

*Research*

## The Relation Between Income and Hunting in Tropical Forests: an Economic Experiment in the Field

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**ABSTRACT.** Hunting in tropical forests is both a major cause of biodiversity loss and an important food source for millions of people. A question with important policy implications is how changes in income level affect how much people hunt. This study, which was carried out in an indigenous community in the Amazon, explored the relation between income and consumption of wild meat using an economic experiment in the form of a lottery, and involved the local people, not only as experimental subjects, but also in the interpretation of results. The results suggested that an increase in steady employment, rather than in income alone, may lead to the substitution of non-hunted foods for wild meat. The kind of social learning that participation in this type of economic experiment implies may potentially affect the way people manage resources in real life.

**Key Words:** *Amazon; economic development; experimental economics; hunting; income; lottery; participatory research; tropical forest; wild meat*

### INTRODUCTION

In tropical forests worldwide, overharvesting of wild game is a major cause of biodiversity loss. Whereas hunting provides an immediate benefit to the hunters and their families, in the long run, they suffer from depletion of the resource base. This affects millions of poor rural people who depend on wild meat for their livelihood (Milner-Gulland et al. 2003). As these people try to raise their incomes, a question with important policy implications is how changes in income level affect how much people hunt. Does increased income lead to decreased hunting effort and recovery of game animal populations, or does it lead to increased hunting effort, exacerbating wildlife depletion? Changes in income level and hunting behavior often occur simultaneously, but they also occur with other changes associated with economic development; this complicates the establishment of cause-and-effect relations. Such other changes that may have profound effects on hunting behavior and wildlife abundance are, for example, road construction and improved access to markets, improvements in agricultural technology, habitat degradation, and

depletion of resources for which wild meat may act as a substitute (e.g., Sierra et al. 1999, Demmer et al. 2002, Brashares et al. 2004).

Economic theory provides ambiguous answers to these questions (Demmer et al. 2002). On the supply side, higher income may facilitate the acquisition of better hunting equipment for rural people, and thus, increase their game harvest. However, growth in employment and wage levels would raise the opportunity cost of labor, thus discouraging hunting. On the demand side, increases in income could encourage a shift away from game meat toward meat from domestic animals or store-bought food. However, increased income may also lead to an increased demand from wealthy consumers who buy wild meat. A cross-household comparison in the Philippines showed that poor households expended more effort on hunting than richer households (Shively 1997). However, a study of game abundance in the forests surrounding two villages with different income levels in Honduras showed that game abundance was higher around the poorer village, although the possibility that this difference could be attributed to other explanatory variables cannot be excluded (Demmer et al. 2002).

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Wilkie and Godoy (2001) suggest that demand for wild meat increases when income increases from an initially low level, but then decreases when incomes increase further because this seems to drive a shift in preference from wild meat to meat of domesticated animals. Peterson (2003), however, suggests that people in tropical forest regions maintain cultural preferences for wild meat, even when their incomes increase, causing an increase in the demand for wild meat. The effects of an increase in income on the individual level are not necessarily the same as those at the levels of communities, regions, or nations.

Another potential approach is that of economic experiments. The use of economic experiments to study human behavior has a long tradition in psychology and economics, mostly with students as subjects in the laboratory, with the provision of cash rewards to make subjects perceive and act on payoffs. Since early works by Binswanger (1980) in India, there has been a growing use of experiments that recruit subjects in the field, rather than in the classroom; these experiments sometimes also use field goods, rather than cash, as rewards to study various aspects of human behavior and responses to different incentives, institutions, and frames (Harrison and List 2004).

Cardenas and Carpenter (2005) reported on a series of economic experiments in field settings in three rural villages in Colombia, which let real common-pool resource users (fishermen, shrimp and clam gatherers, and small coffee growers sharing the same watershed) play a common-pool resource game. These were complemented with community workshops where the villagers discussed the results of the experiments with the researchers. When the researchers repeated the experiment in these sites after 1 year, there was a higher level of cooperation than during the first time, apparently because of a social learning process among the subjects. Potentially, such social learning may lead to higher levels of cooperation in the management of real-life common-pool resources. Seen from this angle, economic experiments in field settings can be considered as related to “participatory” and “constructivist” research. These are largely overlapping concepts, each one comprising quite a wide variety of lines of thought and methodological approaches. One definition of participatory research is that local people affected by the research influence decisions in all stages of the research process, including problem definition, methods

choice, and data analysis (Elden 1981). In practice, however, the degree of local participation varies from mere co-option to full participation and control (Cornwall and Lindisfarne 1995). Some authors emphasize the role of the scientist as developing tools for discovery learning (Hamilton 1995, Jiggins and Röling 1999, Shanley and Gaia 2002), and this is where economic experiments seem to be potentially useful. Including local people in the interpretation of experimental results also helps the researcher learn from the knowledge local people hold about the choices and dilemmas they face in daily life in their own environment (Cardenas 2000). Similarly, Bousquet et al. (2002) and D’Aquino et al. (2003) reported on the complementarity of using role-game playing and multi-agent simulations, and how interactions with resource users through the role games enrich the modeling.

We used an economic experiment to study the relation between income and wildlife harvest, with the explicit purpose for its use by the local resource users as a tool for learning. The experiment tested a few simple hypotheses about the relation between income and wildlife harvest, based on divergent opinions on the matter that had previously been expressed by local inhabitants. Thus, different from most previous economic field experiments, the local inhabitants were involved in defining the research question. In addition, the local people were involved in interpreting the results.

## STUDY AREA AND METHODS

The study was carried out at Sarayaku (1°44’ S, 77° 29’ W), a Kichwa community with about 1000 inhabitants in five hamlets along the Bobonaza River, in roadless land in eastern Ecuador, 65 km southeast of the town of Puyo. The local economy is largely subsistence-based. Fishing is the main source of food of animal origin, followed by hunting, with 89% of households having at least one active hunter. Domestic poultry is a minor complement. About 25 community members of both sexes earn a steady salary, mostly as teachers. These teachers are native to the community and have the same cultural background and values as other community members.

During the last couple of decades, the residents have become concerned about the increasing scarcity of wild game. Hunting yields are severely depressed within several kilometers of the village, and various

species maintain strong populations only in the remotest corners of the community's approximately 1000 km<sup>2</sup> of hunting ground, particularly, woolly monkey (*Lagothrix lagotricha*), lowland tapir (*Tapirus terrestris*), and Salvin's curassow (*Mitu salvini*; Sirén et al. 2004).

The research presented here forms part of a larger research project, involving almost 3 years of fieldwork, aimed at understanding the mechanisms behind resource depletion and searching for solutions (Sirén 2004). This was a joint research project between AS, who was then a doctoral candidate, and the Sarayaku community. JM, who was then undertaking distance studies at the undergraduate level, was appointed by the community as the local counterpart. The project was carried out in coordination with the community's elected Government Council, particularly, to ensure that its capacity-building component was strong enough to make it worthwhile for the community to participate. More specific issues regarding the research and resource depletion were, however, discussed at specific meetings, public workshops, and face-to-face with local hunters in connection with the collection of quantitative data regarding game harvest (Sirén et al. 2004). Many community members argued that the only way to halt game depletion would be to increase peoples' monetary income. They said if they just had money, they would buy chicken netting to raise poultry, or eat store-bought food, such as rice and canned food, instead of hunting. Some considered research to be a waste of time, meaning that any available funds should instead be used for economic development. Privately, however, others put forward the view that people with money always had good guns and plenty of ammunition, and therefore, could hunt as much as they pleased. The people who put forward this view typically considered themselves to be among the less well off, and complained that they had to suffer hunger while the more wealthy people ate well and exterminated wildlife in the process. At a meeting with local secondary school students, this issue led to an intense debate, which finally led to an agreement that one research component should explore the relation between income and hunting behavior. During similar discussions at other occasions, some women also put the blame for wildlife depletion on the men because hunting is almost exclusively a male occupation. Likewise, some youngsters blamed the old, arguing that the young were more conscious about the importance of prudent resource management, but that the old

refused to change their habits.

We discarded the option of performing a cross-household study because estimating income would have required procedures very intrusive according to the local culture, and it would have been difficult to do with reasonable accuracy, given that monetary income tends to be very unevenly distributed in time, and that many people earn much of their income as migrant workers outside the community. Moreover, a cross-household study would not have provided any answers to the question of the effects of an increase in income at the community level.

Instead, we opted to explore the effects of a marginal increase in income at the community level. Would people, as some had argued, be inclined to use the extra money on store-bought food and poultry raising, thus alleviating pressure on wildlife resources? Or would they, as others had claimed, be more inclined to use the money on hunting equipment, exacerbating the problem of wildlife depletion? To explore this, we performed an experiment in the form of a lottery at one of the community's biweekly assemblies. A first and second prize were to be drawn, and for each prize there were different alternatives between which each person had to choose upon receiving the lottery ticket. The alternative prize items were of the same monetary value and could be used either to acquire wild meat or to provide non-hunted food.

For the first prize, one alternative was a muzzle-loaded shotgun because some people had claimed that lack of money to buy good weapons for hunting set limits on their consumption of wild meat. The other alternative was 30 m of chicken netting because others had claimed that, from lack of money, they could not buy chicken netting to protect their poultry from predators, and therefore, had to hunt wild game for food. Both of these prizes cost 420,000 sucres (about 20 USD) in the nearest town, corresponding to 13 days' wages for non-skilled labor in the community. For the second prize, there were four alternatives. Two of these were hunting ammunition, either shotgun cartridges or gunpowder and shot, because some people had claimed that lack of money to buy ammunition set limits on their consumption of wild meat. The two others were food items, either rice and canned tuna fish or a rooster and two eggs. Again, this was because some people had explicitly said that if they had money, they would buy such food instead of hunting. All four alternatives cost 42,000 sucres

(about 2 USD) in the community, corresponding to 1.3 days' wages. It may be noted that, for the first prize, both alternatives were durable goods and means of production. The second prizes were all non-durable goods, but whereas some were means of production (ammunition), others were immediately consumable goods (food). One may argue that this fundamental difference makes these goods incommensurable. However, we selected all of these prize items because proponents of different views regarding the relation between income and wild meat consumption had mentioned them explicitly as part of their argument.

All prizes were exhibited in front of the assembly. We explained the purpose of the lottery (see Appendix 1) and then proceeded to hand out one ticket to each person who, at eyesight, appeared to be above 15 years of age. On each ticket, we recorded the person's choice of prize items, as well as age, sex, and whether the person earned a steady salary or not. The ticket was divided in two parts, one of which we retained (Fig. 1). A total of 208 persons participated. This was about half of the adult population of the community and was fairly representative in terms of the distribution of age and sex. Only a few people declined. Potential biases may be the overrepresentation of people interested in community affairs and people living near the community center. The setting was not fully anonymous because the choices made by each participant could be overheard by several others standing nearby. Although none of the alternative prize items would normally be considered controversial, the particular situation could potentially have created a feeling of social pressure to demonstrate environmental consciousness. Therefore, we very carefully framed the experiment to avoid such a bias (see Appendix 1).

Thus, we used the choice of prize items as an indication of how people may spend their money if they received additional real income. By declaring their choice of prize, even if under the uncertainty of winning the lottery, individuals would reveal the order of their preference. Such an assumption is based on a use function, according to von Neumann and Morgenstern (1944). Although there is some experimental evidence of a reversal of preferences, this is unlikely to occur in this type of experiment because the participants were not assuming a cost for participating in the lottery and were basically choosing one prize over all of the options. For the levels of moderate risk aversion or preference

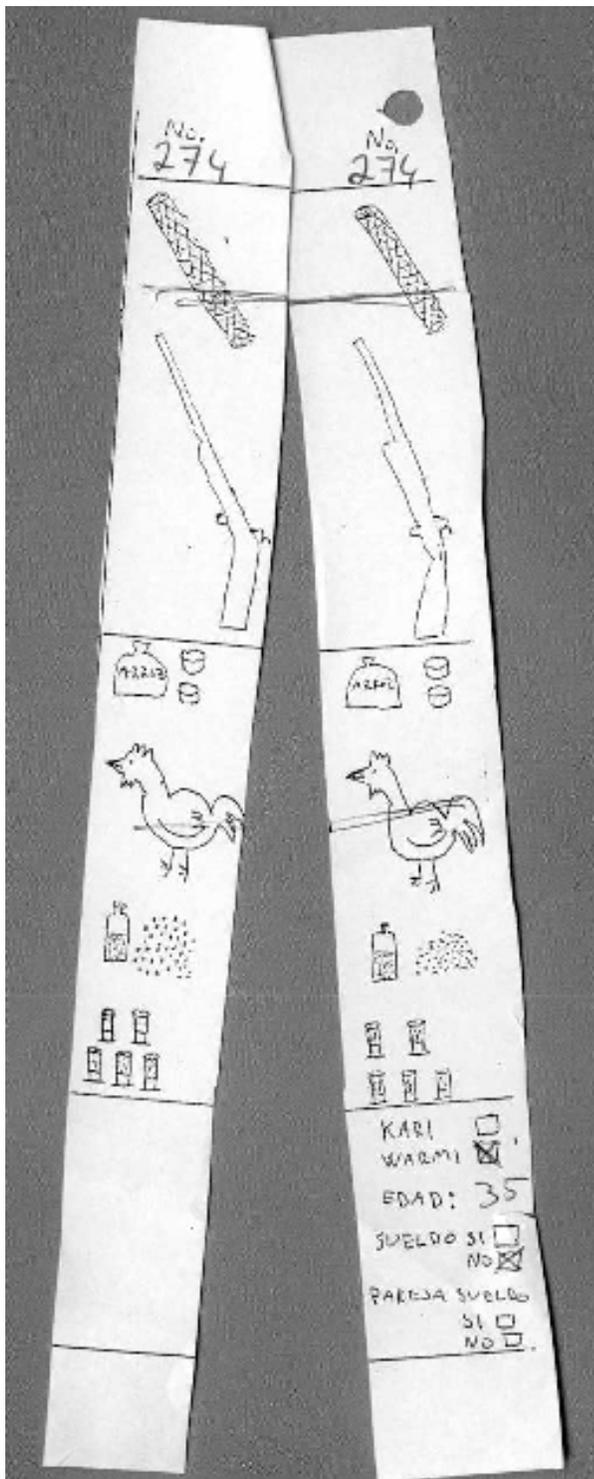
usually observed in experimental studies, the ordering revealed by the subjects choosing between prize options should not be altered by any degree of uncertainty in winning the lottery. Randomly choosing a subset of subjects ex-post in an experimental session to actually pay them earnings is widely used in experimental economics. With the transparent lottery method, each person would reveal his or her preference of the possible prizes, regardless of the probability of earning the prize. Revealing preferences through an exercise with real economic consequences can provide a truer picture of the actual preferences of participants because it can reduce strategic biases often found in contingent valuation methods. It is plausible that a hypothetical survey exercise of simply asking the attendants to rank their preferences over the possible options for spending a one-time unexpected amount of cash could produce similar results because there are no strategic gains for respondents by shifting the average results towards one direction, but this goes beyond the scope of this study. The main goal of this experiment was to explore the participants' choices when facing non-hypothetical incentives.

When each person had received a ticket, we made a preliminary count of peoples' preferences, presented the result to the audience, and then drew the winners. A woman in her 50's won the second prize of her choice, which was the rooster and eggs, whereas a man in his 50's won the first prize of his choice, the shotgun. During the following 2 weeks, we presented results in more detail and discussed their implications at workshops held in each hamlet. Similar workshops related to the research project had been given occasionally during the preceding year. These were typically held in a private home, where the hostess had been paid to prepare cassava brew (with *low* alcohol content) and serve workshop participants to create a comfortable setting similar to usual social gatherings. All adult hamlet members were invited; about 20 men and women attended each workshop. We presented the results with the help of bar diagrams, using pictures so that they could be understood by the illiterate. After presenting each diagram, we asked the people to comment on the results.

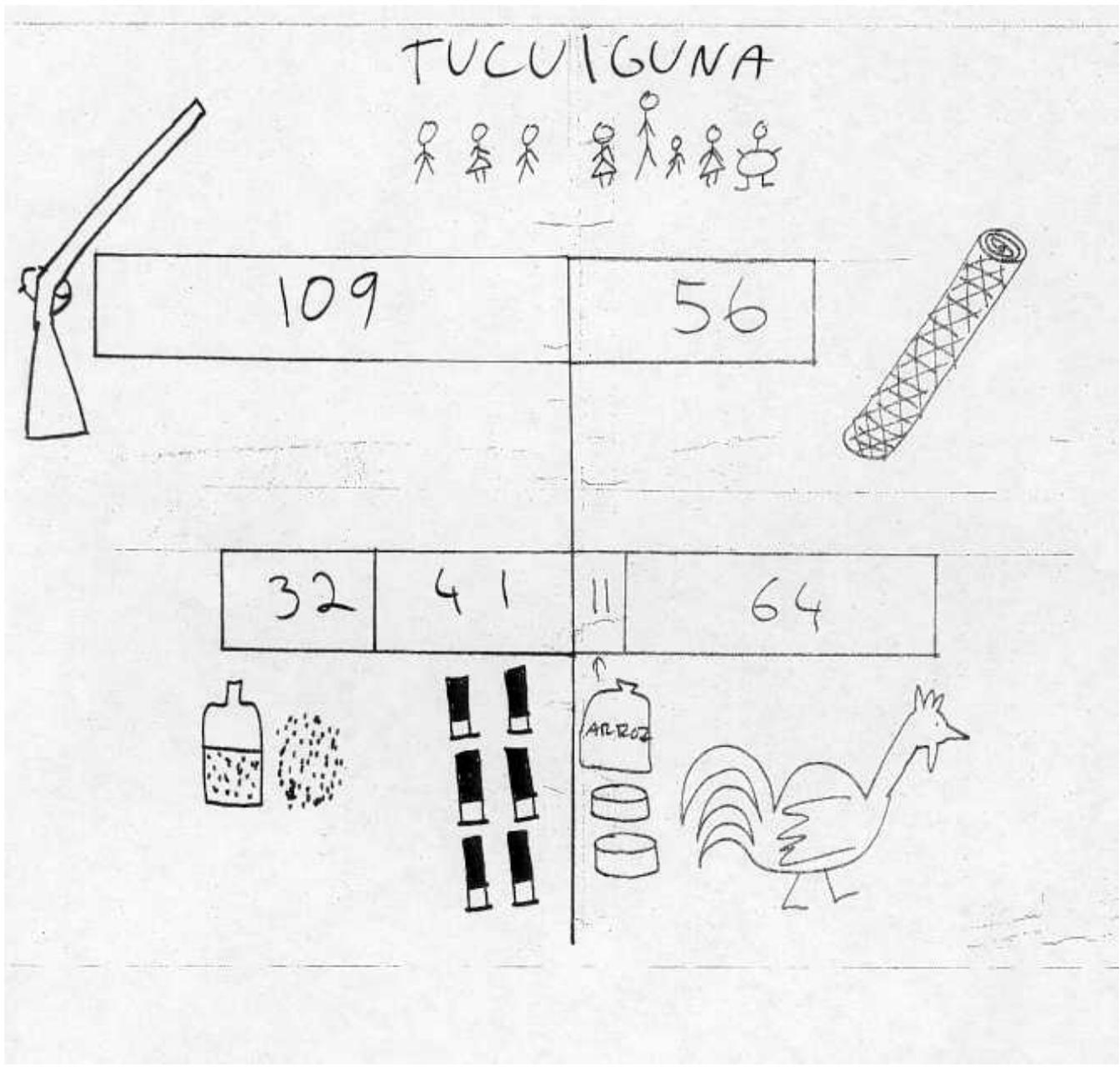
## RESULTS

About two-thirds of the people preferred the shotgun over the chicken netting, whereas preferences were evenly divided between

**Fig. 1.** Example of the lottery ticket used.



**Fig. 2.** Overall experimental results. Figs. 2–5 were scanned from posters that were drawn to present the results at workshops in the community.



**Fig. 3.** Results split between people with and without steady employment.

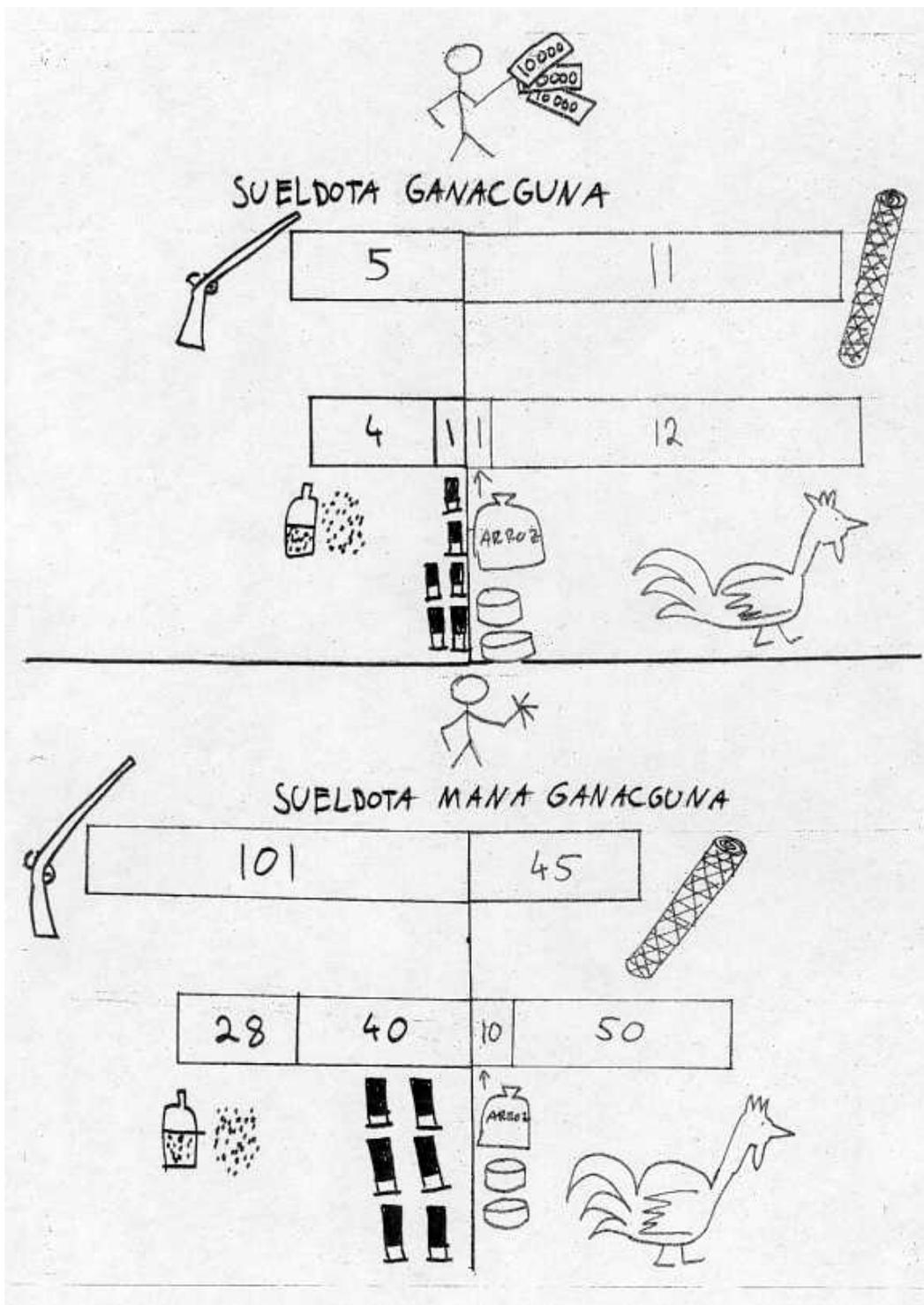


Fig. 4. Results split according to age.

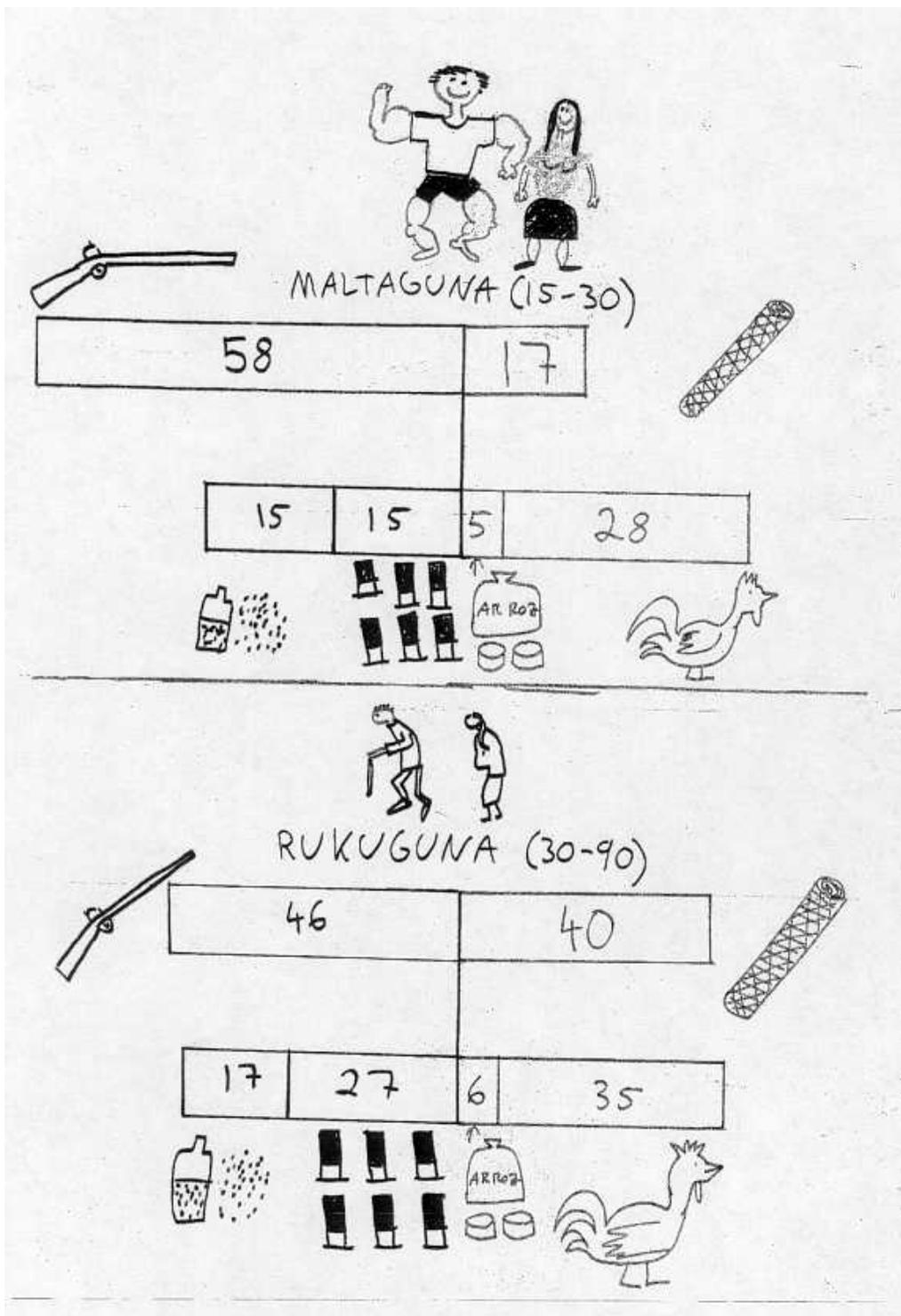
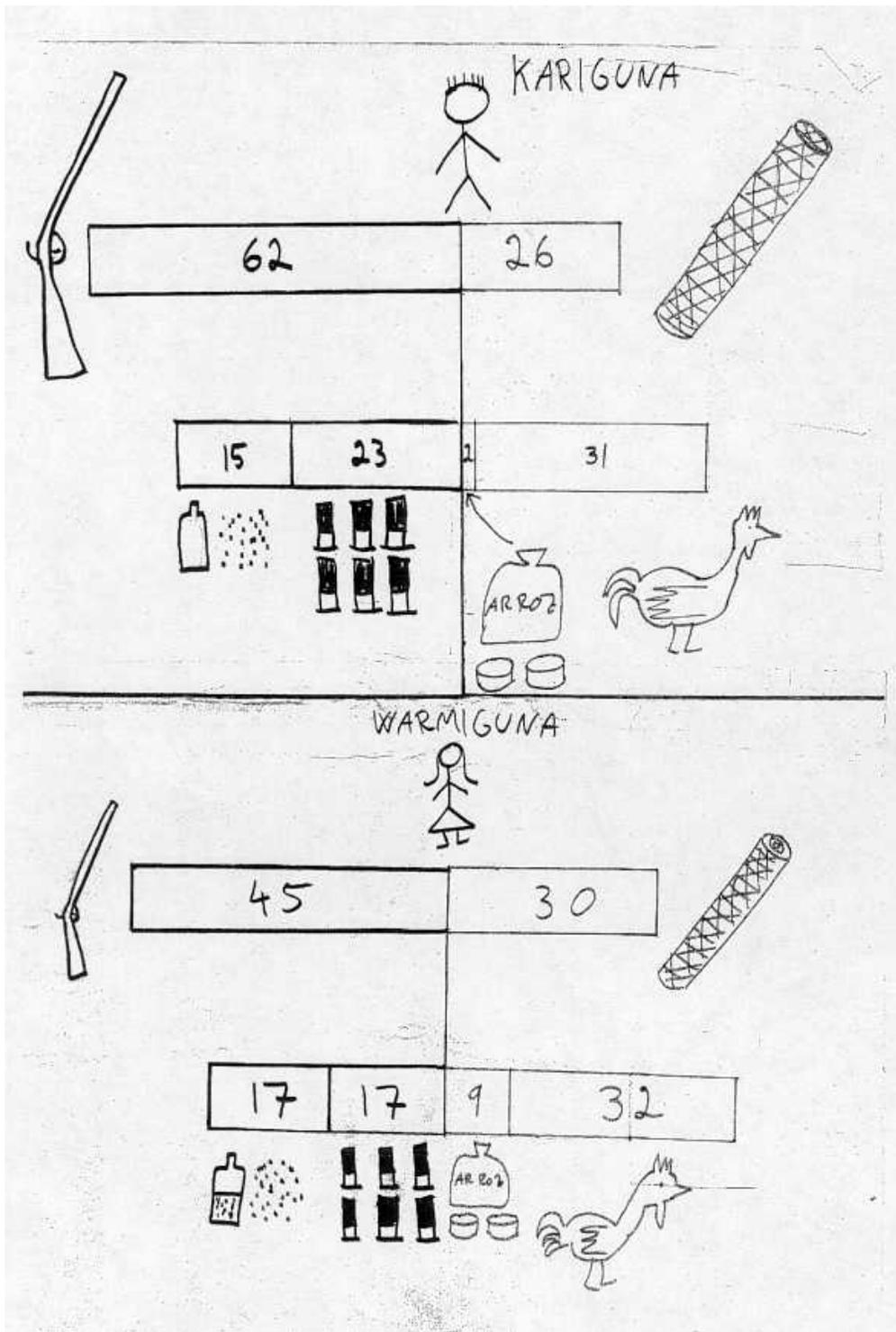


Fig. 5. Results split according to sex.



**Table 1.** Summary of experimental results and results of non-parametric statistical analyses.

		First prize		Second prize	
		People choosing hunting equipment (%)	G test	People choosing hunting equipment (%)	G test
Pooled results		66**		49	
By income	Steady salary	31		28	
	No steady salary	69**	*	53	*
By age	Young	76**		48	
	Old	53	**	52	ns
By sex	Men	70**		54	
	Women	60	ns	45	ns

*Note:* The pooled results and those for each single category (salary, no salary, young, old, men, women) were tested using a binomial test to determine if the frequency differed from that expected if choices were made randomly. Opposing categories (salary versus no salary, young versus old, men versus women) were compared using a G test. For the second prize, the sum of gunpowder and shot and cartridges was compared with the sum of rice and tuna fish and rooster and eggs. \* $P < 0.05$  with no Bonferroni adjustment, non-significant with Bonferroni adjustment; \*\* $P < 0.05$  with sequential Bonferroni adjustment.

ammunition and food (Fig. 2, Table 1). People who had a steady salary showed preferences different from the rest, i.e., they were more likely to choose the chicken netting, rather than the shotgun, and the food items, rather than the ammunition (Fig. 3, Table 1). Splitting the results by age class showed a clear division at around 30 years of age. Most young people preferred the shotgun over the chicken netting, but among older people, preferences were fairly evenly divided between the two alternatives. Both among younger and older residents, preferences were fairly evenly divided between

ammunition and food (Fig. 4, Table 1). Splitting the results according to sex showed that most men preferred the shotgun to the chicken netting. The women, however, were not far behind. Both among men and women, preferences were fairly evenly divided between ammunition and food (Fig. 5, Table 1).

When we presented the results at the subsequent workshops, there was much laughter and people commented that the claims that money would be a quick fix to the problem of game depletion had been

little but unsubstantiated discourse. People did not consider the income level as such to be the main reason why people with a steady salary preferred the chicken netting and food items over the hunting equipment. Instead, many said this was because people who have a job do not have much time to hunt. That the young were more prone to prefer hunting equipment was considered natural because they are the most active hunters. Although women do not hunt with firearms, people considered it natural that women wanted shotguns and ammunition for their husbands and sons to hunt. The participants did not mention any biases in the experimental design as plausible explanations for the results. The people discussed the issues in an analytical manner, seeking a common understanding instead of, as often before, stubbornly arguing for a preconceived opinion on the matter.

## DISCUSSION

Many people were inclined to spend any additional income on hunting equipment, rather than on non-hunted foods, but for many others, the opposite was true. An important result was that those who earned a steady salary showed less preference for hunting equipment than those without a steady salary. The community members themselves did not attribute this effect to the income as such, but rather to employment, which reduces the time available for hunting, an aspect that only recently has been taken into account in other studies of income and hunting (Demmer et al. 2002). Thus, increased income *in connection with steady employment* may have a potential to alleviate pressure on wildlife resources, although this also requires that the income is not used to buy wild meat from others. On the other hand, money achieved without working would not have such a positive effect on wildlife resources, and may even exacerbate wildlife depletion. Sometimes, local people in tropical forests can actually earn money with little or no labor by simply cashing in on oil, timber, and mineral resources (e. g., Turner 2000).

The limited number of alternatives available to the subjects in this experiment does not reflect the multitude of choices available in real life. A slightly different set of alternative prizes may have led to different results. Although the monetary value was the same and both were food items, much more people chose the rooster and eggs than the rice and canned tuna. This shows the sensitivity of this type

of study to the choice of items offered as prizes. The difference in preference between the rooster and eggs and the rice and canned tuna may reflect different pricing mechanisms. All other prizes were industrial goods that are sold in stores at prices set by market mechanisms, but poultry is locally produced and sold directly from producer to consumer at prices set annually at community assemblies. At the time of the study, Ecuador had suffered inflation such that the general price level had doubled over less than 1 year, but the community had not adjusted prices accordingly. Therefore, the price for the rooster may have been artificially low. Indeed, we had a hard time acquiring the rooster for the lottery because there were few available and some owners were reluctant to sell; therefore, if one includes the opportunity cost of searching for the rooster, its total cost would be considerably higher. This may explain why so many people chose the rooster, and without this bias in the pricing, there would probably have been more preference for the ammunition than for the food items.

On the other hand, the monetary value of the prizes may not have been as important a consideration as expected. We gained this insight because of a miscalculation of the time needed to hand out the tickets, which forced us to train some assistants on the spot. We did not manage to make clear to each one of these assistants that, on each ticket, the preferences should be recorded for both the first and second prize. Thus, almost half of the participants indicated only one choice, either a first or a second prize. Interestingly, 40% of those indicated only a second prize, although the first prizes were worth 10 times more money. This may seem irrational, but may reflect that people primarily consider the direct-use value of the items, rather than their monetary value. For example, those who already have enough guns at home may have more use for ammunition than for an additional gun.

Receiving a one-time chance to choose between pre-selected items is not the same as receiving a long-term increase in income. This “windfall money” effect has always been present in psychological and economic experimental studies. When people get unexpected money there seems to be a tendency to spend more of such earnings and to make economic choices that are more risky (Arkes et al. 1994, Clark 2002). Choosing ammunition can probably be considered more risky than choosing food items, so this is a potential source of bias. However, it is less

obvious which one of the shotgun and the poultry netting is the more risky choice. Although hunting yields are highly variable in the short term, they are fairly predictable over the long term, and these people are used to making a living by hunting. Raising poultry could, in principle, provide a more predictable production of meat, but in reality, it also implies risks caused by predators, diseases, theft, scarcity of feed, and, not least, lack of experience with anything other than very small-scale poultry production.

The non-random selection of participants, the lack of full anonymity, and the relatively small real incentives (limited to a small probability of actually winning the item of ones' choice) leave room for speculation about a wide range of additional potential biases. For the purpose of this experiment, i.e., as a learning tool for local resource users, rather than as a means to measure exact quantities, we believe that the effects of any such biases were within an acceptable range.

This study involved local resource users, not only as experimental subjects, but also in the interpretation of results. Thus, the experiment provided new insights, both to the local people and to the researchers. The results did perhaps not advance general theory about the relation between income and wildlife hunting, but they did contribute to a better understanding of this relation in the specific community where the experiment was conducted. Even at this local scale, the experiment does not provide any conclusive answers regarding the net effect of a marginal increase in income. This is because, although we have good reason to believe that increased purchases of guns and ammunition would lead to increased hunting, and increased purchases of poultry netting and store-bought food would lead to decreased hunting, we have no way of quantifying the balance between these opposing effects. The experiment did, however, provide counterevidence to the simplistic view that was commonly held before the experiment that people hunt because they have no money to buy food or to fence in their poultry. This result, and the insight that the lack of money is neither a sufficient explanation, nor a justification for indiscriminate hunting, was highly policy-relevant for the local community. Whereas increasing monetary incomes continues to be a main development objective for the community, it has since adopted a diversified strategy to protect wildlife. By consensus decisions, the sale of wild meat to outsiders was banned, a

strictly protected wildlife reserve was set aside, and a traditional hunting festival was changed from being celebrated annually to biannually. We can not determine whether the social learning that participation in this experiment implied had any role in stimulating such actions. We do feel, however, that the potential of economic experiments as learning tools for local resource users deserves further exploration. The engagement of local people in the process that produces the data increases their interest in the research and in reflection on their own problems.

Responses to this article can be read online at:  
<http://www.ecologyandsociety.org/vol11/iss1/art44/responses/>

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### **Appendix 1.** Instructions given to the participants.

The instructions and explanation of the lottery was given orally in the Kichwa language. Reading loud of a written text was discarded because many of the inhabitants had only a rudimentary understanding of the Spanish language and - as the use of Kichwa as a written language is a quite new phenomenon in the community - also the reading of a text written in Kichwa would sound awkward and could for many be difficult to understand. We presented the purpose of the lottery, making reference to the arguments previously put forward by different community members regarding the relation between income and hunting, and explaining that we used the lottery tickets as a substitute for real money, in order to see what kind of items the people would prefer to buy in case of getting an extra income. In order to minimize the risk that people would perceive any social pressure to choose any particular item rather than any other, we emphasized that we would not judge or condemn anybody for his or her choice. Displaying all the prize items in front of the crowd, demonstrating that we were actually willing to give away any of them according to the preferences of the lottery participants themselves, also helped to make this point clear. The rules of the game were explained as follows:

- Every adult community member present would receive a lottery ticket for free. (Any *mestizo* teachers, or other non-members of the community, would thus be excluded).
  - On receiving the ticket, one must indicate which item one preferred out of the alternatives for the first prize and the second prize, respectively. We would indicate their choices on the lottery ticket.
  - The winning tickets would be drawn at the end of the assembly. The winners would then receive the items they had indicated on beforehand.
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