple activities. While all of the challenges are ones that potentially can be addressed with a much more careful line of inquiry, the problem is that the parsimony of the reservation price approach will be washed away by a more complete set of reservation price

questions across multiple activities. And, will the resulting data be more reliable than the traditional approach of pursuing information on actual activity choices, endowments, and other key explanatory factors?

4. The PSNR, Activity Choice Portfolios, and Reservation Price Questions

The reservation price data examined in this paper were gathered from peasant households who live along the edge of the Pacaya-Samiria National Reserve (PSNR) in the Department of Loreto, in the Peruvian Amazon. Heralded as one of the world's richest areas of biodiversity, the PSNR is flanked by two major rivers, the Ucayali and Marañon, which converge to form the Amazon. Annual fluctuations in these rivers are about ten meters, and the region is comprised of mostly inundated swamp forests, with only a small portion of the land being suitable for agriculture during the low water period. About 80,000 people live along the PSNR in an area the size of the State of New Jersey, spread among about 200 villages. The modal village has 30-50 households, built around a soccer field and a primary school. Boats are the only means of transportation between villages, and most villages have at least daily access to commercial boat transportation.

The local people, called ribereños, pursue a mix of agriculture, fishing, other aquatic extraction, forest product gathering, hunting, and small livestock. This mix can vary substantially based on local environmental endowments (land quality, fisheries, and so forth) as well as on differences in household wealth endowments (Takasaki et al. 2001a, Coomes et al. 2002, and Barham et al. 2002). Fish, manioc, and plantain are the staples of their diet, with game meat or small livestock as an occasional additional protein source and corn and rice as occasional grain sources. Fruits are relatively abundant in the rain forest, though seasonally.

The study sample frame was designed to capture inter-village variations in environmental endowments and intra-village variations in physical wealth holdings. For the former, eight villages were selected based on variations essentially in land and fishery endowments. For the latter, a stratified scheme that over-sampled wealthy households was used to insure enough of them were included to cover adequately the wealth spectrum (Takasaki et al. 2001b). Across the eight villages, 300 households were interviewed over four rounds of visits. Respondents provided information on wealth holdings, activity patterns, demographics, family histories, and reservation prices for some of the major activities in the region. Four reservation price questions on rice production, fishing, palm fruit extraction, and hunting were asked in all of the villages, while specific reservation price questions were asked in individual villages depending on their local endowments (see appendix 1 for all of the actual questions).

The inter-village heterogeneity in land availability provides the basis for our stratification of villages into three groups, Land-Rich, Land-Middle, and Land-Poor. The distinguishing feature of land-rich villages is that they have relatively abundant prime lands (mudflats) for growing rice, which is a high-return agricultural activity. By contrast, the distinguishing features of the Land-Poor villages are that they have relatively little prime agricultural land, but are instead located next to rich fisheries (ox-bow lakes). The Land-Middle villages have some prime agricultural lands, but not nearly to the extent of the Land-Rich villages. What tends to distinguish the land-middle villages from the other two is their higher level of participation in other natural resource activities in addition to agriculture and fishing. These options consist largely of hunting (game meat), palm fruit and heart of palm gathering, and aquatic extraction (aquarium fish and paiche catching).

Activity choice and participation patterns of these three villages types are reported in Table 1. Households in Land-Rich villages derive most of their income (68%) from agriculture, with rice

production playing a major role. Fishing is secondary in Land-Rich villages, accounting for about 18% of the average household's income but with almost universal participation in this largely subsistence activity. The story is almost exactly the opposite in Land-Poor villages, where households rely very strongly on fishing (78% of income), while agriculture accounts for 19% of income. Land-Middle villages fall between the other two village types, with agricultural and fishing income shares of 44% and 26%, respectively). Note also that they are also more reliant and likely to participate in other natural resource extraction activities, whereas the Land-Poor villages report almost no participation at all in rice, palm fruit, or game meat activities.

The reservation price questions were all asked in a manner that was aimed at making the hypothetical question relevant to respondents in all villages. The game meat question is illustrative: "If over the next week you had the opportunity to find an area where animals were plentiful and about fifteen minutes from the village, and were assured of a market for the good, how much would you have to be paid per kilo to go hunting there?" This question clearly abstracts from the actual endowment surrounding the village, and instead describes a plentiful endowment of the resource in question. The advantage of this approach is that it encourages responses especially from households in Land-Poor villages for whom these reservation price questions might have otherwise been too hypothetical given their complete lack of participation in these activities. The main disadvantage is obvious. The reservation price does not reflect the actual endowment and hence households are not incorporating their anticipated marginal product in that undertaking under current conditions but rather under good conditions.

The mean reservation price data in Table 1 provide two results that are consistent and two that are contrary with the conventional notion of a negative relationship between reservation prices and participation. Starting with the former, the lowest reservation price for fishing is in the Land-Poor

village, and the highest is in the Land-Rich village, which is consistent with the relative roles of fishing across the three villages. Also, the lowest to highest reservation prices for palm fruit correspond to the participation rates, with the Land-Middle villages having the lowest reservation price and the highest participation rate and so forth. The contrary results are that: (1) the highest reservation price for additional activity in rice is in the land-rich village where participation and income shares are much higher; and, (2) the lowest reservation price for hunting is in the Land-Poor villages where no households were active in hunting.

Each of these contrary results has a reasonable explanation given our discussion of shortcomings offered above. First, in Table 1, for three of the four activities, the Land-Rich villages report the highest reservation prices, and for the fourth (palm fruit) they report a higher reservation price than the other village where participation rates are not negligible. Overall, it seems likely that the opportunity costs of households in Land-Rich villages tend to be relatively high, especially compared to Land-Middle village households. Specifically, Land-Rich villages may be constrained already in terms of labor that they can allocate toward rice production, and may thus report a high reservation price for all other activities. By contrasts, the low reservation price for hunting in the fishing village may reflect the high shadow value game meat has a consumption item in those villages, where local game meat provision does not occur and prices may be higher. Combine this feature with the purely hypothetical nature of the question for an activity that does not generally occur in those villages, and it is not surprising that they might report relatively low reservation prices.

The response rate to these reservation price questions reported in Table 1 also line up well with the activity choice patterns of the villages. For example, the households in the Land-Poor villages have a significantly lower response rate on the reservation price questions where they have very low

participation rates (palm fruit, game meat, and rice). And, across all the villages there is a positive correlation between participation and response rates to the reservation price questions.

5. Reservation Prices, Participation, Supply Response, and Activity Choices

The core issue is how reservation prices explain participation outcomes at the household level, both for individual activities and across activities. This section explores these outcomes using the PSNR reservation price data and comparing it with actual production data from the same households.

5.1 Reservation Prices and Participation Outcomes

One method for looking at the reliability of reservation prices as a predictor of participation is to compare household participation choices for those who report reservation prices less than or equal to the going market price with those that report reservation prices above the going price. Table 2 does this for each of the four commodities by village type. For fish and palm fruit, households that participate in these activities generally report reservation prices that are less than or equal to the price. For example, in the Land Poor Villages, 90% of participant households in fishing report a reservation price less than the going price, while 73% of the participant households from Land Middle Villages report reservation prices less than the going price. Palm fruit participants are very likely across both Land Rich and Land Middle villages, where this activity is relatively common, to report reservation prices less than the going price (86 and 77%, respectively). The exception to this finding for these two commodities is the case of fish in the Land-Rich villages, where 53% of the participants report a reservation price that is higher than the going price.

Reservation prices for game meat and rice are, by contrast, not particularly good predictors of participation. For example, more than 60% of the non-participants in hunting in all of the village types are likely to report a reservation price for game meat that is lower than the going price. Indeed, these

non-participants are also more likely to report a reservation price lower than the market price than are the actual participants in game meat hunting in the Land-Rich village. In fact, for game meat, only results from the participants in the Land-Middle village make any sense in terms of the negative correlation between reservation price and participation, with 70% of them reporting reservation prices less than the going market price. In the case of rice, in the Land Rich Villages, where nearly 80% of the respondent households were active in rice production, only 14% of the participants reported a reservation price that was less than the market price. Then, in the Land-Middle villages, only 33% of the participants in rice production reported a reservation price that was less than the going market price, which is lower than the to 46% of the non-participants who did so.

The bottom line is that reservation prices as predictors of participation prove to be quite weak in the comparisons offered in Table 2. This outcome is mirrored in simple probit models of participation that use the reservation to estimate activity choice, but are not reported here. While the predictions of the model are only somewhat inferior to models run using data on endowments, demographics and the like, the coefficient estimates on the reservation price data are not significant in any of the regressions. It is just the cross-village differences in participation rates that drive the results.

The weakness of these reservation price measures as predictors of participation have several potential explanations. In the case of hunting, it seems clear that the hypothetical nature of the question, making the potential for finding animals both proximate and plentiful, attracted lots of non-participants into responding with low reservation price estimates that probably reflected far more their effective demand for the meat than it did their actual marginal labor choice conditions. In the case of rice production, the fact that labor supply may be a limiting factor for active producers might explain their high reservation price relative to non-participants. Also, the hypothetical nature of the question for households in several of the villages undercuts the likely accuracy of the prediction of their actual

participation. As such, the low reservation price reported by the non-participants may have more to do with wanting claim to the rice land, and its income potential, than it does how they would respond to actual price conditions. In general, the key point is that these are only potential explanations for reservation price measures that do not appear to do help to predict participation outcomes.

5.2 Reservation Prices and Supply Response

Another way of looking at the participation data are to use them to trace "supply schedule" curves for each commodity on the basis of reservation price responses. This is done in Figures 1 and 2. These figures map the actual volume of production (on the left vertical axis) and probability of participation (on the right vertical axis) associated with different reported reservation prices that were grouped into ranges (bins). Also included in Figure 1 is the actual market price of each commodity, denoted by a **. Figure 1 includes the supply schedules for the four general products already discussed, while Figure 2 does the same for specialty products from individual villages, where those activities are pursued. In a sense then, Figure 1 provides a supply schedule map for the products already mentioned above for which the products in some villages were not likely to be in their current mix of activities. Meanwhile, Figure 2 by focusing on specialty products that are specific to certain villages poses the questions to respondents for whom the prospect of participation is a real and not merely hypothetical option.

A close look at Figure 1 reveals that participation rates rise rapidly more or less around the actual price, but the volume of production levels tend to lag behind the reservation price. This lag is especially evident in the cases of rice and game meat, where the actual price needs to exceed the reservation wage to get the main producers of those products involved. This mapping is consistent with the participation prediction problems we discussed in the previous section, but now matches it to the actual supply of the

good generated by the respondents. In the cases of fish and aguaje, most of the production is achieved before the reservation price crosses the actual price line, so that at the higher prices mostly the marginal production occurs. Viewed in this fashion, we can see how the participation responses and supply levels of two products line up consistently with the reservation price data, while two do not.

In Figure 2, the correspondence between production and reservation price are high for three of the products – turtles, turtle eggs, and honey – but not for the fourth, paiche, a large fish that is speared and like much hunting requires a high level of skill. For the first three, almost all of the production volume is accounted for by households who report reservation prices either equal to or less than the actual price, whereas for paiche households who report reservation prices that are greater than the market price contribute significantly to the overall production. The interesting aspect of paiche is that like hunting it is a high return, high skill activity that very few households do, but many might like to pursue if stocks were higher and thus apparently relatively easier to catch. By contrast, turtle hunting and turtle egg extraction are relatively low skill activities, where the conditions described in the question probably match pretty well the actual conditions. This contrast raises the question of how reservation price questions should be posed for activities where expected marginal products of labor could vary a lot across households (and villages) and be quite vulnerable to perceptions of how easy the activity is to pursue currently as compared to the hypothetical posed in the question. The potential tradeoff between making the hypothetical relevant and making actual conditions irrelevant seems to bind in some of the products reported on here.

5.3 Reservation Prices and the Hierarchy of Activity Choice

A pressing question in tropical forest environments contexts, such as the PSNR, where households pursue multiple activities, is how might they respond to incentives or programs aimed at

changing their resource use behavior? In particular, if they shift out of one activity, how likely are they to increase others? Another way of stating this question is to ask whether households have a hierarchy of product choices, or a ranking of their most preferred activities, ones that generate higher expected returns than others? It would seem that reservation price data might be used to address this question by examining the relative difference between reservation prices and actual market prices, with those commodities with larger negative gaps being those that are most preferred activities.

The exercise reported on in Table 3 ranks for each household the four general products of game meat, rice, fish, and palm fruit in terms of their percentage spread between the reservation price (RP) and actual price (AP), with the largest negative percentage gap (RP – AP)/AP) being the highest ranked. These household data were then pooled at the village level to identify village level rankings. These ranking are compared in Table 3, along with the percentages of households that would rank that commodity first and the associated village participation rates in that activity.

Game meat and rice are the preferred activities in the Land Rich and Land Middle Villages, whereas fish and game meat are the top two activities in the Land Poor Villages. Palm fruit was consistently ranked across all four villages at the bottom of these four products. What is perhaps most interesting about this ranking approach is that game meat, rice, and fishing in the Land Poor Villages are all high return activities where barriers to entry are significant (skill, nearby animal stock, or lack of prime lands or fish stock). Palm fruit extraction, by contrast, is a low-skill, low-return activity that is available to households in many of the villages, but has minimal entry barriers. In that sense, these rankings are consistent with likely returns.

The predictive capacity of these rankings is not so useful, unfortunately. While game meat is consistently ranked either first or second among preferred activities using the measure deployed, game meat also has the lowest participation rate of these four activities in six of the eight villages and the next

to the lowest in the other two. In other words, the high ranking of game meat in Table 3 provides another example of how actual outcomes are not well predicted, or ranked, given the hypothetical nature of the reservation price question for some activities. Fish, on the other hand, is ranked first only in one of the villages, but is pursued almost universally by the respondent households. Overall, then, what the rankings appear to reflect are perceptions about relative returns to activities if they were all equally accessible rather than actual choices given the underlying options actually facing respondent households.

6. The Determinants of Reservation Prices

The last empirical exercise is an exploratory analysis of the determinants of reservation prices. This effort builds on the work of Barrett and Clay, who estimate the determinants of reservation wages in food-for-work programs in Ethiopia. Their approach explores the potential for differences in shadow values of reservation wages to arise across households in a context where imperfect factor markets amplify the effects of different holdings of endowments and realization of income. We apply their reduced form expression for reservation wages to this situation where the concern is with factors that might explain the reservation price of a commodity. Specifically, the reservation price of activity A for household i in region j ($p^A_{i,j}$) is a function of income (y), productive assets (x), human capital (edu), and prices (p).

(2) $$p^A_{i,j} = f(y_{i,j}^*, x_{i,j}, edu_{i,j}, p_j)$$

If, for the moment, we assume away the measurement problems observed so far, we would expect the reservation prices of households to vary positively with their opportunity costs of labor in alternate activities and negatively with respect to their asset holdings that are relevant to the particular activity. The first prediction should be obvious. If a household has ample agricultural land (or high

overall income), then they are expected to have a high reservation price for, say, fishing, because the opportunity cost of time spent in fishing would be high relative to the returns they might generate from agriculture. Similarly, if a household has a high education level, then they might report a high reservation price for any of these productive activities, because they might be better off in their context as teachers or traders or public officials. Conversely, if a household has ample agricultural land, then we might expect them to report a low reservation price for participation in rice because of the relatively high productivity of their land resources.

Recall from above that we have found evidence especially in the case of rice and game meat that non-participants tended to report low reservation prices, reflecting more the hypothetical of what they would do if the resource stock were ample and available rather than the actual production conditions. Relatedly, we argued that actual participants in these activities might perceive high reservation prices to additional effort because of the opportunity cost of their time. These two observations could have the effect of turning around the predictions at least for these two activities, such that reservation prices of rice might rise with land holdings and reservation prices of game meat might rise with possession of a gun (or hunting skill).

The results for four reservation price estimations are reported in Table 4. The regressions use a two-bounded Tobit specification that capture the censoring created by the survey's bounding of reservation prices at both upper and lower ends. Village dummies are used to capture variations in resource stocks and other prices. Each of the regressions is for a reservation price in villages where the activity is an important one to that type of village (e.g., fish in land poor or rice in land rich).

Across the four regressions, very few coefficient estimates are statistically significant at the 5% confidence level. Indeed, only the estimation for rice in the Land Rich villages generates more than one significant coefficient estimate that is not a village indicator variable. In all of the regressions, income is

negatively associated with the reservation price, although it is only statistically significant in the game meat regression for Land Middle Villages. The interpretation of a negative coefficient on the income coefficient seems counter intuitive, except if one reasons that households with higher incomes in the Land Middle Villages are more likely to be hunters and thus report lower reservation prices.

Among the coefficient estimates on productive assets, the only ones that are statistically significant across the four regressions are those for prime rice land holdings in the rice reservation price regression. The positive association between rice land holdings and reservation price only makes sense in the alternate interpretation we developed to accord with the high reservation price among participants that may reflect the diminishing returns to those households of adding additional rice lands to their portfolio. Again, though, the sign of the coefficient estimate is counter to what would be expected from a clean reservation price indicator. Notice also that in none of the regressions does the stock of household labor have a notable impact on reservation prices. This is surprising especially in the case of palm fruit, where it would seem to be the type of marginal activity that extra male labor would pursue if they had a relatively low opportunity cost of time. Finally, across all four regressions, higher education is associated with higher reservation prices (10% confidence level in two regressions). Only this outcome is consistent with a view of higher opportunity costs to labor in other activities associated with higher human capital holdings. Clearly, the coefficient estimates on reservation prices do not provide a consistent story, and are only made sensible by explanations that rest on noting the practical problems that arose from their use in this context.

7. Conclusion

This paper provides a cautionary tale regarding the actual use of reservation price data as a reliable and efficient means of predicting household activity choices in a context with multiple activity

options. However, the fundamental problem with pursuing reservation price estimates is not conceptual. Indeed, they should be robust to variations that arise across households in expected returns from different activities in contexts where factor markets are incomplete, endowments differ, and risk matters. The core problem appears to be a more pragmatic one that concerns how to design effective survey questions that will elicit the desired information reliably without making the actual line of questioning quite exhaustive. Detailed lines of questioning will, of course, undermine the main selling point of the reservation price measure, which is its potential as a parsimonious predictor of participation and supply responsiveness.

Specifically, efforts to construct parsimonious reservation price questions were found to have four practical problems:

(1) **A clear tradeoff can arise between making hypothetical participation questions seem relevant and asking questions that correspond to actual environmental conditions**. Where certain activities are not currently pursued, respondents may require initial scenarios that make the activity seem feasible before they will be able or willing to identify how prices would have to change in their current situation to induce their participation.

(2) **Different activities involve quite distinctive labor efforts "on the margin"**. Some can be done on for a day. Others require longer time commitments. Thus, a careful line of questioning may be needed to determine what respondents mean by participation in response to different reservation prices.

(3) **Identifying infra-marginal versus marginal participation choices may require careful questioning**, because respondents may address reservation price questions in two ways. They may identify what they would do with additional labor given current activity choices (truly "on the margin"), or they may identify the basis for their entry or exit from the activity. But, even a very carefully designed question to identify one or the other may require ones to ensure the reliability of the answer.

(4) **Respondents may or may not be considering 'normal' conditions when they address the question.** The potential for seasonal factors, contingent events, and risk to influence their responses to reservation price questions means that some additional questions are probably needed to probe the sensitivity of their response to other conditions.

Of these problems, this paper provides evidence that the first and third problems, at least, weakened the reliability of reservation price measures that were gathered from a simple battery of questions that we implemented in the Peruvian Amazon. In particular, high return activities with natural and social barriers to entry, such as rice and hunting, were ones where non-participants were quite likely to report low reservation prices, while participants were often reporting high reservation prices. Indeed, in the case of hunting, very low reservation prices for participation were reported in villages where essentially nobody was active in the sector. These outcomes of our use of reservation price data reflect both the structure of the questions that emphasized the hypothetical situation rather than actual conditions and the apparent tendency for participant households to respond to the reservation price questions in terms of whether they would extend their current efforts.

Efforts to identify reservation wages associated with food-for-work programs can specify a given wage or food provision for a given time commitment. Efforts to apply reservation price questions to multiple productive activities, however, give rise to a variety of potential measurement problems that need to be addressed. To do so in all likelihood may require a battery of questions aimed at covering off each of the potential problems. For example, hypothetical questions about participation in a given activity under ideal environmental conditions may be needed to induce the respondent to participate initially. Then, a series of questions could be pursued that move the line of questioning both toward the actual environmental conditions they face in considering the particular activity (and the associated reservation price) as well as toward different "on the margin" labor decisions (initial entry, further participation on a one-time basis, regular basis, seasonally, following contingent events, and so forth). These questions could then be used to generate more reliable indicators of participation at a variety of levels and to generate a more complete picture of supply responsiveness. The obvious problem is that this line of questioning is hypothetical and requires perhaps several cycles of reservation price questions

applied to multiple activities. The costs to respondents and researchers of this effort seems dubious, especially when compared with the potential value of other lines of questioning about the actual practices of these households with respect to the same activity options, both recently and during periods of contingency. Yet, in the final analysis, it seems worth pursuing means to help identify in a parsimonious way the relative attractiveness of different activity options to households in contexts where multiple options exist, and their impacts on conservation and development differ. The question remains open whether lower cost substitutes exist to replace the more standard analysis of wealth, activity choice, and contingent events that have been the mainstay of development researchers around the world.

References

Barrett, C. and T. Riordan. 2000. Asset, activity, and income diversification among African agriculturalists: Some practical issues.

Barrett, C., K. Brandon, C. Gibson, and H. Gjertsen, 2001. Conserving tropical biodiversity amid weak institutions. *BioScience* 51(6): 497-502.

Barrett, C. and D. Clay. Forthcoming. How accurate is food-for-work self-targeting in the presence of imperfect factor markets? Evidence from Ethiopia. *Journal of Development Studies*.

Byron, N. and M. Arnold. 1999. What futures for the people of the tropical forests? *World Development* 27(5): 789-805.

Chambers, R., 1994. Participatory rural appraisal (PRA): analysis of experience. *World Development*, 22(9): 1253-1268.

Coomes, O., B. Barham, and Y. Takasaki. Forthcoming. Targeting conservation-development initiatives in tropical forests: insights from analyses of rain forest use and economic reliance among Amazonian peasants. *Ecological Economics*.

Ellis, F., 1998. Household strategies and rural livelihood diversification. *Journal of Development Studies*, 35(1): 1-38.

Godoy, R.. 2001. *Indians, Rain Forests, and Markets: Theory, Methods, and Analysis*, Columbia University Press, New York.

Pattanayak, S. and E. Sills. 1999. "Do tropical forests provide natural insurance? The case of the small farmer in the Brazilian Amazon." Durham: Duke-University of North Carolina Program in Latin American Studies,Working Paper 23, Durham, NC, 36 pp.

Reardon, T. and S. Vosti. 1995. Links between rural poverty and the environment in developing countries: asset categories and investment poverty. *World Development* 23(9): 1495-1506

Takasaki, Y., B.L. Barham and O.T. Coomes. 2000. Rapid rural appraisal in humid tropical forests: an asset possession-based approach and validation methods for wealth assessment among forest peasant households. *World Development* 28(11): 1961-1977.

Appendix: Reservation Price Questions – Pacaya-Samiria National Reserve

(English translation of questions)

1. Fish: If you had the opportunity over the next week to fish for 500 kilos of good quality fish and within fifteen minutes of the community, and you were assured of a market for the fish, what kilo price would you have to receive for you to go fish?

   0.5 1 1.5 2 2.5 3 3.5 4 soles/kilo

2. Game meat: If you had the opportunity over the next week to find a locale with lots of animals within fifteen minutes of the community, and you were assured of a market for your catch, what kilo price would you have to receive for you to hunt?

   1 3 4 5 6 7 8 10 soles/kilo

3. Rice: If you had the opportunity over the next week to find available rice lands within fifteen minutes of the community, and you were assured of a market for your rice production, what kilo price would you have to be paid to harvest the rice lands?

   0.05 0.1 0.2 0.25 0.3 0.4 0.5 soles/kilo

4. Palm Fruit: If you had the opportunity over the next week to go and collect up to 50 sacks of good quality palm fruit within 15 minutes of your community, and you were assured of a market for the palm fruit, what price would you have to receive sacks to go extract palm fruit.

   5 10 15 20 25 30 40 50 soles/sack

Table 1 - Activity Choice and Reservation Prices By Village Type

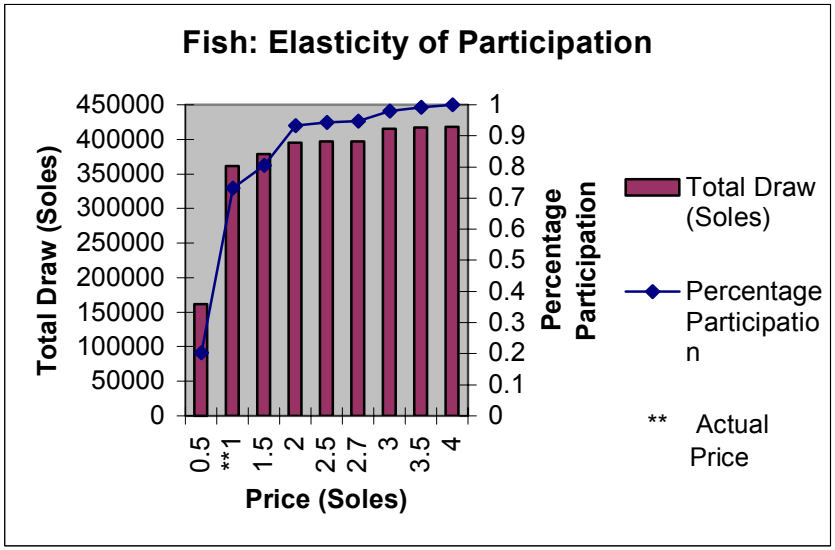
	Land-Rich Villages	Land-Middle Villages	Land-Poor Villages
Average Hhld Income Share			
Agriculture	68%	44%	19%
Rice	29%	8%	0.1%
Fishing	18%	26%	78%
Palm Fruit	2%	8%	0%
Participants	11%	20%	0.1%
Game Meat	5%	5%	0%
Participants	25%	31%	0%
Participation Rate			
Rice	79%	53%	2%
Fishing	98%	99%	97%
Palm Fruit	21%	41%	5%
Game Meat	18%	15%	0%
Reservation Price (% response)			
Rice	90%	79%	61%
Fishing	85%	84%	83%
Palm Fruit	65%	72%	40%
Game Meat	73%	75%	52%
Reservation Price (mean)			
Rice (soles/kilo)	0.63	0.43	0.43
Fishing (soles/kilo)	1.66	1.26	0.87
Palm Fruit (sole/saco)	8.71	8.44	9.53
Game Meat (soles/kilo)	3.75	3.44	2.63

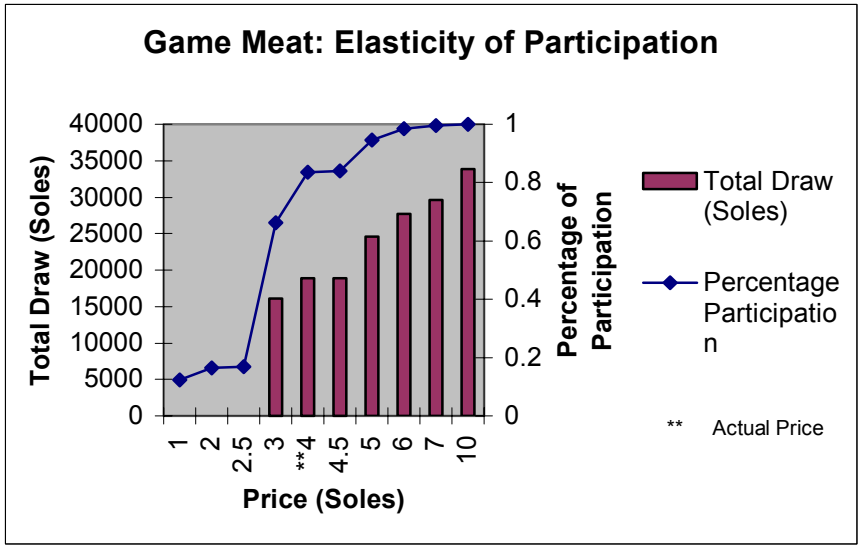
Table 2. Participation, Reservation Wage, Resource Use and Reliance.

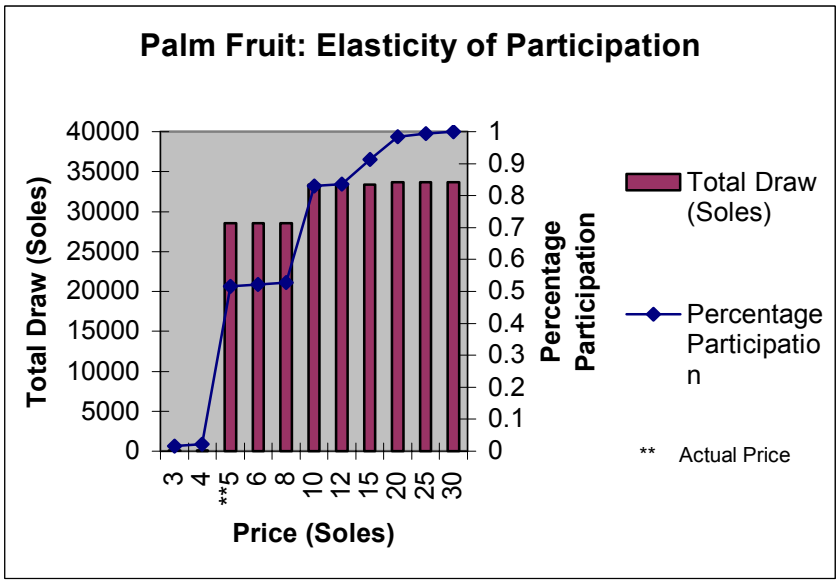
		Land Rich Villages (n=52)			Land Middle Villages (n=149)			Land Poor Villages (n=99)		
		RP<=MP	RP>MP	n	RP<=MP	RP>MP	n	RP<=MP	RP>MP	n
Fish	% Participants	47%	53%	43	73%	27%	120	90%	10%	74
	% Non-Participants	0%	100%	1	0%	100%	1	-	-	2
Game Meat	% Participants	43%	57%	7	71%	29%	17	-	-	0
	% Non-Participants	61%	39%	31	60%	40%	95	82%	18%	51
Palm Fruit	% Participants	86%	14%	7	77%	23%	43	0%	100%	2
	% Non-Participants	48%	52%	27	40%	60%	61	42%	58%	37
Rice	% Participants	14%	86%	37	33%	67%	60	100%	0%	1
	% Non-Participants	10%	90%	10	46%	54%	53	44%	56%	58

Notes: RP=Reservation Price; MP=Market Price

Figure 1. Elasticity of Participation by Primary Product.







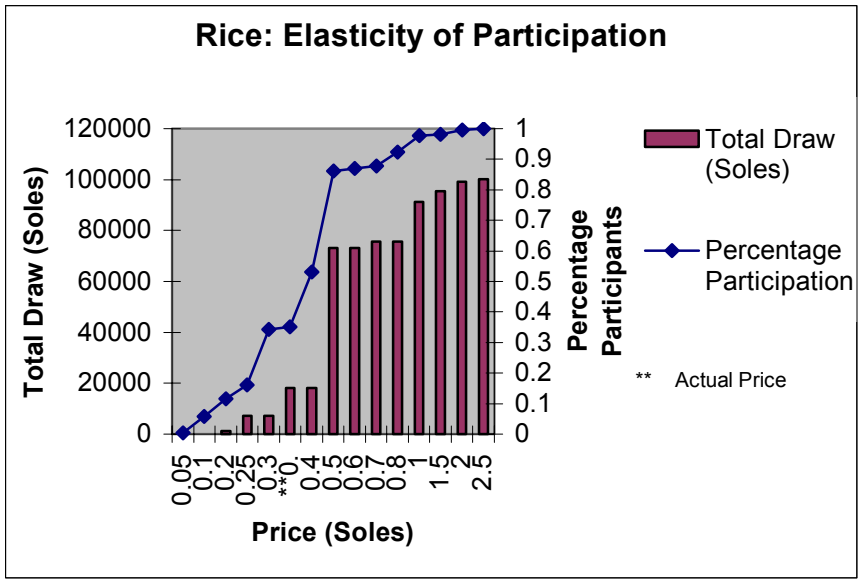


Figure 2. Elasticity of Participation by Specialty Products.

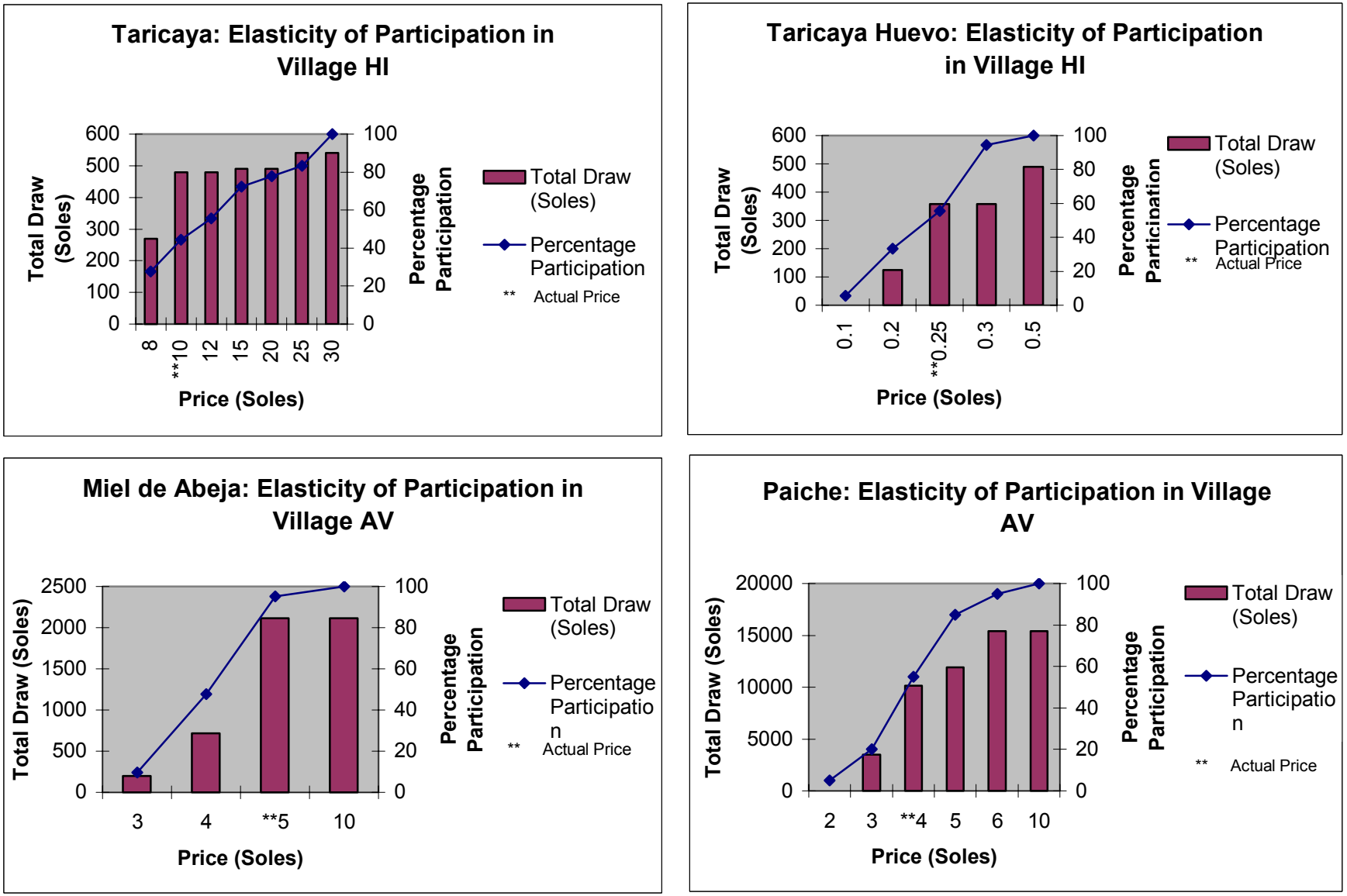


Table 3. Product Ranking by Village Type.

		Game Meat	Rice	Fish	Palm Fruit
Land Rich Villages					
Village V1	Ranking	1	2	3	3
(n=28)	% Ranked First	59%	31%	5%	5%
	% Participation	14%	82%	96%	29%
Village V2	Ranking	1	2	4	3
(n=24)	% Ranked First	50%	45%	0%	5%
	% Participation	13%	79%	96%	4%
Land Middle Villages					
Village V3	Ranking	1	2	3	3
(n=32)	% Ranked First	48%	44%	4%	4%
	% Participation	22%	55%	90%	77%
Village V4	Ranking	2	1	3	4
(n=70)	% Ranked First	31%	45%	21%	3%
	% Participation	16%	42%	97%	34%
Village V5	Ranking	1	2	3	4
(n=26)	% Ranked First	56%	35%	9%	0%
	% Participation	4%	68%	100%	0%
Village V6	Ranking	2	1	3	4
(n=21)	% Ranked First	32%	53%	15%	0%
	% Participation	0%	45%	100%	25%
Land Poor Villages					
Village V7	Ranking	2	3	1	4
(n=31)	% Ranked First	38%	12%	46%	4%
	% Participation	0%	0%	96%	3%
Village V8	Ranking	2	3	1	4
(n=68)	% Ranked First	30%	24%	46%	0%
	% Participation	0%	1%	83%	1%
Overall Product Ranking		1	2	3	4

Table 4. Tobit Analyses of Determinants of Reservation Wage.

	Land Poor	Land Rich	Land Middle	Land Middle
	Fish RW	**Rice RW**	**Game Meat RW**	**Palm Fruit RW**
Total income in 1000s of Soles	-0.013 (0.36)	-0.034 (1.15)	-0.124 (2.23)*	-0.307 (1.43)
Total area+	-0.054 (0.34)	0.200 (3.20)**	0.009 (0.11)	0.244 (0.81)
Total area squared+	0.006 (0.52)	-0.0002 (3.18)**	0 (0.1)	-0.014 (0.77)
Total fishing capital in 1000s of Soles	-0.076 (1.06)	-0.072 (0.56)	0.091 (0.62)	0.382 (0.68)
Total gun capital in 1000s of Soles		-1.335 (1.70)	0.383 (0.5)	-1.88 (0.65)
Number of adult males	0.121 (0.84)	0.007 (0.09)	-0.013 (0.1)	0.533 (1.06)
Number of adult females	0.043 (0.41)	0.261 (1.83)	0.124 (1.13)	0.055 (0.12)
Education of head	0.083 (1.78)	0.049 (1.68)	0.021 (0.46)	0.237 (1.32)
Age of household head	0.008 (0.65)	-0.005 (0.90)	0.001 (0.13)	0.068 (1.41)
Hunting experience		0.422 (1.31)	-0.001 (0.00)	0.536 (0.43)
Piaba experience	0.752 (2.22)*		-0.132 (0.34)	2.282 (1.52)
Paiche experience	-0.615 (1.12)	0.106 (0.67)	-0.576 (1.68)	-0.081 (0.06)
Village dummy (NM)		-0.441 (3.01)**		
Village Dummy (AV)			0.568 (1.49)	5.87 (3.96)**
Village Dummy (HI)			0.609 (1.73)	4.554 (3.27)**
Village Dummy (RF)			-0.296 (0.96)	-1.118 (0.9)
Village Dummy (SU)	1.035 (3.73)**			
Constant	-0.793 (1.45)	0.419 (1.34)	3.413 (5.92)**	1.911 (0.77)
Observations	69	40	97	93
LR Chi2	23.51	30.86	17.04	54.3
Prob > chi2	0.015	0.0021	0.3168	0
Pseudo R2	0.175	0.505	0.0602	0.0975
# censored observations	37	2	5	0
% censored observations	53.62%	5%	5.15%	0%

Absolute value of t-statistics in parentheses

* significant at 5%; ** significant at 1%

+ area in barreal was used in land rich regression