Chapter 5

# Livestock Biodiversity in the Mountains/Highlands – Opportunities and Threats

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## Introduction

In the following the subject of 'livestock biodiversity' is approached from a holistic perspective that includes ecosystem and cultural components and is not restricted to genetic-biological features. Thus livestock biodiversity is considered in terms of the diversity of, and interrelationships between, genes, species, and ecosystems including a cultural perspective.

The first focus is on remote mountain areas of more than 4000 masl, where herders with multifold traditions and cultures live and unique genetic resources with highly adapted species and breeds can be found. The second focus is on tropical highlands of intermediate altitude that are prone to intensive production with high-yielding breeds with a resultant high pressure on local breeds. References are made to examples from my own research in the High Andes and inter-Andean valleys of Bolivia and in the Northern Highlands of Vietnam. The paper covers rangeland-based animal farming in the subnival and upper montane zone (Troll 1968, p 35) as well as livestock-crop mixed farming in upper montane valleys, and includes a discussion of a breeding programme for autochthonous micro-livestock as a contribution to the characterisation of biodiversity and its conservation through systematic utilisation.

The 'opportunities and threats' for research and development are discussed in terms of the need for applied and committed research involving the skills and the will of

farmers and herders in specific regions, and contributing to the solution of present day problems deriving from global climatic, demographic, and socioeconomic changes.

## Harnessing the Potential of Mountain Livestock Resources

### *Guinea Pigs in the Andes*

In the late 1980s, a long-term breeding programme was set up in the Andean Valleys of Bolivia for guinea pigs, which are used traditionally for meat. The underlying aim was to characterise the local guinea pig biodiversity and then to conserve it by means of systematic utilisation. Specifically, the main objectives were to investigate the local genetic resources for their potential for meat production and to identify the genetic base for breeding strategies (Valle Zárate 1996a).

The breeding programme comprised the following.

- Screening of regional ecotypes in comparison with improved exotic lines and establishment of a national gene pool
- Implementation of a selection programme à crossbreeding programme
- Testing of genotype-environment interactions à production of improved breeds for use under different conditions

Figure 5.1 shows details of the comparative evaluation process for the local population with comparisons between purebred and crossbred groups and with high yielding exotic stock from Peru.

Table 5.1 shows the results of the evaluation of various performance traits of the Bolivian ecotypes (sampled across the country), the Bolivian gene pool, and the selected Peruvian line. On first sight the advantages of the exotics over the locals appeared striking with average weight at birth, weaning, and slaughtering higher by 32% to 67%. The exotics were also better than the locals in terms of number and weight of offspring produced in the first litter. However, long-term evaluation of reproduction revealed a different pattern. The locals excelled the selected exotic line both in the number of offspring born and weaned per year and in the total weight of offspring born and weaned per year.

Systematic comparisons between breeding groups kept under different ecological and socioeconomic conditions revealed a clear superiority of purebred locals under harsh environments and crossbred animals kept under improved field conditions. Purebred exotics were only superior when kept under conditions of intensive feeding and husbandry, which are inaccessible for the majority of farmers in mountainous areas.

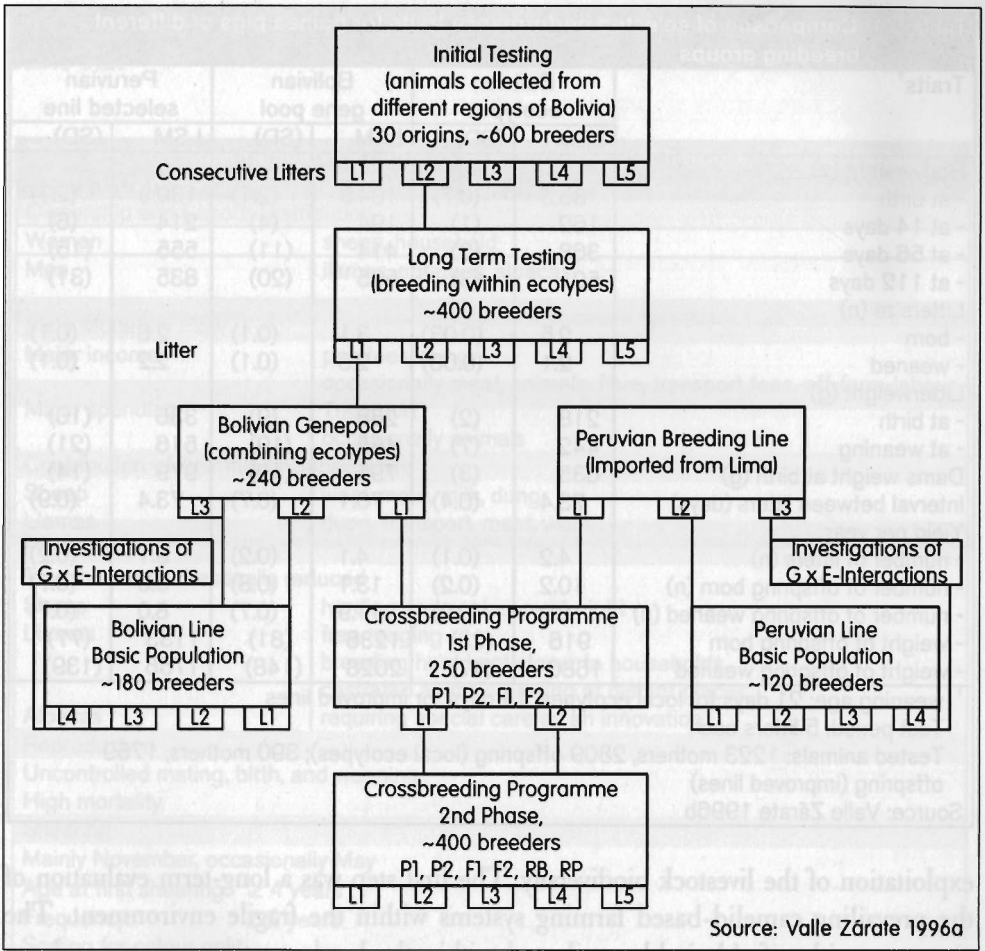


Figure 5.1: **Evaluation of the local genetic resource of guinea pigs in Bolivia as a basis for choice of an appropriate breeding programme**

The results show that local genetic resources play an important role in producing optimised breeding stock for distinct production conditions. Displacement of these resources can best be prevented by identifying environments where they are superior and by combining them systematically with exotic germplasm according to the specific conditions. A prerequisite for the success of the breeding programme was the strict orientation towards the needs of the prevailing farming systems and thorough consideration of aspects of breeding organisation.

### *Camelid-based farming systems in rural communities of the Bolivian Andes*

The second example relates to specialised livestock production (camelids and sheep) on rangelands at altitudes where cropping is strictly limited or completely impeded, the target was conservation of local genetic resources through appropriate

Table 5.1: **Comparison of selected performance traits for guinea pigs of different breeding groups**

| Traits[1] | Bolivian ecotypes | | Bolivian gene pool | | Peruvian selected line | |
|---|---|---|---|---|---|---|
| | LSM | (SD) | LSM | (SD) | LSM | (SD) |
| Bodyweight (g) | | | | | | |
| - at birth | 85.5 | (0.7) | 104.9 | (2.1) | 130.5 | (2.7) |
| - at 14 days | 162 | (1) | 194 | (4) | 214 | (6) |
| - at 56 days | 368 | (2) | 414 | (11) | 555 | (15) |
| - at 112 days | 501 | (3) | 595 | (20) | 835 | (31) |
| Littersize (n) | | | | | | |
| - born | 2.5 | (0.03) | 3.1 | (0.1) | 2.6 | (0.1) |
| - weaned | 2.1 | (0.03) | 2.8 | (0.1) | 2.2 | (0.1) |
| Litterweight (g) | | | | | | |
| - at birth | 218 | (2) | 288 | (9) | 336 | (10) |
| - at weaning | 442 | (7) | 485 | (19) | 516 | (21) |
| Dams weight at birth (g) | 635 | (3) | 795 | (12) | 979 | (14) |
| Interval between litters (days) | 73.4 | (0.4) | 70.1 | (0.7) | 73.4 | (0.9) |
| Yield per year | | | | | | |
| - number of litters (n) | 4.2 | (0.1) | 4.1 | (0.2) | 3.1 | (0.2) |
| - number of offspring born (n) | 10.2 | (0.2) | 13.1 | (0.8) | 9.0 | (0.7) |
| - number of offspring weaned (n) | 8.2 | (0.2) | 11.9 | (0.7) | 8.0 | (0.7) |
| - weight of offspring born | 916 | (23) | 1236 | (81) | 1133 | (77) |
| - weight of offspring weaned | 1680 | (47) | 2028 | (148) | 1756 | (139) |

[1] weaning age: 21 days for local ecotypes, 14 days for improved lines
Test period: 5 litters each
Tested animals: 1223 mothers, 2809 offspring (local ecotypes); 390 mothers, 1759 offspring (improved lines)
Source: Valle Zárate 1996b

exploitation of the livestock biodiversity. The first step was a long-term evaluation of the prevailing camelid-based farming systems within the fragile environment. The aim was to identify 'desirable attributes' within the local genetic resources and use these to design breeding programmes for their conservation by utilisation (Valle Zárate 1996b). Respect of the herders' culture and special ways, and inclusion of the herders from the first steps of planning and preparation, is paramount for the success of this type of breeding work. The methods used and results of the long-term study are summarised briefly below.

The study was conducted over 14 months in Bolivia in the Wallat 'ani Communityarea (16° 56' S and 66° 32' W), Cocapata Canton, Ayopaya Province, Cochabamba Department, and covered 2,000 hectares at 4,400 masl in the Cocapata Cordillera. The study focused on 5 families owning 150 llamas, 400 sheep, and 70 alpacas. The methods used included participant-based observation; interviews with questionnaires and on a range of topics; physical measurement of climate, soil and water; determination of vegetation; measurement of reproduction performance, weight gain, milk yield, and fibre and meat production; and analysis of hygienic status.

The results of the investigation of livestock husbandry patterns are summarised in Table 5.2.

Table 5.2: **Livestock husbandry patterns in a community of herders in the Bolivian Andes**

| | |
|---|---|
| **Ownership and Labour Distribution** | |
| Women | sheep, household |
| Men | llamas, potatoes, alpacas |
| **Main Monetary Flow** | |
| Major income | potatoes, dung<br>occasionally meat, animals, fibre, transport fees, off-farm-labour |
| Major spending | Transport<br>occasionally animals |
| **Contribution of Animals to Subsistence** | |
| Sheep | wool, meat, milk, dung |
| Llamas | dung, transport, meat, wool |
| **Pastoralism** | |
| Transhumance drastically reduced | |
| Sheep | herding and enclosure at night |
| Llamas | free ranging<br>breeding herd kept closer to households<br>castrated animals grazing at distant places |
| Alpacas | requiring special care as an innovation |
| **Reproduction** | |
| Uncontrolled mating, birth, and weaning<br>High mortality | |
| **Shearing** | |
| Mainly November, occasionally May<br>Age at first shearing: ≥ 4 years<br>Frequency: ≥ 2 years<br>Sorting for colour only<br>Prospects for marketing unclear | |
| **Slaughtering** | |
| Seasonal pattern<br>Old or ill animals | |
| **Animal health and hygiene** | |
| Infestation by coccidioes (sarcocystiosis)<br>Scabies (*Sarcoptes scabiei*)<br>Lice<br>High occurrence of diarrhoea in foals<br>Traditional and chemical treatments<br>Treatment sporadic and never on all animals affected<br>Indifferent attitude towards animals' well-being | |
| **Product utilization** | |
| Low extraction rates of animals, meat, milk, and fibre<br>Dung the product used most systematically and extracted most frequently (fuel, market, products, fertiliser)<br>Sheep dung and potatoes the major products exploited commercially<br>Mainly household consumption of milk, fibre, and meat, and home use of llama dung<br>Declining importance of llamas for transport | |

Source: Nuernberg and Valle Zárate 1999

Various characteristics of the fleece quality of the local llama population in Ayopaya were studied and compared with those of a flock from the Andean plains (Condoriri). The results are shown in Table 5.3.

Table 5.3: **Significant differences (LS means) between llama fleece traits in mountain and plains region animals**

| Region | Number of animals | Mean fibre diameter (µm) | S.D. of fibre diameter (µm) | Fine fibre (%) | Mean diameter of fine fibres (µm) | Kemp (%) |
|---|---|---|---|---|---|---|
| Condoriri | 96 | 28.0 a | 11.7 a | 73.3 a | 22.8 a | 15.2 a |
| Ayopaya | 861 | 23.2 b | 8.0 b | 89.3 b | 21.2 b | 0.8 b |

Significant differences are indicated by different letters (Tukey-Kramer $p < 0.05$)
S.D. = standard deviation
Source: Delgado et al. 1999

The Ayopaya llama stock had a very high quality fleece with a high percentage of undercoat and fine fibre of small diameter. The quality was much higher than that of the llama population in the Andean plains, but this advantage has remained virtually unexploited. Currently, breeding activities are in progress with the aim of planning breeding for conservation and further development of the unique Ayopaya ecotypes of llamas.

### *Organisation of on-farm conservation programmes for autochthonous pig breeds with small farmers in mountainous regions of Northern Vietnam*

The third example of a research project aimed at the maintenance of livestock biodiversity in mountainous regions is concerned with the conservation of autochthonous pig breeds in mountainous regions of Northern Vietnam (Lemke et al. 2000). This project is being carried out in collaboration with scientists of the National Institute of Animal Husbandry in Hanoi and focuses on the organisation of on-farm conservation of indigenous breeds. Purebred reproduction is accomplished by means of contracts between farmers and the research station. Different types of contracts are studied, for example with logistically favoured farms, who receive higher prices for their services in reproducing breeds economically not best suited to their farming conditions, and with logistically disadvantaged farms in remote mountainous areas, where the breeds make sense in the farm context but the costs of gathering performance records are increased. This example highlights the necessity of an interdisciplinary approach with a permanent interaction between researchers and the herders and farmers indispensable to programmes for the conservation of livestock biodiversity, especially in mountainous areas. Scientific approaches will only prove useful and sustainable when they are placed in the proper context, incorporating scientific analytical tools and technical skills in local processes of decision-making.

## Factors Influencing Livestock Biodiversity

The following discussion focuses on the interrelationships between livestock biodiversity and nature conservation, sustainable development, indigenous knowledge, and property rights.

### *Livestock biodiversity as a component of nature*

As yet, little has been done to characterise livestock resources, whereas continuous attempts are being made to replace them.

- Government policy is to upgrade and replace local types with improved stock.
- The purity of native types is being lost in some areas through informal programmes carried out by the farmers themselves (Wilson 1997).

### *Livestock biodiversity versus nature conservation*

The worldwide assumption underlying the focus on conservation can be expressed as follows.

Human land use for subsistence leads to degradation and is incompatible with the maintenance of high levels of biological diversity. Therefore more inclusive conservation policies within and beyond protected area boundaries are imperative while recognising

- the difficulties associated with implementing restrictive policies, and
- the fact that human land-use practices may not lead to degradation or to a decline in biological diversity (Saberwal 1996).

### *Livestock biodiversity pro nature conservation*

- Advantage must be taken of the valuable interaction between livestock and natural resources.
- At present, overgrazing of some mountain pastures and undergrazing of others (as a result of the depopulation of animals in environmentally difficult areas) have resulted in land degradation.
- Ecological studies to determine optimum stocking densities should be carried out in each region in order to facilitate sustainablity, biodiversity, and nature conservation measures. Appropriate adjustments should be made in pastureland management regulations and appropriate incentives given to farmers (Zervas 1998).

### *Livestock biodiversity and sustainable development*

The general compatibility of on-farm conservation efforts with livestock development approaches has been shown recently by

- Joshi and Rasali (1998),

- own results and experiences as cited above, and
- Somlo (1997), who reported the results of two projects in Argentina showing the possibility of conservation of environment and biodiversity by means of sustainable development. The projects were concerned with pasture management and livestock production, and livestock and forestry development, respectively, and were aimed at improving food production in an area with special problems and providing opportunities to change from a condition of absolute poverty to one of self-sufficiency with dignity.

Conservation of livestock biodiversity must be included when defining 'sustainablity' because

- the maintenance of the natural capital stock is a minimum condition for sustainable development (Orlove and Brush 1996), and
- sustainability includes aspects of ecological sustainability such as environmental sustainability and maintenance of biodiversity, as well as ethical and economic sustainability (Torp-Donner and Juga 1997).

***Livestock biodiversity, indigenous knowledge and property rights***

The following are already common practice.

- The use of indigenous knowledge for rapidly assessing trends in biodiversity (e.g., Hellier et al. 1999)
- Recommendations of the sort given in the study on 'The importance of genetic diversity in livestock populations of the future' by Notter (1999): "Maintain an aggressive program of sampling and evaluation of exotic breeds with potential for immediate use." This basically means looking for favourable alleles in otherwise lowly productive stocks. The intention is to use this cryptic variation as a contribution to future selection response.

Pertinent considerations are as follow.

- Distance measures describing similarities resulting from common ancestry should be used only as an initial criterion in making breed conservation decisions (Barker 1999).
- Biodiversity and indigenous knowledge systems should be recognised under a new intellectual property regime (Dobhal 1999).
- Much depends on the local knowledge of agriculturalists about the importance of different species and the conditions for their survival. Thus it is not only important to preserve this diversity, but also to avoid the acquisition of local knowledge by developed countries becoming expropriation of this local knowledge without proper reward (Gomez Benito 1995).

## Threats and Opportunities: Conclusions

*Threats (challenges)*

- There is still a very powerful tendency to replace local livestock resources with ill-adapted high-yielding exotics.
- Much work remains to be done in the characterisation of the performance and special traits of local breeds.
- Genetic impact analysis is not yet routine in areas where exotic breeds are used, neither in the choice of the appropriate level of intensification of breeding and production, nor in the re-evaluation and worldwide diversification of breeding goals.
- There is a common belief in the competence of the international scientific system to come up with simple solutions for the complex problems of specific local people and ecosystems. However, the solutions offered are often technically narrow and short-term and result in
  - the investment of available funds mainly in (aggressive) programmes for sampling and evaluation of exotic breeds with potential use elsewhere; and
  - decisions about which breeds, strains, or ecotypes should be conserved being taken on the basis of mostly questionable, narrow approaches to the description of genetic diversity.
- The importance of livestock biodiversity as an integral part of nature conservation and sustainable development, particularly in fragile and globally important ecosystems such as the mountain areas, still tends to be overlooked and the implications neglected.

*Opportunities*

- There is increasing recognition of the important role of livestock keepers in safeguarding domestic animal diversity through their animal husbandry (Hall 1996).
- After decades of development debacles with alien breeds, scientists and developers have at last come to appreciate the vast animal genetic resources that ordinary farmers and herders have developed through the ages, especially in the South (McCorkle 1999).
- Many rural societies are confronting the loss of biological diversity and culture. Fortunately, there are also many examples of rural people strengthening their knowledge, traditions, and spirituality to meet the needs of the next millennium (Dankelmann and Ramprasad 1999).

In order to encourage and empower local people to continue keeping their unique genetic livestock resources in ecologically fragile, globally important environments, it is necessary that herders and farmers in programmes of biodiversity conservation and regeneration are directly involved and supported in the following.

- Decision-making, planning, and implementation
- Direction of funds to the specific sites of action
- Provision of legal support and assistance for problems related to property and utilisation rights
- Provision of subsidies for such things as landscape protection services in situations where farmers and herders are encouraged to develop extensive production systems with local genetic resources on the basis of local fodder rather than opting for individually more profitable intensive high-input, high-residue production systems

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