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## Stated preferences of functions of llama keeping in Bolivia

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### **Abstract**

*Bolivia accounts for approximately 63% of the South American llama population. Llamas keep playing an important role in the sustenance of smallholdings in the Andean regions fulfilling various functions in the productive, social and cultural life of the people. However, these functions have not yet been valued scientifically. This study therefore evaluates functions of llama keeping as prerequisite to the formulation of a communities' driven breeding programme.*

*A ranking approach was applied with 75 farmers in 6 villages. The different functions of llama keeping were presented visually. Each farmer was asked to arrange the illustrations according to his preference order. The following 10 functions were suggested: i) Means of transportation to cultivated areas, ii) Means of transportation for other purposes, iii) Llama dung as energy source, iv) Consumption of fresh/dried meat, v) Sale of live animals for free disposition, vi) Sale of live animals for emergency purposes, vii) Sale of fibre, viii) Domestic use of fibre, ix) Integration of animals in cultural events/rituals, x) Herd as capital resource. Subsequently, ranking frequencies of stated preferences were calculated. Odds ratios (OR) comparing each pair of functions were computed with a multinomial cumulative logit model.*

*The capital function was most important (14.6% of total ranking frequency), followed by the transport function to cultivated areas (13.7%) and the transport function for other purposes in third place (10.9%). Logistic regression analysis indicates that functions were highly significant. Estimated odds ratios showed significant differences for the three highest ranked functions, with the odds of the capital function being 4.65 times the odds of the transport function to cultivated areas ( $P < 0.0001$ ). The odds of the latter were 2.51 the odds of the transport function for other purposes ( $P < 0.01$ ).*

*It was concluded that functions indicating the sale of live animals or fleece (ranked in 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> position) were actually not perceived as highly important by the farmers, a fact that has to be taken into account when aiming at the improvement of llama husbandry and breeding.*

### **1 Background and aim of the study**

Since the domestication of the llama (*Lama glama* L.) in pre-hispanic times, camelid husbandry in Bolivia remains an essential survival strategy for the local indigenous people in the Andean highlands. Although the population of llamas had been steadily decimated with the Spanish invasion which resulted in their disappearance from the greatest parts of their reign, they survived within the framework of a traditional and socioeconomic organization and keep playing the most reliable nutritional and economic resource available to the peasants who inhabit zones at, or above, the upper limits of agricultural productivity (SUMAR 1988). In smallholder agricultural communities the animals contribute to the economic and social life of their herders by a variety of functions and products. They not only provide food and wool, but also dung for fuel, a means of

transport and fulfil cultural as well as capital functions (SUMAR 1988, FLORES OCHOA and MC QUARRIE 1995, CAMINO and SUMAR 2000, NÜRNBERG 2005).

Despite recurring statements of the various functions and products provided by llamas in the relevant literature, these yet have not been valued scientifically. However, this is a prerequisite for their consideration in setting up communities' driven breeding programmes. Therefore, the aim of the present study was to evaluate the importance of the functions of llama keeping from a breeder's point of view.

## 2 Methods

### 2.1 Data set

The study is based on primary data collected in 6 communities in Ayopaya region, Department Cochabamba, Bolivia. Data collection was carried out from August to November 2005. In total, 75 farmers were interviewed. The 6 communities are composed by one central community in terms of infrastructure and transportation means available from and to the next bigger city, and 5 remote villages.

### 2.2 Study material

The following 10 functions were selected based on literature information and common sense. To two of the functions a purpose of use was added:

- i) Means of transportation to cultivated areas,
- ii) Means of transportation for other purposes,
- iii) Llama dung as energy source,
- iv) Consumption of fresh/dried meat,
- v) Sale of live animals for savings,
- vi) Sale of live animals for emergency purposes,
- vii) Sale of fibre,
- viii) Domestic use of fibre,
- ix) Integration of animals in cultural events/rituals,
- x) Herd as capital resource.

The functions of llama keeping were presented visually in the form of illustrations prepared by a local painter. After a short explanation by the researcher, each farmer was asked to arrange the illustrations according to his/her personal preference order.

### 2.3 Analysis

For the analysis of the ranking approach a multinomial cumulative logit model was applied. Ranking frequencies to obtain a general preference order were calculated. Based on this order log odds ratios comparing pairs of consecutive functions were computed and logistic regression analysis was applied to investigate the differences in the ranking order of functions.

The econometric model is as follows:

$$\text{Odds } (Y_{x-1/x}) = (P (Y=X-1) / P (Y=X))$$

where Y is the dependent categorical variable, X = number of functions and P = probability of a function to be ranked higher than the other. In total X-1 events can be compared.

$$\text{OR } (Y_{1/2}) = \text{Odds } (Y_{1/x}) / \text{Odds } (Y_{2/x})$$

where OR being the odds ratio of function one over function two

Simultaneously X-1 regression equations can be calculated:

$$\text{Logit}(Y_{x-1/x} | X) = b_{0(x-1/x)} + b_{1(x-1/x)}X_1 + b_{2(x-1/x)}X_2 + \dots + b_{k(x-1/x)}X_k$$

where b is the specific regression coefficient

### 3 Results

Frequencies of responses were calculated for total observations, as well as separately for men and women. Results showed that for all three sets (total ranking order, male and female ranking order) the capital function and the transportation function to cultivated areas were ranked in first and second place respectively (Table 1).

**Table 1: Rank orderings of llama keeping functions\***

Total (n=75)		Men (n=48)		Women (n=27)	
1. Capital resource	(14.6%)	1. Capital resource	(13.8%)	1. Capital resource	(15.9%)
2. Transportation to cultivated areas	(13.7%)	2. Transportation to cultivated areas	(13.7%)	2. Transportation to cultivated areas	(13.7%)
3. Transportation for other purposes	(10.9%)	3. Consumption of fresh or dried meat	(10.8%)	3. Transportation for other purposes	(12.2%)
4. Consumption of fresh or dried meat	(10.6%)	4. Sale of live animals for emergency purpose	(10.2%)	4. Dung as energy source	(11.4%)

\* only first four rank orders are shown; Percentages of total frequencies in brackets.

The transportation function for other purposes was on average ranked in third place. However, men stated the consumption of meat tertiary. The function of the llama dung for cooking purposes was already ranked fourth by women whereas it appeared only in 6<sup>th</sup> position in the total rank order as a result of being ranked by men only in 9<sup>th</sup> place.

Logistic analysis of deviance, applied to the full set of observations, indicates significant differences in ranking position for the two highest ranked functions. The odds of the capital function are 4.65 the odds of the transportation function to cultivated areas; the odds of the latter being 2.51 the odds of the transportation function for other purposes (Table 2). Comparison of the other groups of functions showed no significant differences except for the cultural function ranked in last position.

**Table 2: Estimates of odds ratios for pair of functions\***

Pair of functions	Estimate	Standard error	Pr > ChiSq
Capital resource/transportation to cultivated areas			
LogOR	1.54	0.34	<.0001
Exp(LogOR)	4.65	1.57	
Transport to cultivated areas/transportation for other purposes			
LogOR	0.92	0.29	0.0016
Exp(LogOR)	2.51	0.73	
Sale of fibre/integration of animals in cultural events			
LogOR	2.09	0.31	<.0001
Exp(LogOR)	8.11	2.55	

- only significant results are shown

#### 4 Discussion and conclusions

This study emphasizes the traditionally important functions of the llamas in terms of wealth accumulation as well as transportation. While, at the time of the Incan empire llamas represented wealth and the most important means for transportation (FRANKLIN 1982), several authors assumed a decreasingly importance of llamas as pack animals through the extension of the road and path network even in remote areas of the Andes and the decline of barter trade (CARO 1992, IÑIGUEZ and ALEM 1996). Although in the Altiplano-Puna plateau this could especially be the case, NÜRNBERG (2005) already stated that in the eastern cordillera of the Andes the transportation function of llamas cannot be completely substituted.

While this study confirms the high actual importance of the transport function, the major function turned out to be keeping llamas as capital resource as shown by the outstanding odds of the capital function to the next ranking function of transport to cultivated areas. The value and role of llama keeping in a mixed system was moreover highlighted by the fact that farmers ranked the transport to cultivated areas over the transport function for other purposes. The integration of llamas into the cropping activities underlines their value in securing livelihoods.

The llama dung, which is mainly used for cooking purposes, constitutes an essential energy and nutrient resource within the Andean agro-ecosystem. Alternative energy sources are either not available or more cost-intensive (WINTERHALDER et al. 1974). However, the actual value of the dung is often not perceived by the farmers (NÜRNBERG 2005). The ranking approach can partly support these statements, in particular in the case of men, who ranked the importance of the llama dung in second last position, affecting considerably the total ranking order with the llama dung being in 6<sup>th</sup> place. However, as rank ordering of women shows, llama dung is much more appreciated by the gender group who directly uses this resource.

Functions indicating the sale of live animals or products (in 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> position of total ranking order) were actually not perceived as highly important by the farmers. Economic gains in Ayopaya region are mainly derived from the production of seed potatoes. Llama products are only sold sporadically. These results have to be taken into account when aiming at the improvement of llama husbandry and breeding.

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