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Income Analysis in South American Domestic Camelid Farms

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Abstract. This paper analyses the production costs and income of eight groups of farms: five private farms and three belonging to the Andean rural community. These farms are located in Peru and Bolivia and breed alpacas and llama for both meat and fibre. The research is based on case studies. Each case study includes several farms, grouped according to similar characteristics: available resources; breeding techniques and geographical location. A farm economic data analysis was undertaken by determining economic budget income. Statistics and data from 2003 were analysed to determine farm resources and farm production costs, per animal head and net farm income per labour unit and livestock head. This paper is relevant as regards economic data for production systems which are more often analysed for sociological and cultural aspects and less often for economic data and identification of real productive economic data which are not generally market driven.

Keywords. South American domestic camelids, farm management analysis, meat production, Peru, Bolivia.

JEL Codes. Q12

1. Introduction and objectives

From an environmental sustainability point of view, the Peruvian and Bolivian *Altiplano* is extremely fragile. The *Altiplano* rises to heights from 3,800 to 5,000 metres above sea level and extends over 180,000 square kilometres. The plateau is a unique eco-region shared by Peru and Bolivia where the main pastoral farms of South America are located. The main problems of the area are its geographical isolation from rural communities, over-grazing, soil erosion, deforestation, underdevelopment of human resources and low farm productivity.

Alpacas and llamas are fundamental to the livelihood of a large part of the *Altiplano*. The importance of these animals is evidenced by the fact that the vicuña, the wild ances-

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tor of the alpaca, is portrayed on the Peruvian flag while the llama is represented on the Bolivian flag. Many studies have been dedicated to the analysis of various aspects of the *Altiplano*: ecosystem and farming; livestock genetics; farming and breeding systems to rural development and social conditions. There are very few economic analytical studies of camelid breeding farms (Westreicher *et al.,* 2006); this number is even more limited when compared to available analyses of other animal species in other countries. When potential livestock production within countries is analysed, the particular aspects and contribution to farm economic sustainability and their market prospects have neither been assessed nor recognised.

The key objective of this paper is an economic budget income and production cost analysis of eight groups of llama and alpaca camelid breeding farms in the *Altiplano*: five private enterprises and three belonging to the Andean rural community. These farms, located in Peru and Bolivia, breed camelids for both meat and fibre. Furthermore, we try to make recommendations for farm improvement in the future.

The initial thrust of this project responds to needs expressed by camelid breeders and some of their organisations to increase income levels. The overall aims of the research, however, were motivated by the necessity to improve breeding and meat processing techniques and to inform various organisations in order to stimulate the domestic camelid sector.

The aim, as above, is relevant as regards economic data for production systems which are more often analysed for sociological and cultural aspects and less often for economic data and identification of real productive economic data which are not generally market driven.

2. Camelid farming in South America

Alpacas and Llamas, South American Domestic Camelids (SADC), are the only practical and productive activity in the *Altiplano* (Fernández-Baca, 2005: 11; IPACPERU, 2012).

The Camelidae family is a small group of mammalian animals. Two members of the Old World camels live in Africa and Asia (the Arabian and the Bactrian) and four members of the New World camels live in South America: two domestic alpaca and llama (SCLA, 2012) and two protected species – guanacos and vicuñas, which remain in the wild (Fernández-Baca, 2005: 16; Westreicher *et al.,* 2006: 2).

Currently there are 2,863,333 alpaca and 3,227,412 llama in Latin America (Pachao, 2005; cfr. Fernández-Baca, 2005: 14; Fairfield, 2006: 31; Petrie, 1995). There are 3,128,000 alpaca and 3,315,000 llama worldwide (FAO, 2000 cited by Bonanni, 2004: 87). Ninety-six percent of the South American alpaca and llama are in Peru and Bolivia. The remaining 4% is divided among Argentina Chile, Ecuador and Colombia.

More than 80% of alpacas and the entire population of llamas belong to small farmers and peasant communities with very limited resources, located in isolated areas of the Andes without access to basic services such as health care and education (Fernández-Baca, 2005: 7). The remaining 20% of alpaca are distributed between medium sized farmers and communal enterprises. According to research by INEI-CENAGRO, 60% of alpaca and 76% of llamas in Peru are found in farms with less than 50 hectares (Fernández-Baca, 2005: 20). Farms under 3 hectares of land have 32% of alpacas and 46% of llamas. This

situation creates high animal population per land unit, and overgrazing resulting in land erosion and insufficient feed supply.

Several differences in farm size, organisational level and technical skills can be observed in Alpaca and llama breeding farms. According to Fernadez-Baca (2005: 23) there are three categories of breeders: 1) Andean rural community (c*omunidades campesinas*) and *minifondi* (small farms); 2) small and medium sized producers; and 3) associated companies. Rural communities in Peru (*Ayllu*) and *minifondi* possess 80% of alpaca farms and almost all of llama farms. Communal ownership of land is usually found in rural communities while livestock belongs to individuals or single families (Fernández-Baca, 2005: 21). Furthermore among these farms the *Ayni* system of reciprocity is widespread (Shepherd, 2005: 38). This is a system of time differentiated exchange of labour, seed, coca and the like which works to bond the Andean peoples together (Distaso and Ciervo, 2006; CEPES, 2009). Distribution of seed was governed by informal and flexible networks based on reciprocity between families and communities, the *ayllu*. For farm jobs that require several individuals, a family may ask relatives and neighbours to collaborate. Payment is generally made by returning the favour.

In general, farm breeder communal organisations group together several family units ranging from 25 to 100 or more families; the number of livestock heads depends on the number of families in the community. Families are related to one another at various levels of kinship. Traditionally and within the livestock farms, families share grazing areas according to local norms; this is true especially for crop rotation and times when land lies fallow (Castañeda, 2011). The property system introduced under Spanish colonialism, originally despoiled traditional Andean kinship-based rural communities of their collective livelihood. *Ayllu* territorial control was limited almost exclusively to remote herding communities whose pastoral economies had little appeal for the landed oligarchy (Healy, 2004: 28).

Smallholders constitute the majority of farmers and comprise over 80% of the *Altiplano* farm population practicing a highly diversified agriculture. An average, *Alpaquero* families (alpaca herders) own 80 animals; families with fewer than 100 animals represent 80% to 90% of all producers. However, a small proportion of families owns 400 or more animals and has much greater economic opportunities. *Alpaqueros* with fewer than 100 animals are engaged in subsistence production. A herd size of less than 100 animals is considered too small to maintain good genetic quality, unless reproducers are regularly exchanged with other herds. In some very poor regions, families may own as few as 20 animals (Fairfield, 2006: 32).

Over 70% of privately owned Andean farms in Peru are less than five hectares in size. The largest land holdings are the property of corporate communities, such as the numerous Peasant Communities (*Comunidades Campesinas*) and Peasant Groups (*Grupos Campesinos*). In 1991 it was estimated that 5,500 of these communities still existed. In 1990, these official forms of common entitlement, as opposed to individual private ownership, accounted for over 60 percent of pasture lands, much of which lies in the Punas of the southern Andes (Vera, 2006).

In Bolivia in 2001, about 2.7 million people were living on small farms, which constitute 87% of all agricultural units. These small farms cover only 14% of the country's arable land. Forty six percent of these small farmers live in the valleys, 37% live in the *Altiplano*,

and 17% live in the lowlands. Small farms in the *Altiplano* and the valleys are defined as those spanning 3.5 or fewer hectares, while small farms in the lowlands refer to those with less than 50 hectares (Fairfield, 2004: 3).

Small and medium Peruvian producers own from 10-12% of the alpaca population in farms with 500-2,000 or more heads of livestock with above average production levels. These farmers have an enterprising spirit, carry out animal checks, use modern technology, are informed and market oriented (Fernández-Baca, 2005: 21) and reach above average production levels.

It has been estimated that associated farm enterprises in Peru own about 8% of the total alpaca livestock in farms with several thousand heads.

Various institutions work with SADC. These include regional and state herder and producer associations, peasant worker confederations, government institutions (MINAG, 2012; CONACS; CONVEAGRO), along with research centres, universities and NGOs (Bebbington, 1996, 1997a and 1997b; Bebbington and Thiele, 1993). Despite there being numerous organisations, their political and overall influence is weak (Fairfield, 2004: 23-24). In general, there is a lack of co-ordination between and among public institutions. In the agricultural sector, for example, numerous different agencies handle projects that should either be closely coordinated or handled by a single institution.

Principal SADC products and services include: fibres for clothing and other textiles, fresh meat or salted *charqui* (jerky) and *chalona*, transporting individuals and goods such as hides, manure pellets for fuel and fertilizers.

Peruvian alpaca fibre is a major export for high quality products. Llama fibre on the other hand is not as highly prized and is destined for internal use (Fernández-Baca, 2005: 15). Peruvian alpaca fibre producers are among the very poorest members of Peruvian society. The *Alpaqueros* are poorly organised and geographically spread out over the area (Papaioannou, 2005). Intermediaries capture much of the value in the production chain, leaving *Alpaqueros* with very low prices for their fibre. It has been estimated that 85% of alpaca fibre production goes to the industrial market – mainly the export market; 15% is destined for skilled craftsmen and personal use (Fernández-Baca, 2005: 34).

In 2004, 3,200 tonnes of alpaca fibre was produced in Peru (CONACS, 2005 cited by Fernández-Baca, 2005: 33). Statistics for llama fibre are not reliable. It is estimated that 40 percent of llama fibre is destined for processing by skilled craftsmen or industry; the remaining 60% is for personal use. In 2001, according to the Peruvian Ministry of Economy and Finance, the total production was 800 tonnes (Fernández-Baca, 2005: 35-36).

For SADC breeders meat is an important product, both nutritionally and from an income point of view and is on a par with fibre production (Fernández-Baca, 2005: 20 and 39; Fairfield, 2006: 43).

In Peruvian urban areas camelid meat consumption is quite low while in rural localities and among poorer individuals it is rather widespread (Fernández-Baca, 2005: 41). Among the factors with a positive influence on SADC meat consumption are its nutritional value, the high level of environmental sustainability of the breeding method and the positive consumer perception of the product due to the uncontaminated landscape of the Andean plateau production areas. The main problems limiting market potential for camelid meat involve sanitation issues and strong prejudices on the demand side. Urban consumers tend to identify this food with the poverty of the *campesinos*. In fact, as income

grows, urban consumers prefer other kinds of meat, such as beef (Bonanni, 2004: 44; Sammells, 1995; Sammells & Markowitz, 2004).

Camelid meat is largely traded in informal markets. Significant quantities of meat travel from the highlands to markets as far as Lima (Peru), but there is no cold chain in transport (Fairfield, 2006: 43). Uncertified llama meat was marketed in quasi-clandestine fashion - often camouflaged as sausages sold as hotdogs on the street corners of downtown La Paz (Bolivia); its unauthorised possession is punisheable by municipal fines (Healy, 2004: 31). The absence of municipal slaughterhouses equipped for llamas in Bolivian cities in the *Altiplano*, such as La Paz and Oruro, penalised indigenous camelid herders as well as poor urban consumers by preventing fresh llama meat from entering the marketplace in sanitary conditions (Healy, 2004: 31).

A potential international market for alpaca meat exists but it is a far and distant goal. Sanitary conditions are still inadequate, and strict restrictions have been imposed by Western Countries on meat imports (Fairfield, 2006: 45).

3. Data collection and methodology

A case study approach was used and the methodology adopted to analyse economic data of some groups of breeding farms (case studies) in Bolivia and Peru was the calculation of the economic budget (Kay *et al.,* 2004; Olson, 2004).

Farm net income was calculated by subtracting the variable and fixed costs from farm gross income. Farm net income incorporates remuneration from the following production variables: rented land, farm capital interest, farm labour and profit. Production costs are the individual farm's total variable and fixed costs; these costs have been calculated per animal. Net income has also been calculated per labour unit and per animal head, subdividing total net income by the corresponding number of workers and animal heads.

Although this is not an innovative methodology, the overall lack of accounting data, absence of market driven policy on some farms in the research area and the scarcity of economic studies on camelid breeding farms, ensure that the application of original data is still of interest.

The choice of this research method arises from the need to collect, elaborate and compare detailed data from various productive and cultural situations in a uniform manner; to the capacity of farm groups to reflect the various production systems in a specific territory; to constraints due to limited resources for the survey.

Each group is made up of several farms grouped by similar available resources, homogeneous breeding techniques and geographical location. Farm groups were selected to represent the specific local area where they are located; for this reason they do not reflect state statistical averages in the countries studied. The methodological starting point was the selection of farms in each group.

Each individual farm was required to meet the following criteria to be included in a group: 1) available resources: quantities per farm system; 2) highly specialised production: the largest share of farm income comes from the product being studied; 3) production technique: per farm system; 4) profitability: the farm is able to remain in the market; 5) entrepreneur (breeder): market oriented, relatively young, open to innovation and collaboration in the research project.

The criteria for selecting the farms for the survey were established by determining first the farm reference group (type) to be investigated. The farm reference model is used to illustrate the farm production system and most common income levels achieved in the environmental, professional and institutional context of the territories under discussion. In general, the farm system should reflect the wealth of the majority of the people employed in a significant number of farms specialised in the production of the goods studied and located in a determined territory. In this way, case studies (with each farm group representing a case study) are determined by regional camelid experts taking into consideration: 1) agro-ecology and location of the farm, 2) herd size; and 3) production systems that make the most significant contributions to regional production.

The first step in the construction of the farm system is the identification of the particular territory and/or the geographical area devoted to SADC production: the geographical area with the highest density of animal population. The definition of the most convenient dimension of the farm system productive resources can be deduced either by statistical analysis of the farm's reality or empirically. The analysis of the regional statistic distribution of the farms for classes of economic dimension (average turnover) makes it possible to identify the most common classes and their average size. The choice of this method is conditioned by the availability of reliable statistical data. The most frequent empirical investigation in the farm system consists in the information offered by experienced witnesses. The advantage obtained by operating empirically lies in eliminating the cases of scarce importance. The risk could consist in devoting greater importance to more visible productive realities although with lower statistical incidence in the context.

A farm group consists of a minimum of 5-7 farms and reflects a farm system representing the local productivity area (Agribenchmark, 2012; Deblitz *et al.,* 2002; Garcia and Gomez, 2006). Technical and economic data for each farm group are the average values of the farms that belong to that group.

A preliminary test interview was carried out on two farms before beginning the actual research. This was done to ensure that the questionnaire was fit for purpose to generate meaningful data and to reduce interview time. This preliminary test was carried out by the authors of this paper in collaboration with local technicians. Data reliability was ensured by way of a budget analysis presented by these two test farms. In conclusion, we have identified eight farm groups, five of them being private enterprises and three rural community farms.

Data was collected from 53 Peruvian farms (PE) and 16 Bolivian farms (BOL) located in the *Altiplano* and specialising in llama and alpaca breeding. Three Peruvian farm groups are family managed and located in the south of the country (Arequipa region).They include small, medium and large farms: the size of the farm system is determined by herd size (llama, alpacas and sheep) and available land area. The two private Bolivian farm groups are in the south-central region and western region of the country. The three Andean rural community farm groups are located in the south- central and southern regions of Bolivia (Table 1).

The reference year used for six of the farm groups was 2003. The biennial period 2003/04 was used for BOL Curahuara and BOL Oruro Turco; values for these two latter farms have been averaged over the two-year period.

Data collection was initially carried out using a standard questionnaire drafted in English and translated into Spanish. The questionnaire was identical for all farms. The

questionnaires have been edited by the authors who personally, or in collaboration with some local technicians known to farm personnel have visited the breeding farms, interviewed the persons in charge and collected the technical and economic farm data. Farm data collection was carried out using structured interviews with farmers during repeated visits to their farms by the authors of this paper or technicians trained by the authors.

The difficulties encountered during data collection were due to the complexity of this activity caused mainly by limited or non-existent farm accounting data; a further complication was the fact that many farms, especially those in rural Bolivia, are not market oriented; the need to travel hundreds of kilometres to reach farms that are isolated from populated centres rendered the task time consuming and difficult.

The number of farms in each farm group range from a minimum of three to a maximum of twenty-eight. Although the small number of farms in the Bol Quetena, BOL Coroma and the BOL Pozo Cavado group is not highly representative they have been included because they are not private farms but rather rural community farms with total surface areas of about 4,000, 3,000 and less than 1,000 hectares respectively.

A labour unit (LU) has been defined as 2,700 work hours per year, 300 work days per year, nine hours per day. These numbers reflect a situation where available labour exceeds demand both as regards the market and the individual family farm needs. Defining labour units in terms of hours facilitates comparisons among the farms studied. In some farms, various jobs are carried out by several individuals only for some months of the year and on some days actual work is limited to a few hours on family farms. The total number of nine work hours is the average effective minimum number of work hours per day.

4. Results and discussion

4.1 Farm resources

The main farm resources are grazing pastures and livestock followed by farm equipment and machinery. The first resource is represented by the quantity of *bofedal* land available per head. *Bofedales* are naturally irrigated peat pasture grazing land capable of producing large quantities of forage. Wetlands of the high Andean mountains are exceptional ecosystems due to their hydrological characteristics in a surrounding arid environment (KLIMA 2012). In general and above all there are very few *bofedales* or wetlands on farms and especially in rural communities.

In all farms camelid breeding is carried out along with sheep rearing. The use of grazing land depends on the total number of livestock, camelid and sheep, per hectare. The minimum number observed in rural communities is 0.14 heads per hectare and in one community, where only wetlands were taken into consideration, there were none. The largest total number of livestock per land surface, on the other hand, was noted in a group of Peruvian farms: 0.70 for small farms, 1.07 medium farms and 1.61 for large farms. In other private Bolivian farms the average number was 0.42 livestock heads per hectare.

The composition of farm capital reported in the farm groups has been shown to depend almost exclusively on livestock patrimony. The relationship between the number of llama and alpaca heads varies greatly (Table 2). The alpaca is the most common species noted in the Peruvian farms, whereas in Bolivia it is the llama. Finally, in the Bolivian

Table 1. Average values for groups of farms (2003 and biennial 2003/2004 for BOL Curahuara and BOL Oruro).

Farm groups	Country, Department, Region	No. of farms in the group	Land (ha)		Livestock (heads number)		No. of labour units
			Total	*Bofedal* -Wetlands	Llama and alpacas	Sheep	
Private family farms							
PE Small	PERU, Arequipa, Arequipa	9	176	*28*	70	53	4.2
PE Medium	PERU, Arequipa, Arequipa	28	232	*47*	191	57	4.2
PE Large	PERU, Arequipa, Arequipa	6	427	*120*	583	106	4.2
BOL Curahuara de Carangas	BOLIVIA, Oruro, Curahuara de Carangas	5	522	*164*	249	26	2.9
BOL Oruro Turco	BOLIVIA, Oruro, Turco	5	789	*25*	226	25	3.0
Andean rural community							
BOL Quetena	BOLIVIA, Potosì, Sud Lipez	3	3055	*50*	313	17	2.9
BOL Coroma	BOLIVIA, Potosì, Sud Oeste (South West)	3	910	*48*	191	28	1.8
BOL Pozo Cavado	BOLIVIA, Potosì, Altopiano sur	3	3834	*0*	190	79	4.0

rural communities only the llama is present. The average financial amount for case studies, calculated by multiplying the number of llama, alpaca and ovine heads by their annual average market value surveyed in the territory where the farms are situated, varies from a minimum of USD 4,500 to a maximum of just under USD 38,000.

The equipment and machinery capital includes only some health and sanitation tools (syringes for vaccination equipment), sheep shears and in some instances, motorcycles or trucks. Agricultural machinery is nonexistent. In the Peruvian case studies and for the BOL Quetena Andean rural community 3% of company capital was allocated to equipment and machinery whereas in the other cases it was less than 1%. The value of these production factors corresponds to their actual value when wear and tear is taken into consideration.

The infrastructure available to camelid breeders is, in general, quite limited as is the farm area allocated for: butchering, administering anti-parasite baths, animal rest as well as pens, and rudimentary fenced areas built with any materials available. The deficiency of electric energy determines the impossibility to realize a cold chain (Bonanni 2004: 86).

In all of the farm groups there is a complete lack of farm product reinvestment (stored forage, seeds etc.).

The reduced number of labour units (LU), at a maximum of 4.2 LU for Peruvian farm groups, highlights the characteristics of family farms. There is also a wide variety in the total number of animals per LU which varies from about 29 animals to over 160 animals (Table 3).

Table 2. Farm stock capital value (USD)* (2003 and biennial 2003/2004 for BOL Curahuara and BOL Oruro).

Farm groups	Livestock		Equipment and machinery		Total	
	Amount	%	Amount	%	Amount	%
Private Family Farms						
PE Small	5794	*97.8*	129	*2.2*	5923	*100.0*
PE Medium	13228	*97.3*	357	*2.7*	13585	*100.0*
PE Large	37961	*97.2*	1086	*2.8*	39047	*100.0*
BOL Curahuara	11208	*100.0*	0	*0.0*	11208	*100.0*
BOL Oruro Turco	12401	*99.2*	103	*0.8*	12504	*100.0*
Andean Rural Community						
BOL Quetena	16084	*96.9*	508	*3.1*	16591	*100.0*
BOL Coroma	4491	*99.6*	19	*0.4*	4510	*100.0*
BOL Pozo Cavado	7483	*99.7*	24	*0.3*	7507	*100.0*

*1.00 US Dollar equals 3.479 Peru Nuevo Sol (PEN), year 2003; 1.00 US Dollar equals 7.85 Bolivian Bol., year 2003 and 2004.

Table 3. Animal heads (2003 and biennial 2003/2004 for BOL Curahuara and BOL Oruro).

Farm groups	Llama and alpaca heads number per LU	Total livestock heads number per LU
Private Family Farms		
PE Small	16.7	29.3
PE Medium	45.4	59.0
PE Large	138.8	164.0
BOL Curahuara	85.9	94.8
BOL Oruro Turco	75.3	83.7
Andean Rural Community		
BOL Quetena	107.9	113.8
BOL Coroma	106.1	121.7
BOL Pozo Cavado	47.5	67.3

4.2 Farm proceeds

In general the main portion of income depends on the result of the economic budget for llama and alpaca breeding and sales of other products of animal origin (sheep, cuts of meat, *charqui*, *chalona*, fibre and leather). The result of the economic budget for llama and alpaca breeding takes into consideration the following variations: (±)growth of the livestock during the year (comparison between initial and final inventory of the live capital); (+)sales of live heads during the production year; (+)personal meat consumption (farm product not sold), i.e. fresh and dried meat, maize, potatoes, quinoa, etc. consumed by the

herder and his family (-)purchasing of heads during the year.

Other farm proceeds includes sales from: vegetable products (vegetable crop sales, including maize, potatoes, quinoa, etc.) and vegetable family consumption (*chuño*, or dehydrated products or even freeze dried mountain potatoes or other tubers, and quinoa); other products/services (rural tourism, house building and handcrafted articles such as knitted items, textile products and and work activity, also extra-agricultural, done in other farms; personal consumption of sheep heads, fibre, leather, *charqui* and *chalona*.

Farm gross income per head (total farm proceeds of the sale of the farm products divided by the average number of animal heads present in the farm groups) varies from 19.07 USDs to 6.03 USDs (Fig. 1). The high farm proceeds in the PE Small herd might be due to intensive family work in other activities, for example the sale of handmade textile products and meat processing. On the other hand, those with the lowest proceeds, namely the rural communities, have a production system based on local product and service exchange which is not open to business markets.

Results show that farm proceeds derive in large part either directly or indirectly from animal stock capital. In particular, and excluding the BOL Coroma, proceeds from llamas and alpaca 'breeding economic budget' and from other sales of animal origin products ('sheep sale, meat cuts, *charqui*, *chalona*, fibre and leather') account for a minimum of 73% of total farm group proceeds to a maximum of 93%. The BOL Coroma is different from the other farm groups because farms engage in highly differentiated activities.

Farm proceeds from 'other products/services' represents from two to seven per-cent, with the exception of BOL Coroma which exceeds 40%. BOL Coroma does shearing and slaughtering, BOL Curahuara operates in rural tourism while BOL Oruro works in the building trade-house construction.

There were only two farm groups with vegetable production.

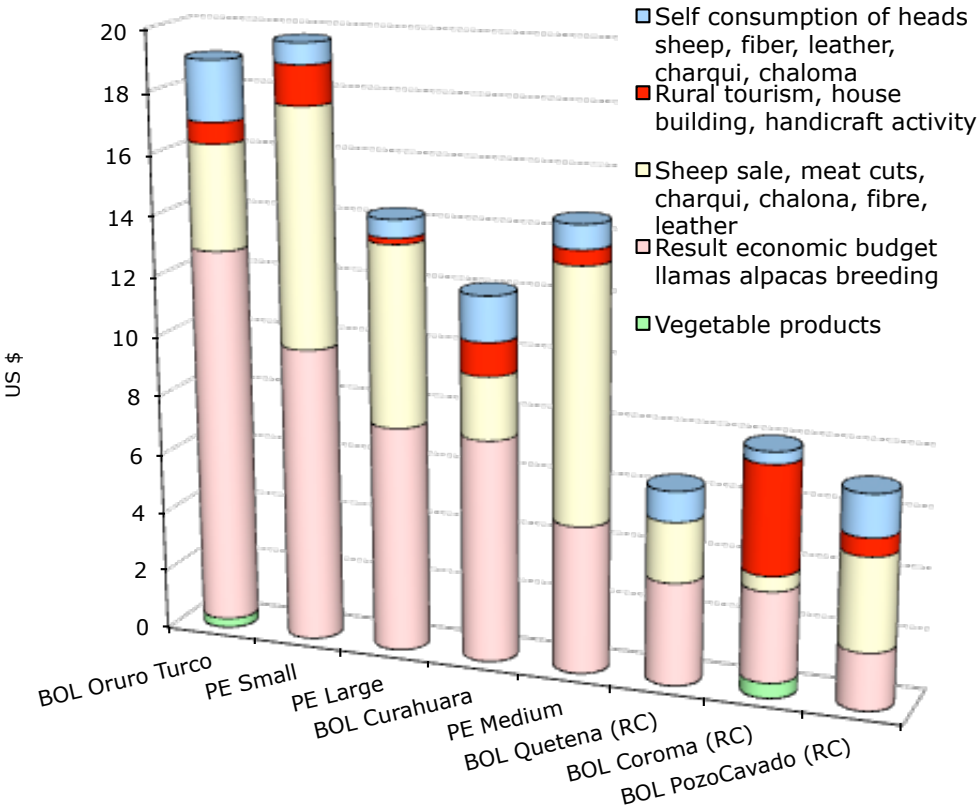
Finally, personal consumption of heads of sheep, fibre, leather, *charqui*, *chalona*, for the breeder and his family is common in every farm group and varies from a minimum of 3% to a maximum of around 17% of total farm proceeds .

4.3 Production costs

We can distinguish between variable and fixed costs; the former indicates costs that change with production levels, for example part-time labour, transport, sanitary costs to maintain healthy livestock (medicinal, sanitary consultations), etc. Fixed costs are the production means that remain constant regardless of production levels, for example, wages, taxes, mortgage costs, maintenance and building insurance, depreciation of machinery and instruments, bank interest, etc. Finally, fixed costs include land costs and farm capital interest. Land costs refer to costs for land use; for example if the land is owned, the cost can be equivalent to the cost of local rents. Farm capital interest is the cost sustained to invest money in stock and to advance capital.

The production cost per animal per year ranges from USD 9.40 to a low of USD 3.00. Variable costs range from USD 0.20 per head to a maximum of USD 4.40 per head (Fig. 2) and are lower in the Bolivian farm groups. In fact, the rural Bolivian communities, which use grazing lands only for animal feeding do not purchase production equipment and have no variable wage costs (cfr. Distaso and Ciervo 2006).

Figure 1. Farm proceeds per animal head per year (USD) (2003 and biennial 2003/2004 for BOL Curahuara and BOL Oruro).



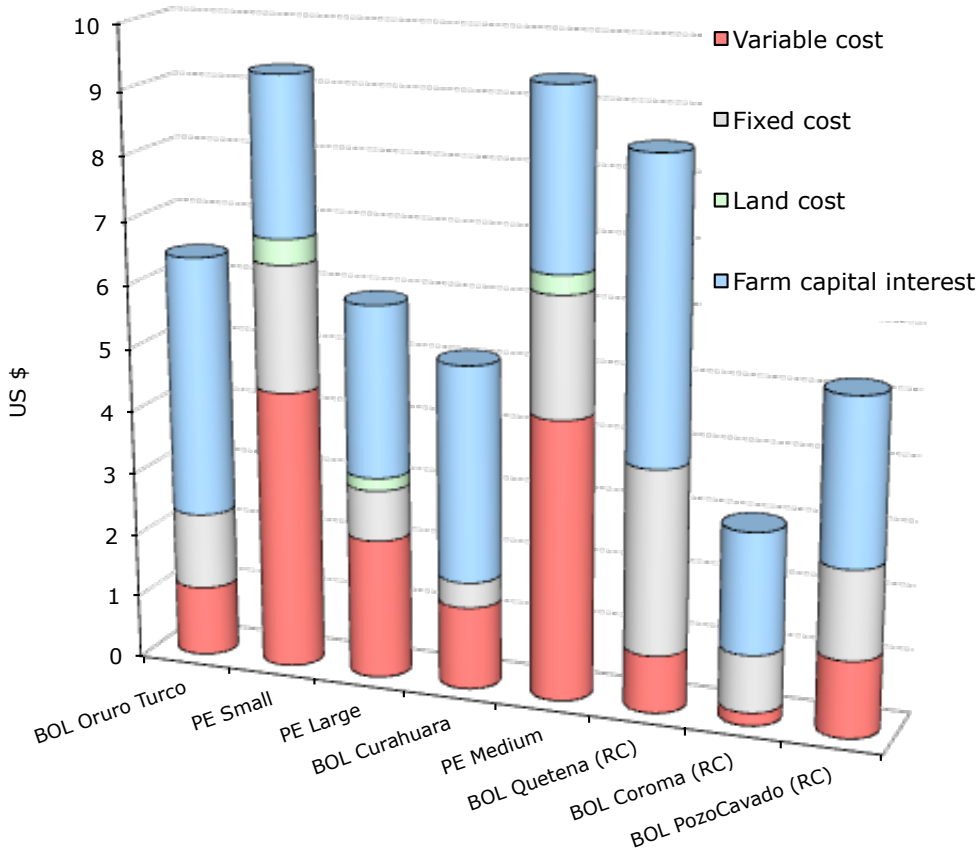
Fixed costs range from a low of USD 0.40 per head to a high of USD 2.90 per head.

Land costs have been taken into consideration only for the Peruvian farm groups. Bolivian rural communities have no market for land. In Peru, the amount of average rent contracts for land is known and it is therefore on this basis that land costs for production have been estimated. Land costs range from a low of USD 0.20 per head to a high of USD 0.40 per head.

Interest on overall farm capital is in proportion to return on stock capital (animals, equipment and machinery), advanced capital or loans necessary to cover at least a part of costs to purchase production equipment to begin farm production. Interest varies from USD 1.90 per animal head to USD 4.7 per head.

The high incidence of interest costs in Bolivia is due to the following: 1) high value of animals; in the BOL Oruro Turco, for example, the value of the 257 animals (llama, alpacas, sheep) accounts for 99% of company capital; 2) extended period needed for capital advances (on average 12 months); and 3) inflation – at the time of this study inflation in Peru was 4.52% while in Bolivia it was as high as 8.34%.

Figure 2. Production cost per animal head per year (USD) (2003 and biennial 2003/2004 for BOL Curahuara and BOL Oruro).



4.4 Farm net income

The variability of net income per labour unit (LU) and per animal head in farm groups highlights the difficulty in arriving to a general conclusion. The positive results of net income, both for LU and per head, show that all of the farm groups' income exceeded fixed and variable costs.

The highest level of total farm income was 7,606 USD while the lowest was as little as 834 USD (Table 4).

In Peru, although the total number of LUs does not noticeably change among farm groups, it would seem that the total farm income is proportional to the number of raised heads. In the private Bolivian farms, the BOL Oruro higher income (4,323 USD) in comparison to that of BOL Curahaura (2,840 USD) seems justified, with an equal number of LUs, by a greater sale of "other products of animal origin". In the rural communities, the BOL Coroma with a higher level of income seems to depend on the presence of a smaller

Table 4. Farm net income per year (USD) (2003 and biennial 2003/2004 for BOL Curahuara and BOL Oruro).

Farm groups	Total farm net income USD	Farm net income per LU USD	Farm net income per animal head USD
Private family farms			
PE Small	1642	391	13,3
PE Medium	2025	482	8,2
PE Large	7606	1811	11,0
BOL Curahuara	2840	979	10,3
BOL Oruro Turco	4323	1441	17,2
Rural community			
BOL Quetena	834	287	2,5
BOL Coroma	1449	805	6,6
BOL Pozo Cavado	1116	279	4,1

number of working units and on lower costs per head. Farms in the PE Large reported the highest net income per LU at USD 1,811.00, while BOL Pozo Cavado reported the lowest net income at USD 279.00.

For Bolivian private farms, net income ranged from USD 1,441.00 per LU to a low of USD 979.00. This seems to indicate that since the work hours are the same, the difference is due to greater sales of other farm products rather than from animals.

The highest net income per LU in the rural communities was USD 805.00 and this seems to be the result of a lower number of LU and lower costs per animal head.

It is interesting to compare data from the existing literature in the field. According to Fairfield, whose information is based on data collected from interviews with experts, an average *Altiplano* family earns about USD 200-300 per year (2004: 4-5). In the poorest regions of Northern Potosí, family incomes are as low as USD 70 per year. The highest incomes for small producers in the *Altiplano* reach around USD 2,000-3,000 per year. Healy describes how llama breeders in the southern Bolivian province of Pacajes saw their incomes increase from about USD 996 to USD 1,752 per year in 1995 as a result of the services provided by AIGACAA, the herders association of the High Andes and some assistance from universities and NGOs (2001: 194 cited by Fairfield 2004: 4-5). Fairfield's income estimates for a typical family with about 80 animals range from USD 345 to USD 800 per year (2004). On the low end, a Conacs representative estimates income from fibre at a mere USD 122 per year, with a total annual income of only USD 345 from all sources, including fibre, meat, and sale of live animals (2006). Some studies, however, have concluded that small alpaca herders receive about half of their income from fibre and about half from meat.

Net income per animal head per year ranges from USD 17.20 for the BOL Oruro farm to USD 2.50 for BOL Quetena.

Among the most important causes that contribute to explain the variability of farm net income, are the low farm productive specialization and limited market orientation. As regards meat production techniques, for example, we have noted the following less than per-

fect production techniques: i) animal stock is the main, if not exclusive, farm capital. Farms breed several types of animals. Llama is present on all farms but is never the only animal as llamas are raised along with alpacas or sheep; ii) high variation in age at which the animal is slaughtered. As reported by Condori *et al.* (2001) the best age for slaughtering is between 16 and 18 months for alpacas and 19–21 months for llamas, while in reality slaughtering takes place when animals are over 30 months old. The main reason for this is not due to market type but depends on the family's need for money to cover private expenses. In order to accomplish this, the best heads are saved to produce quality textile fibre for eventual sale and to meet personal family needs. Consequently, those animals not suitable to produce high quality fibre are slaughtered. Farmers do not consider specialised animal breeding for meat to be an important factor to raise income; and iii) farms engage in producing a wide range of raw materials and processed products, including selling livestock, fresh meat, llama and alpaca *charqui* and lamb cured meats along with textile fibre and skins.

5. Conclusions

From the point of view of farm breeding techniques and economic data we have identified the farm production systems of some groups of breeding farms in Bolivia and Peru by applying empirical criteria and identical methodology.

Among production systems in general, the level of intensive farming seems to depend above all on the size of the herd, which in turn depends on the ability of the farm to produce animal feed, the amount of land available, particularly naturally irrigated peat pasture grazing land, and the type of farm, namely whether it is a private or rural community farm. For example, the number of llama and alpaca head does not exceed 0.20 per hectare in rural communities; in particular the BOL Pozo Cavado, with its 3,834 hectares, barely reaches 0.04 head per hectare. On the other hand, and as far as private farms are considered, there are higher numbers ranging from a minimum of 0.28 heads per hectare (BOL Oruro) to a maximum of 1.36 (PE large). Furthermore, the number of heads raised per labour unit increases from small private family farms to larger farms. In the PE small family farm, the number of llama and alpaca heads per labour unit is scarcely more than 16.66, while in other farm groups there are on average 46.48 heads per PE medium sized private family farms and in the BOL Pozo Cavado rural community, 80.59 on the Bolivian Oruro and Curahuara private farm groups and 117.61 on the BOL Coroma, BOL Quetena and PE large private family farms.

From the point of view of farm net income, all farm production systems identified - even with different farm net income results, located in the difficult geographical regions and from the point of view of fodder production and in spite of the fact that they are not generally market driven - are still sustainable. Farm net income incorporates remuneration from the following production variables: rented land, farm capital interest, farm labour and profit. Economic sustainability is an important factor necessary to channel these production systems towards an improved market approach.

Factors that impact greatly on farm net income include the size of productive areas and the level of production specialisation. Both in Peru and in Bolivia private market orientated farms have herds that are larger than average. On the other hand, low income farms are for the most part in rural communities with herd numbers below average and

located at a noteworthy distance from the market. From the point of view of a market economy, the fact that these rural communities have persisted should not be the only factor to be considered. Their production system is unique and characterised, in particular, by reciprocity of services and collective land ownership. In this sense, their vulnerability depends for the most part on how they face future social changes and in particular the impact on community equilibrium should they become more market orientated.

This study, due to the lack of farm organisation that made technical and accounting data collection difficult, in no way represents an exhaustive study of the economic situation of the Andean camelid breeding farms. This study is limited in fact, to a small sample of farms over a one or two year period. It is a small contribution that can be extended to other situations to overcome difficulties associated with technical and economic data collections. It also stimulates the application of this method to determine net income per farm group.

Based on these research results, the authors have made recommendations for future farm improvement. These recommendations include reducing farm production costs by improving technical management such as introducing proper slaughtering procedures and implementing budgeting techniques to include systematic collection of accounting data.

To increase income, farms could implement the following strategies: improve genetic selection for both alpaca and llama to be used for fibre processing; and increase the sale of live heads and fibre, add other sellable products with higher added value including handmade textile products, meat processing and rural tourism. Finally, and to ensure that the farms increase their market share, they should set up professional training programmes and encourage breeders to join breeding associations with an eye to producing greater added value in rural areas.

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