PEOPLE AND ANIMALS

TRADITIONAL LIVESTOCK KEEPERS: GUARDIANS OF DOMESTIC ANIMAL DIVERSITY

FAO INTER-DEPARTMENTAL WORKING GROUP ON BIOLOGICAL DIVERSITY FOR FOOD AND AGRICULTURE

PEOPLE AND ANIMALS

TRADITIONAL LIVESTOCK KEEPERS: GUARDIANS OF DOMESTIC ANIMAL DIVERSITY

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F O R E W O R D

Achieving food security for all is at the heart of the mandate of the Food and Agriculture Organization of the United Nations. The key role of agricultural biodiversity in meeting this objective was once more emphasized by the Secretary-General of the United Nations on World Food Day in 2004, when he urged for greater attention to the role of biodiversity in the fight against hunger.

By protecting and increasing the world's stock of genetic resources, small-scale farmers and herders are making an especially important contribution to food security. Their role as guardians of biodiversity has formally been recognized by the Convention on Biological Diversity (CBD) in article 8j. Furthermore, in Decision VII/3 the CBD invited all governments to mainstream agricultural biodiversity in their national plans, programmes and strategies with the active participation of local and indigenous communities. It also encouraged them to recognize and support the efforts of local and indigenous communities in conserving agricultural biodiversity.

The Commission on Genetic Resources for Food and Agriculture facilitates and oversees cooperation between FAO and the Conference of Parties to the CBD. It coordinates FAO's interaction and work with the CBD and with other international bodies, in the areas of conservation and sustainable utilization of genetic resources for food and agriculture, as well as the fair and equitable sharing of benefits derived from their use.

In collaboration with livestock communities, research centres, universities, governmental and non-governmental organizations (NGOs), FAO identified and documented 13 case studies on how communities manage their local animal genetic resources. These case studies demonstrate that local knowledge is crucial in preserving the equilibrium between farmers, their animals and the environment. However, livestock keepers' role in maintaining this balance and conserving biodiversity is under a great deal of pressure from changing land tenure policies to the benefit of the private sector and the expansion of natural reserves. Formal government involvement could significantly reduce farmers' exposure to these risks. This study aims to raise awareness and subsequently encourage decision-makers to include conservation and development of animal genetic resources in legal, regulatory and institutional planning.

Peter Kenmore
Chair
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INTRODUCTION

Domestic animal diversity is being lost at an alarming rate. Worldwide, local livestock breeds are being crossed or replaced with higher-yielding animals under the motto "exotic is better". Furthermore, the native habitats of pastoralists and their animals are steadily disappearing, relinquishing their domain to agriculture, protected nature reserves and industrial activities. This trend is further encouraged by existing formal policy, short-term profit opportunities and a decreasing appreciation of the value of local breeds.

The present variety of farm animal species and breeds is the result of centuries of local knowledge-based selection by traditional livestock keepers. Through traditional farming systems a broad diversity of livestock breeds is being preserved and developed to provide meat, dairy products, eggs, fibre, fertilizer, manure and draught power. Consumers in both developing and developed countries benefit from this diversity since it offers them a wide choice of products for a varied and nutritious diet. Finally, livestock diversity represents future capacity to meet unforeseen needs and opportunities.

With the help of pastoral communities, case studies on traditional livestock farming systems using local breeds were compiled in order to understand and establish:

> how communities manage local animal genetic resources;
> local knowledge and good practices;
> how animal genetic resources interact with their environment;
> how communities cope with threats to their local animal genetic resources;
> long-term solutions and sustainability of strategies.

Pastoral communities that live in similar ecosystems in very different regions of the world adopt comparable farming strategies, so the chapters of this publication have been classified according to ecosystems. Each chapter briefly describes the challenges faced by livestock keepers in a specific ecosystem, while the case studies illustrate how communities have dealt with these challenges.

The main lessons to be drawn from the case studies are:

1. Technical and political decision-makers are often unaware of the far-reaching impact of their decisions on the conservation and sustainable use of livestock genetic diversity; consequently, raising awareness and teaching are essential elements.
2. Communities in general have identified the challenges they face in making their farming systems profitable enough to support their livelihoods. Such knowledge should be consolidated by decision-makers, who have huge potential to contribute to solving problems related to the loss of livestock diversity faced by farming communities.
3. Connecting people with others who have already addressed, or are addressing, similar problems generates new ideas and solutions. It also empowers people to formulate solutions serving both their own and common situations and to take appropriate action.

INTRODUCTION

BRIEF DISCUSSION OF THE DRIVERS OF CHANGE FRAMEWORK

The Drivers of Change framework (see Figure 1) which is derived from a Report of the Conceptual Framework Working Group of the Millenium Ecosystem Assessment published in 2003, summarizes and effectively introduces the reader to the underlying dynamics of the relatively complex case studies. This framework is derived from 13 case studies spanning five continents.

Changing land tenure policies is one of the key drivers of change in livestock farming systems based on transhumance. Large areas of previously common land are either privatized or used for other purposes such as afforestation and wildlife conservation. In most cases, these lands are no longer accessible to livestock keepers, forcing them to find new migration routes and to compete for the remaining communally available grasslands. This often leads to conflict among livestock keepers and between them and sedentary farmers. Moreover, the animal density on the accessible lands increases above sustainable levels, resulting in permanent serious pasture degradation. Ultimately, farmers either have to adapt their management strategies drastically or, when this is not an option, abandon livestock farming altogether.

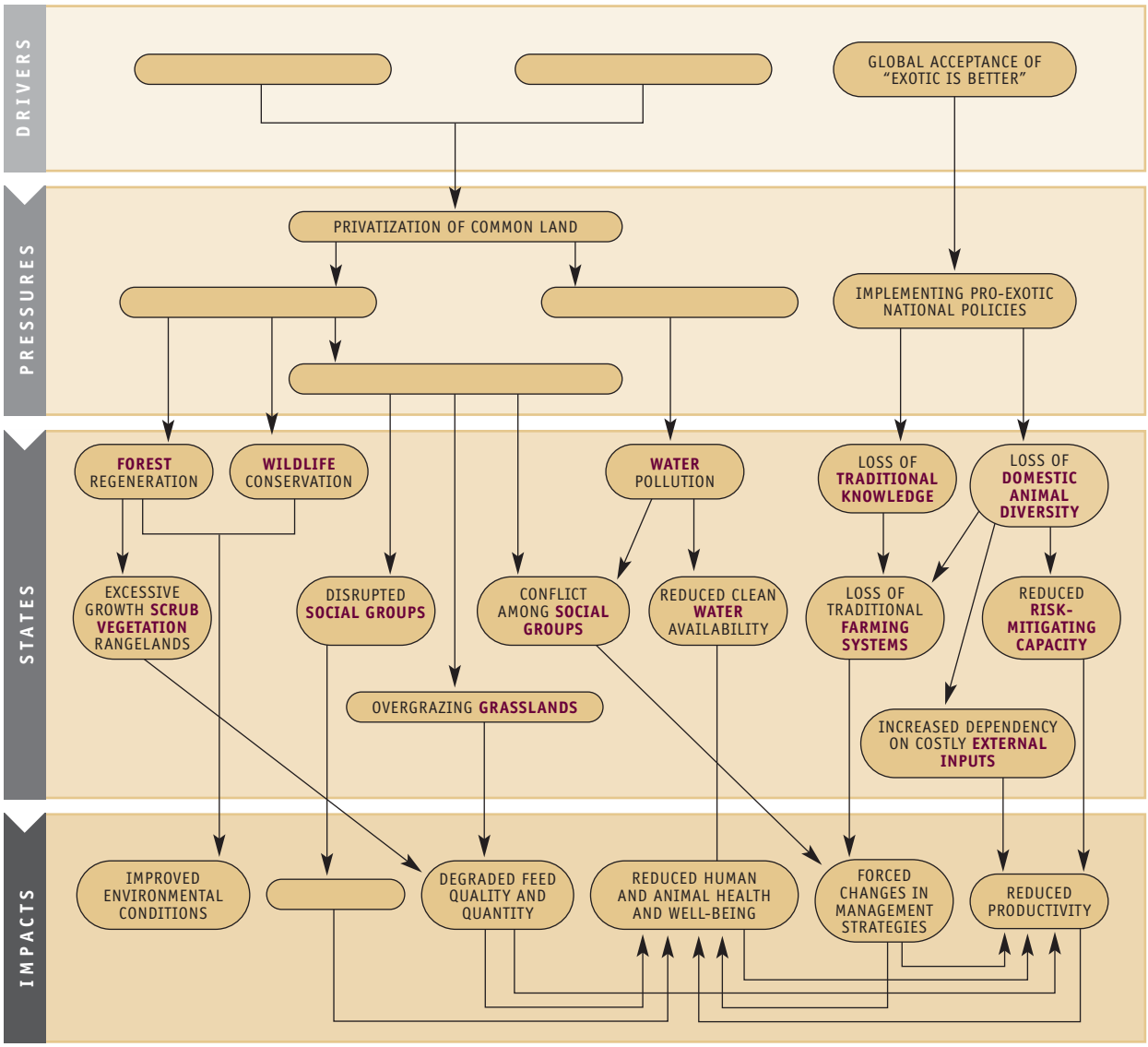
With governments encouraging foreign investment, industrialization is expanding rapidly in developing countries. In one case study, a major driver of change is the polluting mining industry. Foreign mining companies have invaded an area where local communities have been sheep herders for generations. Water sources in the region are currently highly polluted with toxic heavy metals and acid-forming minerals. If improperly managed, contaminants in mine waste can spread in surface and groundwater causing serious pollution that may last for many generations. Availability of clean water has become limited and both human and animal health and well-being have been seriously affected.

The idea that exotic livestock breeds have a higher production performance than local breeds is still widely accepted, yet few efforts are being made to explain in what context this statement is valid. Policies favouring the distribution of exotic breeds are common in many countries. By replacing local livestock with exotic breeds, traditional knowledge becomes superfluous and livestock diversity, as a whole, is drastically reduced. Farmers wishing to raise exotic livestock breeds are forced to abandon their traditional way of farming. They become increasingly dependent on costly external inputs, such as manufactured feed and vaccinations. Moreover, local breeds often serve as savings for rural households. In difficult times, they can easily be sold to generate the extra income needed. By replacing local breeds with exotic ones, this risk-mitigating capacity is being lost.

Numerous responses to the changes described above have been put forward by the authors of the case studies; these are highlighted at the end of each case study and summarized in the last chapter of this publication. Once again, the framework is only a summary of the key drivers of change as identified in the case studies and more detailed explanations can be found in the text.

INTRODUCTION

FIGURE 1. **DRIVERS OF CHANGE FRAMEWORK**



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A Report of the Conceptual Framework Working Group of the Millenium Ecosystem Assessment. 2003. *Millenium Ecosystem Assessment. Ecosystems and Human Well-being. A Framework for Assessment*.

1. The Neuquén criollo goat and its production system in **PATAGONIA**, **ARGENTINA**
2. Community-managed yak genetic resources and breeding system in **LAYA**, **BHUTAN**
3. Revitalization of the Basotho pony mare camps: a step towards increasing populations of the Basotho pony in **LESOTHO**
4. Managing lowland buffaloes in the hills of **NEPAL**

CHAPTER 1
COPING STRATEGIES IN **SUBTROPICAL MOUNTAIN ECOSYSTEMS**

Case studies were collected in subtropical mountain ecosystems in Argentina, Bhutan, Lesotho and Nepal to better understand how communities manage their local goat, yak, pony and buffalo genetic resources.

While the climate and topography of the three subtropical mountain ecosystems differ in detail, despite some variation in rainfall, climate and altitude, there are significant similarities between them. All areas are characterized by the presence of extensive grasslands. Temperatures vary greatly and environmental threats include soil erosion, overgrazing (often a result of inappropriate grassland management policies) and invasion of exotic plants. The extremely harsh and often unpredictable climate favours livestock keeping rather than crop growing. Large farming communities still depend entirely on livestock for income and livelihoods. Some governments acknowledge that livestock alone cannot provide a sustainable income for herders and are therefore actively promoting alternative income sources such as ecotourism.

Maps below:

Location of
Neuquén criollo goats in
Neuquén, Argentina

THE NEUQUÉN CRIOLLO GOAT AND ITS PRODUCTION SYSTEM IN PATAGONIA, ARGENTINA

M.R. Lanari, M.J. Pérez Centeno, E. Domingo

SUMMARY

Neuquén are small, hardy goats raised by small-scale herders in a transhumance system under cold, semi-arid conditions. Their area is contiguous with Chile which, until border closure, was a source of genetic exchange as well as a major market for goat products. Herder families are now settled while herds continue to migrate on their transhumance circuit although land development and forestry now hamper transit routes and resting sites. Neuquén genetic resources are doubly threatened: development projects push larger, exotic breeds although crossbreeds do not thrive under transhumance; exchange of breeding stock with Chile is no longer possible. A conservation programme is in place, within the production system, using selection criteria proposed by the producers.

Argentina has about four million goats, mostly in amorphous herds. Neuquén Province has around 640 000 goats, of which 53 percent are criollos (INDEC, 2002). The production system has its roots in aboriginal societies: livestock brought by the Spaniards had far-reaching changes in these societies' habits and organizational patterns. *Crianceros'* (small-stock producers) economic activity centres around goat-keeping. Their production system incorporates elements from indigenous cultures, such as transhumance and *castronerías* (sites where groups of owners keep their males out of season). This goat/transhumance/*criancero* triad is a core component of the culture and identity of the north of Neuquén Province. This study was conducted between 1997 and 2003.

Neuquén Province, in the north of Argentine Patagonia between 71° and 68° West and 36° and 38° South, encompasses over 30 000 km². The terrain in the north is broken. The Andes are paralleled by the Cordillera del Viento, a natural barrier averaging 3 300 metres. The main watercourses form the Neuquén river basin (Méndez Casariego, 2002).

Bran (2002) defines six ecological units in Neuquén; three are in the study area: the northern mountain range, the sierras and northern highlands, and monte austral. The traditional system is structured around seasonal pasture use. Summer pastures are in the northern mountains between 1 500 and 2 000 metres; the vegetation is gramineous, with variable proportions of subshrubs and shrubs. The main grasses are: *Festuca pallescens*, *Poa ligularis* and *Stipa speciosa*. The most common shrubs and subshrubs are *Mulinum spinosum*, *Acaena splendens* and *Adesmia* spp. The *mallines*, (humid meadows in valleys with humic soils) are a good forage resource: the predominant species are *Poa pratensis*, *Juncus balticus*, *Trifolium repens* and *Carex* spp.

The sierras and northern highlands between 750

and 1 400 metres are arid to semi-arid. Degradation of ground cover is serious to very serious. The vegetation includes *Grindelia chiloensis*, *Senecio filaginoides*, *Haplopappus pectinatus* and *Schinus polygamus*. The monte austral has mid-height shrubby vegetation of *Larrea divaricata*, *Atriplex lampa* and *Prosopis alpataco*. Oil drilling and livestock are the main economic activities (Bran, 2002). Winter forage production is 35 to 100 kg DM/ha on degraded slopes and up to 2 000 kg DM/ha in the *mallines*; in summer grazing lands *mallines* may produce 2 500 kg DM/ha. (Ayesa *et al.*, 2002)

In the north there are two longitudinal zones: one between the mountain ranges; the other east of the Viento range (Méndez Casariego, 2002). In summer grazing above 1 500 metres, precipitation is 800 mm to 1 200 mm as one moves from east to west and falls entirely as snow. Annual mean temperature is 11 °C, with monthly means between 18 °C in January and 3 °C in July. In the winter pastures temperatures are less extreme and it snows less. The precipitation pattern is Mediterranean, with the wet season from May to September. Precipitation is from 150 mm in the east to 400 mm in the west. Annual mean temperature is 14 ºC, with monthly means between 19 ºC in January and 6 ºC in July and August (Pérez Centeno, 2001).

The first inhabitants were hunters-gatherers (Mendez and Ivanow, 2001) and movements between winter and summer settlements predate the introduction of livestock. The region was colonized in the late nineteenth century, but had been subject to strong European influence (Bandieri *et al.*, 1993): by the seventeenth century the Mapuche had become horsemen, stockmen and traders (Bandieri *et al.*, 1993).

Criollo settlers who supplanted the indigenous population continued livestock exchanges and transhumance; the agrarian system took in territory in Chile. Deterioration in relations with Chile closed the border (Pérez Centeno, 2001), interrupting the flow of livestock and gradually isolating herds from their source of genetic exchange.

Northern Neuquén has a population of around 32 000 (Méndez Casariego, 2002). Some 1 600 are subsistence producers of goats and other livestock. A typical *criancero* has 240 goats, 30 sheep, 18 cattle and 11 horses; mostly on government land. Domestic consumption of goat meat rose from 20 to 57 percent over the past 20 years (Bendini *et al.* 2002). The authors' estimates, based on goat production indices, puts on-farm consumption at 60 percent. Health indicators point to less malnourishment among the rural population than in urban centres.

The whole family went on transhumance; social ties were formed along the route and near grazing lands. Increased school enrolment and improvement of housing near winter pastures altered this, and the household no longer migrates. As more and more grazing lands (especially winter pastures) have been fenced, herding routes and the distribution of resting places have been altered. This has had a serious effect on people who herd animals over more than 100 km. Since 1995 more and more stock are trucked, particularly cattle. Goats are usually trekked (Photo 1).

Livestock are supplemented by irrigated forage crops (especially *Medicago sativa*) and vegetables are grown for home consumption. Cereals used to be grown, but after integration with cereal-producing zones, were replaced by forage. Forestry, which began about 20 years ago, competes with summer grazing and restricts herding routes as more and more land is fenced.

Marketing of goat products which had centred on Chile (Bandieri, 1991) was redirected within the province after border closure. Traditionally, kids were marketed by merchants, bartered or paid for by merchandise bought on credit. This asymmetrical relationship was reinforced by border closure (Pérez Centeno, 2001).

In the nineteen-eighties, the provincial government promoted cooperatives (in which *crianceros* played a role) to market kid meat. Financial difficulties forced these to close and marketing is back in the hands of merchants. The scattered locations of the *puestos* (where *crianceros* live), low population density and remoteness put constraints on associative marketing. Transhumance is an obstacle because not all kids are ready for market when the time comes to move to

K. Tempelman

PHOTO 1. Goat herder migrating with his animals from summer to winter pasture in northern Neuquén Province

summer pastures (November–December).

CHANGES AND CONSTRAINTS AFFECTING THE TRADITIONAL PRODUCTION SYSTEM

Criancero households are now settled; the head of the household or some older children travel to the summer pastures, so it is more difficult for one generation to pass on know-how to the next. Other factors which impact on the traditional system include:

- restrictions on movements of producers in Chile and Mendoza, who used to pass the summer in Neuquén;
- the ban on cross-border transactions involving stock on the hoof;
- constraints limiting transhumance such as fencing, privatization of government land, restrictions on passage in or out of a given area, forestry; and
- deterioration of natural resources, particularly winter pastures and paths used by herders.

NEUQUÉN CRIOLLO GOATS

Cashmere was found in 89 percent of Neuquén criollo goats (Scaraffía, 1993), so they were regarded as an important genetic resource. Phenotypic and genetic research (Lanari *et al.*, 2000 and Lanari *et al.*, 2003b), along with a health survey confirmed the absence of Brucellosis and of Caprine Arthritis-encephalitis (CAEV) (Robles *et al.*, 1999).

There are two ecotypes: the short-haired Pelada often has different layers of colour; and the long-haired Chilluda, whose coat is usually white and layered. The fleece of both contains an outer coat of thick medullary hair shafts and a fine, non-medullary undercoat. Their distribution follows a geographic pattern: the southeast is populated by Chilluda (Photo 2); the Pelada is found in the north (Photo 3); in the central eastern part there is a mixture of types; in the west the influence of Angora


M. Pérez Centeno

PHOTO 2. Neuquén criollo goat: Chilluda (long-haired) ecotype


M.R. Lanari

PHOTO 3. Neuquén criollo goat: Pelada (short-haired) ecotype

goats is evident (Lanari *et al.*, 2003b).

They have rapid daily weight gain to weaning at 60 days, with an average of 150 grams/day (Lanari, 2003). Milk production between 30 and 60 days was 1.5 litres per doe, with 5 percent protein 40 days after birth (Cueto and Lanari, personal communication, 2003). The prolificity ratio was 1.4 kids per doe. Neuquén criollo herds have higher prolificity than Angora crossbreeds. Genetic studies confirm the marked variability and differentiation of these ecotypes. Evidence of the isolation of the Chilluda ecotype in the southeast from the rest of the population is particularly strong. These studies confirm the influence of the Angora in the west. The occurrence of rare alleles and of genotypes not described in the literature help to differentiate and define this population (Lanari, 2003). Their number is estimated at 340 000 (INDEC, 2002). Herds average 240 goats, but range from 150 to over 1 000; on average, they are composed of 144 dams, 48 replacement stock, 30 kids, 14 wethers and 4 bucks.

Herds are managed by the family. Does are re-bred within the herd; bucks are traded between neighbours. Re-mating of bucks only occurs partially in very large herds. Sometimes bucks of exotic breeds are bought from merchants, or provided by development programmes, particularly Angoras in the southwest. There is no marketing system for replacement stock; *crianceros* indicate this as a serious problem (Domingo, 2002).

Production is seasonal, with mating in autumn and kidding in spring. Weather, forage availability, transhumance and the timing of peaks in market demand all combine to determine the production cycle. Goats' reproductive behaviour is not strictly seasonal (Cueto, 2002), so *crianceros* have developed strategies to ensure seasonality, notably the *castronerías* system.

CASTRONERÍAS

Castronerías are usually in remote locations (Photo 4). *Crianceros*, who look after bucks during the off-season (called *castroneros*), are paid one doe kid per buck. *Castroneros* and the location of their sites vary from year to year. The Provincial Land Act expressly prohibits them since it states that *crianceros* may run only their own stock on public land. No records are kept of the number of *castronerías* nor where they are. Introduction of bucks to herds causes the does to go into heat – the "buck effect". The health and genetic implications of this reproductive system are discussed in Lanari (2003).

CRIANCEROS AND STOCK SELECTION

Selection of stock by *crianceros* is a major factor of differentiation. A study of 242 producers and more than 600 goats found a correlation of 0.82 between selection criteria and the phenotypes observed in various areas (Lanari *et al.*, 2003a). *Crianceros* prefer large, compact animals which is related to meat yield and having goats

capable of withstanding extreme conditions. Preferences for an ecotype depends on the area. Preference for white goats is related to selling the fleece, but coloured goats are easier to manage in snow-covered pastures where snow lasts longest and prolificity ratios are the highest. *Crianceros* pay attention to does' suitability as breeders and how they kid.

GENETIC RESOURCE CONSERVATION

A programme for conservation and improvement of the Neuquén criollo goat, in place in northern Neuquén Province since 2001, aims to forestall the breed's genetic dilution and preserve the traditional production system. It focuses on both the goats and the production system. Breed improvement aims to conserve genetic variability, hardiness and productive efficiency within the traditional system. Work on the production system entails evaluation of natural resources, identification of cut-off points and the development of technologies. *Crianceros'* organizations support the implementation and dissemination of technologies. The programme is developing a system for supplying improved strains of the two ecotypes, based on selection criteria proposed by the *crianceros*.

CRIANCEROS, THEIR FAMILIES AND HERD MANAGEMENT

Members of this social group have strong ties to the land and livestock, and want to continue with stock-rearing (Pérez Centeno, 2001 and Bendini *et al.*, 2002), which paves the way for transmission of knowledge from one generation to the next.

Family roles are well defined; all take part during the first 30 days of kidding. Women milk goats and make cheese. Men shear, helped by women and children (Photo 5). Herding is done by teenage boys and men. Increase in school enrolment since the 1980s and access to secondary schools is breaking down the rural family structure. The reduced availability of family labour, and access to other jobs, set the stage for a progressive reduction in the transmission of

K. Tempelman

PHOTO 4. A Criollo Pelada *castroneria*, Neuquén Province

M.R. Lanari

PHOTO 5. *Criancero*'s son helping with goats

knowledge.

CRIANCEROS' RELATIONS WITH THE STATE AND NON-GOVERNMENTAL ORGANIZATIONS

The 1958 development policy encouraged growth of towns in the northern region, formation of producer organizations and establishment of Asociaciones de Fomento Rural (AFRs) and marketing cooperatives. AFRs are an organizational centre for the community, train rural leaders and are a channel for services provided by provincial government (Pérez Centeno, 2001). Informal training was boosted in the 1990s with the establishment of rural training stations.

THE LEGAL FRAMEWORK FOR GOAT PRODUCTION

The lack of clear legal title to land discourages investment in infrastructure and makes it difficult to obtain finance. Absence of legal recognition renders *castronerías* ineligible for subsidies. The failure of tax legislation to take account of the specific features of small-scale producers' economic activities is a severe constraint on their marketing.

STATE PROMOTION OF EXOTIC BREEDS

The strongest State impact on genetic resources is the promotion of exotic breeds. In the 1980s development agencies considered Neuquén criollo goats mixed-breeds of little value and that efficiency and productivity could be attained by introducing specialized breeds. Crosses of Neuquén criollo with Angora showed good adaptability, but crossbred fibre was of low quantity and quality. In the late 1980s INTA and the provincial government launched the Programme for the Improvement and Dissemination of the Angora Breed, which has had a very considerable impact on the goat population. The Angora is not adapted to the north of the province nor to its production system. Despite pressure, *crianceros* prefer Neuquén criollo goats. Angoras had difficulty in surviving in an extensive system. Initially *crianceros* were attracted by their size, but have rejected them because of lack of hardiness and high nutritional needs.

STATE VALUATION OF LOCAL GENETIC RESOURCES

The concerns of *crianceros* on social affairs, production, natural resource conservation and forestry have given rise to conflicts of interest which have usually resulted in contradictory public policies. Aid programmes aim to improve the situation of producers and rural households, but many are unfamiliar with the traditional system's production potential and give producers and their economic activities a passive role in the larger economy.

CRIANCEROS' VALUATION OF LOCAL GENETIC RESOURCES AND THE TRADITIONAL PRODUCTION SYSTEM

The *crianceros'* relationship with their animals is typical of pastoral societies. There is an implicit valuation of the genetic resources and this social group's ability to manage them. *Crianceros* value Neuquén criollo goats' hardiness, their herding behaviour, that the does are good mothers and their resistance to disease. Given the changes in interrelationships within this system, producers are more vulnerable to the adverse effects of the introduction of exotic breeds, practices or technologies. An example is the formation of herds of exotic or crossbred milk goats near urban centres.

LIMITATIONS OF THE SYSTEM

Crianceros express concern about storms in the kidding season and predators. Factors that have deteriorated in recent decades include desertification, shortage of forage and marketing problems. Destabilization of the transhumant system by these constraints is clearly

described by the producers, but they are reluctant to take action to palliate them. Some individuals are working out solutions, such as building kidding sheds or shelters (Photo 6).

OUTLOOK FOR NEUQUÉN CRIOLLO GOATS

Traditional goat raising is complex; research on relationships within the system and on the sensitivity of the natural resource/social agent/genetic resource cluster is needed. The transhumant system was sustainable when land use was unrestricted (Photo 7) and the region open to cross-border exchanges. The deterioration of natural resources is the outcome of modifications to the system. These processes should be identified and assessed to help the system attain a new equilibrium. The interdependence between genetic resources, the people who use them, the way this social group is evolving, urban/rural integration, new forms of land use that are emerging (non-agricultural production, tourism), the nature of households and the changeover from one generation to the next all impact on this system, and need to be understood.

The levels of on-farm and local consumption and potential supply for marketing in the region or beyond must be determined. Identification of factors that may alter the end use of output would contribute to an understanding of productive and social behaviours and decisions for which a straightforward production model does not explain.

M.R. Lanari

PHOTO 6. A kidding shelter for Neuquén criollo does

An analysis which tracks the gene flows generated by the cultural practices of this system and the area's isolation, would help understand the differentiation processes in this goat population and to assess their influence on the breed's genetic structure. Since utilization of genetic resources by *crianceros* is the best way to conserve them, other production options should be investigated, existing ones improved and the revival

K. Tempelman

PHOTO 7. *Criancero* gathering his goats at the end of the day

of those that have been lost promoted. The production of cashmere and milk is also promising.

K. Tempelman

PHOTO 8. Winter pasture in Neuquén Province

K. Tempelman

PHOTO 9. Criollo goats being driven back to their corral

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K. Tempelman

PHOTO 10. Neuquén criollo goat: Chilluda ecotype

K. Tempelman

PHOTO 11. Criollo Pelada *castroneria*, Neuquén Province

Map below:

Location of Laya, a cluster of six yak herding villages, Bhutan

COMMUNITY-MANAGED YAK GENETIC RESOURCES AND BREEDING SYSTEMS IN LAYA, BHUTAN

Pema Gyamtsho

SUMMARY

Subsistence, transhumant yak herding is the main livelihood in the higher areas of Bhutan. Traditionally herds were in contact with China, but since border closure, they no longer have access to that breeding material. Poor winter feed, high calf mortality and gid disease are serious problems. Pasture quality is exacerbated by a ban on the use of fire as a management tool. Herders exchange or purchase sires, and government support is available for acquisition of superior bulls, but a widening of genetic diversity and introduction of new blood-lines is desirable.

The yak (*Bos grunniens*) is the main source of livelihood for the high-altitude communities of Bhutan; it provides a way of life for approximately one-tenth of the country's population. Yak milk and dairy products fetch premium prices. Yaks were the main vehicle for trade with China until the border was closed in the late 1950s. In northern Bhutan yaks provide the vital and often only link between herders and their neighbours. Age-old traditions and a lifestyle worthy of preservation have evolved around them. Yaks can utilize alpine grasslands where low temperatures and difficult terrain limit expansion into cattle or crops (Photo 1); there is tremendous potential for ecotourism in which yaks could play a central role.

Laya, in northern Bhutan, is a cluster of six villages with about 800 inhabitants. Altitude ranges from 3 000 to over 7 000 metres. The area experiences wet summers from June to September and cold winters from December to March. Spring (April–May) and autumn (October–November) are relatively short. Mean temperatures range from -8 °C in January to 15 °C in July, while annual rainfall varies between 500 and 750 mm.

P. Gyamtsho

PHOTO 1. The yak is a multi-purpose animal particularly valued for its milk in Laya

Mixed conifers dominate the vegetation up to 3 500 metres, with scrub forests up to the permanent snow line at around 4 700 m on shady slopes and 5 500 m on sunny ones. Alpine meadows are found within forests, but mainly dominate the area between 3 500 and 5 000

m. Snow and glaciers account for over 30 percent of the area.

Most households own a few yaks; yak products contribute up to 49 percent of their income with another 14 percent from hiring pack animals (Gyamtsho, 1996). Most trade is with the lower valleys. Yaks provide household necessities, ranging from food and fibre to draught and manure for cultivating barley and mustard (Photo 2).

Highly resilient herd management and breeding systems have evolved over many years but external factors now pose serious challenges to their sustainability.

YAK HERD SIZES AND HERD COMPOSITION

Laya has about 2 800 yaks (Dorji, 2000). Household herds range from under ten to over 300. From a sample survey of 24 herds, 48 percent of the animals were above eight years and only 15 percent were between two and four years (Gyamtsho, 1996), indicating a high mortality among young animals. The number of females was only marginally higher than males, as male yaks provide transport and draught; they are also savings which can easily be sold. The proportion of milking to dry cows was practically 1:1, indicating that herders manage to ensure even milk distribution throughout the year.

PHYSICAL CHARACTERISTICS

P. Gyamtsho

PHOTO 2. Laya villages depend upon yaks for a variety of common household necessities

P. Gyamtsho

PHOTO 3. Laya yak herders

Laya yaks are slightly bigger than average and appear bulky because of long hair on their flanks and a heavy and wide forehead with long, narrow and slightly dished faces and short ears. A striking feature is their symmetrical arc-shaped horns which taper in elaborate curves to pin-sized sharp tips. Their legs are short and their bodies compact with well-developed forequarters and 15 thoracic ribs that are long and arched. Coat colour varies from black, brown and greyish-golden to a mixture of black and white or white and brown (Tshering, 1994).

REPRODUCTIVE CHARACTERISTICS

Oestrus is seasonal; females in Laya improve in body condition in spring and attain peak condition towards August when they come into heat. Mating takes place in July and August. Signs of oestrus are not as marked as in cattle, but herders can detect them. Laya herders (Photo 3) have an intimate knowledge of the time and sites where best mating results can be obtained and can time the season in such a way that it coincides with the best summer pastures.

Bulls are put to service at three to four years. Their sexual function decreases from seven to eight years, but performance often depends on factors other than their inherent character. The presence of stronger and older bulls usually discourages a stud bull from mating and affects his performance as a sire.

Females are mated for the first time at three years and most have calved by their fourth or fifth year. Most conceive after being served several times. Conception

rate in a herd is around 80 percent or more, although herders report achievements of 100 percent. The gestation period is eight to nine months. Since mating is at pasture, monitoring the time of conception is difficult and it is hard to keep records of individual animals. Abortion is reported to be area-specific and often related to disturbance by other animals or predators rather than to reproductive disorders. Calving rates depend as much on feeding and management as on genetic factors. Most females (81 percent) calve in alternate years, while about 18 percent calve yearly. Females have a long reproductive life extending to over 15 years. When a dam is due to calve she is kept under constant watch. Survival rates of calves are very low. Herders repeatedly reported losing more than 5 percent of the previous year's calf crop due to infection by gid, weakness over winter, or predation. Calf survival is improved by not milking the dams for several days to weeks following parturition and allowing the calves to suckle. Once-a-day milking is practised as a strategy to improve the survival rate. In winter, supplementary feed is given to calves using buckwheat dough, porridge and brewing by-products.

BREEDING SYSTEM

There is no cross-breeding with other species in Laya, although herders know of the higher milk yields from hybrids, but prefer pure yaks since hybrids carry the stigma of inferior quality milk and meat and infertile males.

Mating is by the herd's own sire or by a more dominant bull from neighbouring herds. Bulls roam freely among herds, challenging rivals. Herders are generally unsure of the male pedigree of progenies. Bulls do not reach peak performance before seven or eight years. As a selection criterion, meat and draught are equally important. Bulls are selected from within the herd or bought. They should have the following characteristics.

- *Body size;* bigger than bulls of the same age.
- *Body conformation;* well proportioned without deformities.
- *Colour;* a black coat, a white tail and a white spot on the face are preferred.
- *Horns* should be large and symmetric as they are highly correlated with fighting ability (Photo 4).
- *Temperament;* a bull should be dominating and aggressive.

Breeding bulls are given concentrates at the end of the mating season. The productive life of a sire is up to 12 years after which it is castrated or culled. Non-breeding males are castrated at three to four years.

Herders exchange bulls or procure them permanently. Exchanges are normally between families with established connections. For purchases, buyers rely on information on the pedigree of the bull and its physical characteristics. A bull's performance is judged on its reproductive traits and the survival rate of its progeny. If conception rates are poor and calf mortality high, the bull is a source of bad luck and replaced in the following year. If good results are obtained, the bull is given extra care and recognized as a Norbu (precious gem).

MAJOR CONSTRAINTS TO YAK PRODUCTION IN LAYA

Inbreeding. Bhutanese herders used to have access to breeding stock from China, but now depend on local sources which has resulted in degradation through inbreeding. The pool of genetic material is small and gains from selective breeding are often marginal.

Nutrition and health. A major constraint to yak productivity is lack of winter fodder (Miller, 1987;

P. Gyamtsho

PHOTO 4. A typical yak bull in Laya

Harris, 1987; Gibson, 1991; Johari, 1993; Caron, 1994; and Gyamtsho, 1996). Weakness as a result of malnutrition causes high mortality (Gyamtsho, 1996). Gid disease continues to be a major problem.

Inappropriate pasture policy. The Bhutan Forest Act of 1969 banned fire as a means of managing pastures. Herders used to burn to control scrub and encourage palatable plants. Thereafter many sites were invaded by scrub that inhibits the growth of herbs and restricts the movement of yaks. Gyamtsho (1996) found that scrub cover was as high as 60 percent of the registered grazing lands in Laya and Lunana. This has forced many herders in central Bhutan to give up yak rearing.

POLICIES TO SUPPORT YAK PRODUCTION AND BREEDING

Genetic improvement. The Government supports the procurement and supply of superior yak bulls. Initially, it covered the whole cost, later only transport was subsidized. Artificial insemination with semen from China was tried recently with little success. Import of breeding stock is considered a more viable option.

Veterinary cover. The Government has provided free veterinary services since 1961. Gid only occurs sporadically. Regular vaccination against foot-and-mouth disease, anthrax and other diseases is provided annually.

Feed and fodder development. Since the late 1970s, attempts have been made to improve high altitude pastures and introduce more efficient ways of haymaking. Seeds and fertilizers were supplied free to encourage herders. Success has been modest as a result of unfavourable land tenure. The Government is aware of the negative effects of banning the burning of alpine pastures and has plans to amend the Forest Act to accommodate this.

Diversification of economic opportunities for yak herders. Yak rearing alone cannot provide a viable livelihood for herders. The Government is actively promoting ecotourism and nature treks as alternative sources of income. Efforts are being made to promote the cultivation of medicinal and incense plants in yak-rearing areas.

CONCLUSION AND RECOMMENDATIONS

In Laya, yak rearing will continue to be the main source of livelihood, but the following priority actions are recommended:

> Improve genetic diversity and selection characteristics in yak populations and introduce bloodlines.
> Study the physiological and management factors influencing the reproductive performance of yaks.
> Study the production characteristics of yaks, i.e. growth rate, body weight, milk yield and milk composition, fibre production and draught performance.
> Amend the Forest and Nature Conservation Act to allow controlled burning of pastures.
> Improve the economic condition of yak herders by actively engaging them in modern avenues of income generation, such as tourism and the commercial cultivation of medicinal plants.

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P. Gyamtsho

PHOTO 5. Yaks: perfect pack animals for northern Bhutan

Map below

Habitat of Basotho ponies, Lesotho

REVITALIZATION OF THE BASOTHO PONY MARE CAMPS: A STEP TOWARDS INCREASING POPULATIONS OF THE BASOTHO PONY IN LESOTHO

Jinny Martin

SUMMARY

Basotho ponies developed from Cape stock, under natural selection in a mountain environment. They are hardy, have thick-walled hooves suited to rough ground and are mainly used for transport, now also for trekking. Large numbers were exported as remounts during the Anglo-Boer war; thereafter indiscriminate crossing with exotic breeds was the norm. The creation of a national stud failed to remedy the situation. Farmer-centred mare camps, which provide for pony breeding under controlled conditions, have been developed to assure the breed's survival and expansion. Farmers manage the camps with assistance from extensionists; they form breeding associations and now control their breeding programmes. Further assistance is desirable in disease testing and training in record keeping. Stock-theft is a problem.

The Basotho pony is descended from horses sent to the Cape in 1652 which were of a strong Persian and Arab strain. After decades of natural selection, it was recognized as a breed in the mid-nineteenth century.

At the end of the nineteenth century Lesotho was depleted of its best breeding stock. In 1894, 519 horses were sold and the export trade grew until 1900 when 4 419 horses were relinquished during the Anglo-Boer War. The resident Commissioner said in August 1900,

R. Cardellino

PHOTO 1. Community gathering of Basotho pony breeders


R. Cardellino

PHOTO 2. Basotho ponies and their owners


R. Cardellino

PHOTO 3. Ecological tourism: trekking through the hills of Lesotho on a Basotho pony

"Though the possession of horses by individuals is a feudal condition imposed by the chiefs for national defence, no bar was placed upon free sale and export of these for Imperial purposes, and it is probable that no less than 10 000 remounts went to the army". By 1901 the Acting Resident Commissioner said, "15 000 horses have been sent out, making a total of 20 000 horses from Basutoland for the use of the army".

Unstructured management strategies were widespread. Breeding and trading were unregulated and indiscriminate cross-breeding with exotic breeds became the norm. In 1975 a study revealed the severe loss of the pony's true characteristics, dating back more than half a century.

WHY CONSERVATION OF THE BASOTHO PONY IS IMPERATIVE

In 2001, the Basotho pony population was about 100 000 head and is probably much lower today, especially purebreds. Most ponies are in the foothills and mountain areas. The pony is primarily used for transport, but has become popular for trekking. The breed is well adapted to the environment, endures extreme temperatures and is able to survive on pastures of variable quality. Because of its thick-walled hooves the pony can easily negotiate mountain terrain and does so by tripling (a gait slightly faster than the trot).

CONSERVATION EFFORTS THROUGH THE BASOTHO PONY PROJECT

After the 1975 study, the Government, in conjunction with the Government of Ireland, initiated the Basotho Pony Project. Two systems were established: an intensive National Stud, and associated, more extensive community-based managed "mare camps". Both had the goal of conserving the Basotho pony.

The National Stud was to produce top-quality breeding stock; it set up a marketing centre, but did not achieve its goals; many stock were lost through *Senecio* poisoning and snakebite. In 2004 FAO bought the Stud's last stallions and distributed them among 18 mare camps

Mare camps provide for pony breeding under controlled conditions; stock are inspected and registered, as are their progeny. These farmer-centred production camps are in Lesotho's mountain district. Large grazing areas are at their disposal. Farmers are responsible for the success of the camps, while the extension programme allows them to strengthen their management knowledge. Farmers have grouped to form breeding associations and now control breeding programmes. As explained by McCormack (1986), camps are the key to extension in breeding management and to encouraging teamwork and cooperation among farmers.

The most important advantages of pasture breeding are:

> Low labour requirement. Ponies graze freely and the system is based on natural mating; the herd hardly

needs to be supervised.

> Heat detection by stallions. Natural mating leads to high conception rates.

> Strong cooperation among farmers, because they are in control of the production centres.

The mare camp has disadvantages. While a social hierarchy is rapidly established among stallions, young ones are exposed to injuries because there is little supervision. Since pastures are not fenced, other stallions can intrude, disrupting the herd's social structure and affecting the quality of the progeny. All mares are grouped together and are therefore vulnerable to theft.

CURRENT POLICIES AND SUGGESTIONS FOR THE FUTURE

The main objectives of the Equine Section of the Department of Livestock Services are to:

> ensure that the rural population, particularly in remote areas, has continuous access to Basotho ponies for transport;

> conserve and develop the breed's genetic and phenotypic characteristics according to the selection criteria of the farming communities;

> develop domestic and export markets for the breed.

The Equine Section has facilitated the formation of breeding associations; inspected and tested breeding stock for disease; supported the organization of races and shows to promote the breed; and enhanced commercialization of the ponies throughout the country. Despite Government efforts to conserve the Basotho pony, some activities could be improved at a relatively low cost:

> Testing for disease is insufficient. A survey could identify camps with disease problems.

> Mare camps require little supervision, but herders need training in record-keeping and should be selected carefully.

> Some mare camps do not have access to good stallions.

> Characterization activities need to be continued on all breeding stock.

> More guidance should be given to the farming communities that manage the mare camps.

> There has been little commitment by the government to combat stock-theft. Fencing, in combination with more supervision, could be a more costly but more realistic option.

The Basotho Pony Project has demonstrated that breeds on the verge of extinction can be revitalized. For such initiatives to be sustainable, commitment, planning and continuity are vital.

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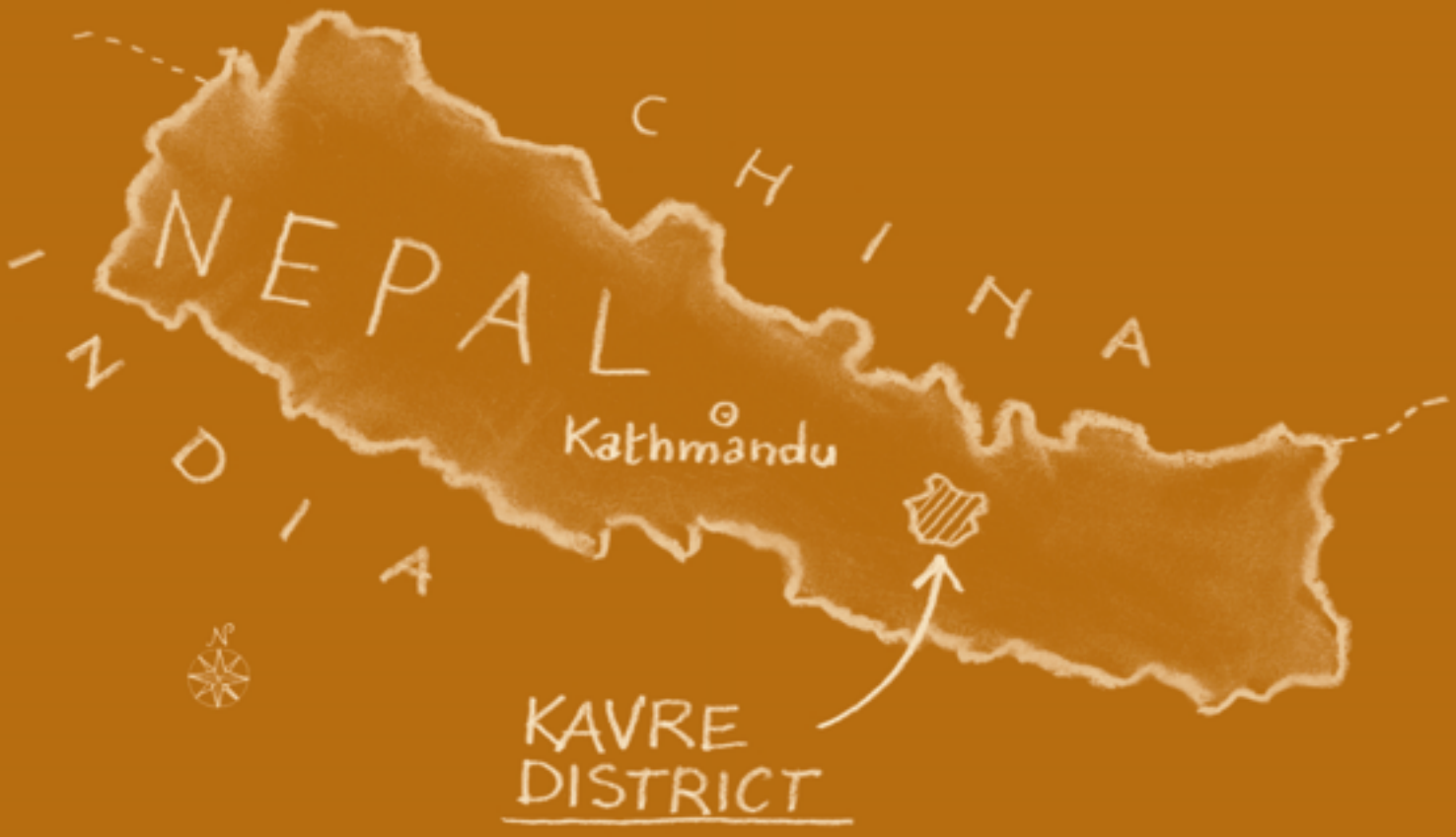
Map below:

Kavre district, new home to exotic Murrah buffaloes, Nepal



MANAGING LOWLAND BUFFALOES IN THE HILLS OF NEPAL

Kamala Gurung and Pradeep Tulachan

SUMMARY

Traditionally, farmers in the Hills of Nepal kept Lime buffaloes which grazed freely and were the predominant breed, but they are now only 5 percent of the buffalo herd. Population pressure has almost eliminated the grazing land and buffaloes are mostly stall-fed on crop residues and forest fodder. Murrah buffaloes, from India, which are far better milkers have replaced the local breed; sires and pregnant females are bought from neighbouring Bihar. Farmers have upgraded their management systems to accommodate these more demanding but profitable animals. Much of the trading is through middle-men so there is a need for more information on breeding methods and selection criteria in Bihar to ensure that these accommodate Nepalese needs.

The water buffalo (*Bubalus bubalis*) is the most important domestic animal in East Nepal. Until 30 years ago, farmers raised Lime buffaloes, which fed in grassland and forest areas. Recently, high-yielding Indian Murrah buffaloes have been introduced. The study took place in the Jaisythok Village Development Committee (VDC) in Kavre, at an altitude of 500–600 metres in a subtropical climate. More than a third of the Committee's 644 ha is used for crops.

INTERACTIONS BETWEEN PEOPLE, THEIR ANIMALS AND THE ENVIRONMENT

Only wealthy households can afford to raise two or three exotic buffaloes. Most milk is for home consumption. Milk products play a key role in Hindu religious ceremonies, as do male buffaloes, which are often sacrificed during social and cultural events. Exotic buffaloes produce more milk than Lime buffaloes. Men are responsible for marketing milk.

WHY AND HOW EXOTIC BUFFALOES WERE INTRODUCED

Parcelling out land as a result of population growth has had a large impact on buffalo farming. Households have sold local buffaloes and bank loans have encouraged the purchase of exotic ones that can be stall-fed. More than 95 percent of households have one to three exotic buffaloes. About 65 percent of households buy new animals in lactation yearly – at approximately US$ 320 per head – while selling dry ones

P. Tulachan

PHOTO 1. Exotic buffalo traders, local farmers and researchers

for meat. Private traders play a much more important part than the government in promoting exotic animals (Photo 1). For almost 20 years, two Indian traders monopolized the supply of Murrah buffaloes; now the number of traders has increased significantly.

MANAGING EXOTIC BUFFALOES

The Hills region is between 500 – 2 500 m; the terrain is very steep with narrow valleys. Livestock, although an integral part of agriculture, is secondary to crops. Climate varies from subtropical to warm-temperate; 80 percent of precipitation falls during June to October. Most of the eastern and central hilly areas receive 1 500 – 2 500 mm; the west gets 1 000 – 1 500 mm. Holdings are tiny. Grazing land is very scarce; livestock depend on feed from crop land and the forest.

Feeding. Residues such as paddy straw, maize stover, wheat and millet straws and vegetable wastes are fed. Manufactured feed and veterinary medicines are supplied by dairy cooperatives. With the growing use of high-yielding exotic dairy buffaloes, farmers have introduced stall-feeding (Photo 2). Collecting green fodder, feeding animals, cleaning sheds and milking are done by women; men assist during the harvesting season. Children take the buffaloes to graze. Women have learned to manage exotic buffaloes and know far more than men in recognizing high-quality local fodder, feeding and traditional veterinary practices. The community values knowledge on feeding, as it is the key element in improving milk production.

Selecting buffaloes. Local breeders buy male Murrah which are selected according to the milk yields of their offspring and the lactation history of their mothers. Other important selection traits are age, weight, body conformation and skin condition. Only female buffaloes that produce between 8 and 10 litres of milk per day are selected for breeding. They are preferred to higher-yielding animals, as they require less grass and concentrates. Male elders dictate breeding strategies and often consult animal traders to discuss the performance of buffaloes.

LOCAL BUFFALO GENETIC RESOURCE AT RISK OF EXTINCTION

The Lime buffalo, now raised in only 5 percent of households, is relatively small and generally has a light brown coat with chevrons of grey or white hair below the jaws and around the brisket. It has fairly small sickle-shaped horns curved towards the neck (see photo 3). It is severely threatened by the massive introduction of the Murrah and no measures are being taken to conserve it.

INVOLVEMENT OF THE GOVERNMENT AND OTHER PARTIES

The Government provides vaccination services and forage seeds on a regular basis. Livestock Services Centres train farmers.

NEEDS OF THE COMMUNITY

In Jaisythok VDC, the needs of the community dictate

P. Tulachan

PHOTO 2. Private breeder with exotic breeding bull

that farmers' activities focus on improving the Murrah buffalo at the expense of conserving the Lime. Learning how to raise the Murrah has been long and difficult, especially in terms of feed and health. Farmers soon realized that chopped rice straw mixed with green fodder, homemade concentrate and manufactured feed suited the exotic breed and resulted in higher milk production. Traditional health and sanitation methods were replaced by modern veterinary ones.

Initial obstacles for managing the Murrah have been overcome and farmers do not wish to return to the past; their priority is to improve management to achieve even better production. Since the main problem farmers face today is the availability of high-quality feeds and medicine for their animals, they are lobbying strongly for the establishment of a government institution for quality control.

CONCLUSION

Economic factors can be a driving force for farmers to exchange traditional methods for new management strategies. Farmers' joint efforts have allowed them to keep exotic buffaloes successfully with higher economic returns and an improved standard of living. Farmers can now send their children to school. The sustainability of this system has come under threat since supply of buffaloes is endangered by possible trade restrictions from India and increasing transport costs. To maintain and sustain this economically beneficial genetic resource in the local community, the public sector needs to act and to develop and implement a participatory community breeding-policy strategy to make exotic buffaloes easily available and to eliminate the community's dependence on private traders. Government has a crucial role to play in monitoring the quality of manufactured animal feed and veterinary services offered by the private sector, since these are

P. Tulachan

PHOTO 3. Local Lime buffalo grazing in an open area

essential for the sustainability and success of the livestock farming system.

SUGGESTIONS FOR THE FUTURE

All exotic buffaloes come from Sitamani, Bihar state, India. It would be of great value if support could be provided to study:

- on what criteria buffaloes are selected in their place of origin, how they are bred and how they are managed before entering their lactation period;
- what type of local knowledge is involved;
- whether there is any public or institutional support for buffalo breeding;
- what type of national breeding and trade policies in India directly affect the farming practices of the communities.

Analysis of data and information on the above issues will provide insights which could serve as a basis for the development of a breeding policy framework for farmers in the hills of Nepal. This framework, in turn, would ensure the sustainability of the farmers' stock rearing system and their livelihoods.

5 Domesticated camelids, the main animal genetic resource of pastoral systems in the region of **TURCO**, **BOLIVIA**

6 Management of sheep genetic resources in the **CENTRAL ANDES** of **PERU**

CHAPTER 2
PHYSIOLOGICAL ADAPTATION TO **TROPICAL MOUNTAIN CONDITIONS**

Two livestock systems in tropical mountain ecosystems are presented. One looks at how communities in the Altiplano of Bolivia use and manage llamas and alpacas, while the other examines the sheep farming systems in the Peruvian Andes. Rural households in these regions are confronted with extreme climate and environmental challenges, including altitudes up to 5 000 m, intense solar radiation, low levels of atmospheric oxygen, average annual temperatures of around 6° to 7 °C, limited vegetation coverage and poor forage. Frequent frosts throughout the year are a major obstacle to crop cultivation, so livestock is often the farmer's only resource for food security, clothing and extra income. Livestock raised in these areas are both physically and physiologically adapted to the harsh environmental conditions. They are protected against altitude sickness by the high level of haemoglobin in their red blood cells; can survive on scarcely-available and low-quality feed resources; are capable of digesting plant varieties that no other animal can; and their grazing behaviour does not have a degrading effect on the environment.

Map below:

The Turco region in the Province of Sajama, Department of Oruro, Bolivia

DOMESTICATED CAMELIDS, THE MAIN ANIMAL GENETIC RESOURCE OF PASTORAL SYSTEMS IN THE REGION OF TURCO, BOLIVIA

C.T. Rodríguez and J.L. Quispe

SUMMARY

The Turco region has a harsh, microthermal, semi-arid climate, but people make a living there from llamas and alpacas which have advantages over exotic species and are managed in a transhumant system. These camelids are the main source of food and income for herders. The inhabitants have a holistic world view and see themselves, the land and their animals as an integrated unit. Group selection is being done by herders assisted by the Camelid Research and Improvement Centre. There is little conservation activity by government agencies or NGOs. A programme, compatible with the maintenance of genetic diversity and the producers' interests and economic needs, is needed to focus primarily on *in situ* conservation, inventorying, characterization and utilization.

Bolivia has one of the largest herds of domesticated South American camelids; [illegible]572 llamas and 416 952 alpacas (UNEPCA, 1999), raised by more than 50 000 households.

This paper discusses how ecotypes and breeds of camelids are managed in the Turco region and aims to encourage research to provide a basis to ensure their conservation and appropriate use. The authors have drawn upon secondary information and data from a survey of producers and authorities in the Marcarani and Challuma communities.

Turco is in the Department of Oruro (17° 57' south and 68° 15' west). The Canton is divided into six Ayllus (political division whose borders re-trace those of the region's traditional social organizational patterns, which were in place when the Spaniards arrived and survive to this day) (Izko, 1992, as quoted by Genin, 1995).

THE ECOSYSTEM

Turco is a puna ecosystem (Ellenberg 1981): shrub steppes in which grass steppes, halophytic vegetation, *bofedales* (wetlands conducive to the growth of high-quality forage) and salt marshes are also found (Genin, 1995).

Genin and Alzérreca (1995) define three major topographic zones: the pampas, up to 3 800 metres; the hills and plains which are a transition zone between 3 800 and 4 100; and the intra-Altiplano between 4 000 and 5 000 m. Vegetation is low-quality grasses known as *pajonales* (32 percent), tolar-*pajonal* vegetation (20 percent), montane vegetation and tolar shrubs (35 percent), graminoids (9 percent) and *bofedales* (4 percent) (Genin and Alzérreca, 1995). The main species of the arid plains of the Altiplano are shown in Table 1 and Photos 1–3 (Alzérreca, 1988).

The carrying capacity of natural pastures in the arid

TABLE 1. MAIN TYPES OF PASTURE IN THE ARID BOLIVIAN ALTIPLANO

TYPE	DOMINANT SPECIES	YIELD (kg DM/ha/year)
Tolar	*Parastrephia lepidophylla*	170
Pajonal de Iru ichu	*Festuca orthophylla*	130
Tolar–*pajonal*	*Parastrephia lepidophylla, Stipa ichu, Festuca orthophylla*	210
Graminoid	*Distichlis humilis, Muhlenbergia fastigiata*	600
Bofedal	*Distichia, Plantago*	2 450

Altiplano is low. Cardozo and Alzérreca (1983) calculate those for the Turco region at 0.41 llamas/ha/year in dry areas and at 3.8 llamas/ha/year in humid areas.

The climate is microthermal, lacking a well-defined cold season, with a dry season from April to December and a wet season from January to March. During the dry season, the daily temperature range is over 25 °C. Frosts are frequent (265 days of the year) and may occur at any time. Average annual precipitation is 330 mm (data for 12 years), but varies sharply (90–500 mm). The mean annual temperature is 7 °C (Genin, 1995).

THE ECOLOGY AND CAMELIDS

Camelids are adapted to the Andean region; the "altitude sickness" that strikes many introduced species (such as cattle) does not affect them (Branchero *et al.*, 1971, and Sillao *et al.*, 1972, as quoted in JUNAC, 1990). They cause less damage to the grasslands since they bite off their forage (Wheeler, 1982, as quoted in JUNAC, 1990). Their soft, padded feet do not damage the terrain. Camelids are well able to digest grasses that are high in lignin. San Martín and Bryant (1987) note that the South American camelids are more efficient than other species in digesting fair-to-poor quality forage, due to:

- longer retention of forage in their digestive tract;
- higher frequency of stomach contractions and rumination cycles;
- higher ratio between salivation and stomach size;
- ability to maintain a high concentration of NH3 in the first and second compartments of their stomachs.

INTERACTION BETWEEN HUMANS, THEIR ANIMALS AND THE ENVIRONMENT

According to Soto (1995), Oruro was inhabited in the pre-Inca era. Carangas settled in Sajama Province where the most camelids are; the influence of Aymara settlements of Carangas, Soras and Quillacas is reflected in the present-day community. Throughout the Aymara region, the community is the basic organizational pattern. The Inca presence, the *reducciones* (reservations) set up in the sixteenth century, the Republic of 1825, the 1952 agrarian reform programme and the passage of the Popular Participation Act of 1994 are all factors that – in conjunction with the implementation of other measures by the State, government agencies, foreign development-oriented NGOs or religious groups – have played a role in modifying the organizational structure (Soto, 1995).

In Andean culture, nature is highly sensitive, being capable of both positive and negative responses. Life is an integrated, functional, cyclical entity encompassing all beings and all events that they experience and learn about. The Andean culture's concept of the world relates it to the ongoing changes and domestication of nature. Andean herders' world view is holistic; everything is integrated and revolves around Mother Earth, or the *pachamama* (Llanque, 1995).

In exchange for the benefits that grass bestows on them, herders provide an offering of another *manq'a* so that the land can maintain its life force and continue to provide their livelihood. The *manq'a* is an offering to Mother Earth and the divine community in general. "The land does not belong to man. Man belongs to the land. We are part of the land" (Llanque, 1995). "Animals are loaned to men by the gods, who offer them their wool and meat; in

return, man should take care of them, love them; otherwise, they will be taken away or confiscated and will return to their place of origin, the springs of life" (Llanque, 1989, as quoted by Llanque, 1995).

THE ROLE OF ANIMAL GENETIC RESOURCES IN COMMUNAL SOCIETY AND CULTURAL ACTIVITIES

In the Aymara world, llamas are the people's central offering when they worship and in their magical/religious ceremonies (Photos 4 & 12). Farmers and their families have an affective relationship with them that influences how they handle their herds and the households' way of life (Soto, 1995). In addition to the activities mentioned earlier, inhabitants use their stock during festivals, in roofing their houses (*achuqalla*), in designating officials, as offerings to the gods in seeking good weather, and other activities.

The Andean herder's view of activities takes in sociocultural and religious dimensions (Llanque, 1995). Husbandry practices are rational and have been developed over millennia. "This attests to the effectiveness of this knowledge, whose possessors have historically been the heirs of those who domesticated the camelids and who even today control an absolute majority of livestock businesses of this sort" (Gundermann, 1984, as quoted by Llanque, 1995).

STOCK MANAGEMENT AND THE ORGANIZATION OF PRODUCTION ACTIVITIES

Herders have several dwellings. The main one is the ranch, which is surrounded by corrals and may be next to those of relatives, or near a *bofedal* which provides water. They have temporary, seasonal dwellings in outlying pastures near a source of water, used in the transhumant system (Llanque, 1995).

The main livestock activities are: mating, marking, dipping and shearing (Llanque, 1995). Male and female camelids run together from December to March. Two systems are used: in one, the female is constrained; the other is free mating. Males may be owned, borrowed or leased. Females who have been mounted are daubed. This mating system is waning, as fewer and fewer males are available due to the shortage of grazing lands and the decline in herding males to these locations

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PHOTO 1. ***Bofedal*** **grassland**

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PHOTO 2. Tolar grassland

T. Rodriguez

PHOTO 3. ***Pajonal*** **grassland**

K. Templeman

PHOTO 4. Group of llamas during the annual and traditional *marcación* ceremony (Sajama Province)

(Llanque, 1995). In the ongoing, free system, females are kept with one or two sires. The sires' sexual activity is between December and March.

Females give birth in February and March; those at pasture can be moved to the main ranch to calve there. Weaning is natural; young leave their mothers of their own volition at about 8 months. Some may continue to suckle past their first birthday; in extreme cases, a stick is passed through the calves nostrils (Llanque, 1995). Stock are marked in February–March during festivals to give thanks to Mother Nature when young from the preceding brood are counted (Llanque, 1995). Parasites and diseases are treated with both traditional and veterinary techniques. Shearing takes place between October and December and at other times, depending on the household needs (Llanque, 1995). Alpacas and T'amphulli (thick-fleeced) llamas are routinely sheared. Q'aras (short-haired) llamas are sheared only rarely. Part of the animals' hair is left to protect them from the cold.

PASTURAGE ON THE PAMPAS

Stock are usually herded by wives or children. Herders need extensive, quality grazing lands and sufficient human labour to maintain a numerous herd. Income levels are determined by the number of animals, but expansion of a herd hinges on the availability of

pastures and the constraints associated with social conflicts. The rainy season (December–March) is the busiest time of year; all members of the household work and, if necessary, people are hired. (Llanque, 1995).

Female and male llamas and alpacas graze in separate groups. Males of several households are grouped and herded by one person in remote grasslands. If there are many females, plentiful grazing lands and labour available, the herd may be split. Stock go to graze very early in the morning, with the shepherd guiding them to the pastures that have been selected. The length of time that stock spend in each pasture depends on the type of herbage, its condition, the type of animals and the distance from their base. Drier pastures are used during the rainy season (Llanque, 1995).

Between January and June, stock are kept on the main property (Figure 1); dams and young graze together. Grazing is rotational, with stock being moved from one pasture to the next. When gramineous plants become scarcer (July), stock are moved to far pastures until January. Rotational grazing is combined with circular and vertical movements based on the grazing land's condition. Camelids are always put to graze first, followed by sheep, otherwise, the camelids refuse to graze (Llanque, 1995).

GENETIC RESOURCES AND LOCAL FOOD SECURITY

Herders use their stock primarily for food, but sell some to meet their basic needs. Soto (1995), states that llamas and sheep are virtually the sole source of livelihood for peasant households in the area. Producers use fresh meat, jerky, *chalona* (meat dried on the bone), and offal. Jerky and chalona will keep a long time.

Crops account for 5.2 percent of the land, and are slightly more common where irrigation is possible. The main crops are potatoes, barley and, to a lesser extent, quinoa (*Chenopodium quinoa*) as well as vegetables. Potatoes and vegetables are for on-farm consumption. Some producers say that their vegetables last until June and thereafter they have to buy them.

Livestock products are sold on the ranch, at local and regional markets and in the cities of Oruro and La Paz. Most producers sell llamas on the hoof and as meat; some also sell jerky. Young animals (2 years), males over 4 years and older females are usually sold on the hoof. Stock are sold to middlemen, to a company called Inti Raymi and to jerky-makers. Inti Raymi take stock to its feedlot; for slaughter and sale in La Paz. Six microenterprises producing jerky (using solar dryers) usually buy stock on the hoof but sometimes purchase carcasses.

FACTORS BRINGING ABOUT CHANGES IN THE TRADITIONAL SYSTEM FOR GENETIC RESOURCE MANAGEMENT

Factors that may lead to changes in the traditional stock-raising system are migration, natural disasters, jerky-making, preference for white hair or wool and

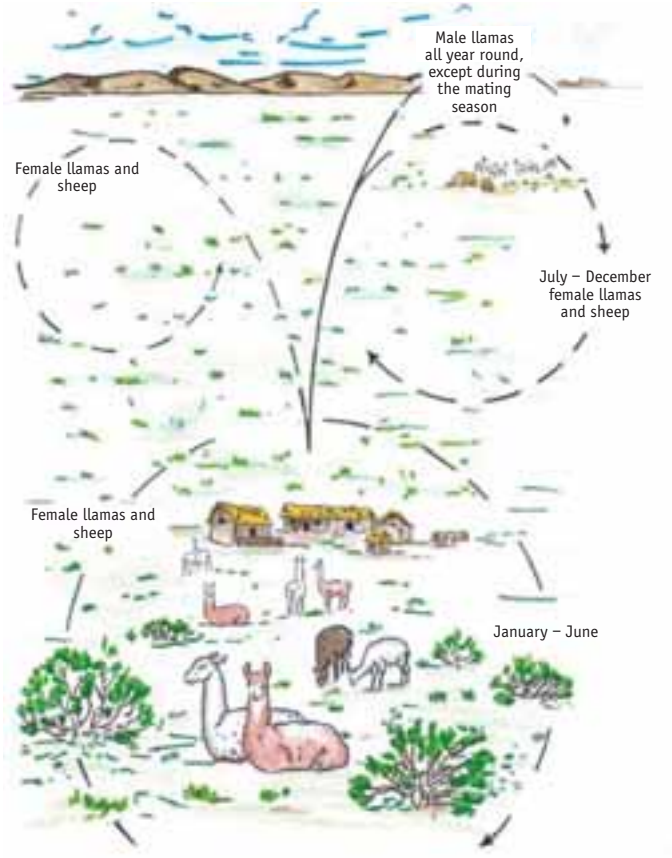

FIGURE 1. Pasturage infrastructure and system in the pampas of the Turco region (adapted from Llanque, 1995)


J.L. Quispe

PHOTO 5. Llama ecotype: Q'ara


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PHOTO 6. Llama ecotype: T'amphulli

some legal statutes. So far these are not prompting major changes. Although there are high rates of permanent (2.6 percent) and temporary (4.2 percent) emigration, the Turco Participatory Municipal Development Plan (1997) indicates that there is always someone in a family who decides to remain in the community and look after the livestock.

The issuance of municipal permits for the sale of fresh meat and the increasing volume of jerky made has not led to indiscriminate culling because herders know that their herds are their livelihood and limit the number of animals that they slaughter. When natural disasters such as droughts and snowstorms occur, producers reduce slaughter rates to offset the losses. Tichit (1994) notes that, during a critical year, a reduction in the number of breeding females, combined with a low birth rate, led to a reduction of up to 18 percent in some herds, but in others the number of breeding females was maintained by reducing slaughtering.

LLAMA ECOTYPES AND ALPACA BREEDS

In Turco, 46.5 percent of llamas are of the Q'ara ecotype, 48.7 percent are intermediate, 4.7 percent are T'amphulli and 0.1 percent are Suri; all alpacas are of the Huacaya breed.

Q'ara llamas are slim, long-bodied, and have short coats with conical, "sausage-curl" locks and visible bristles or guard hairs (Photo 5). T'amphulli llamas are coats with conical, "sausage-curl" locks and visible bristles or guard hairs (Photo 5). T'amphulli llamas are compact, short-bodied (Romero, 1927, as quoted by Cardozo, 1995) and have very thick coats. They have finer hair than the Q'aras and their fleece contains fewer guard hairs (Photo 6).

Huacaya alpacas are handsome, curvilinear animals. They stand taller than the Suris, their fleece is spongy and curly, with the hair perpendicular to the body. They are more resistant to harsh weather and high altitudes (Huanca, 1990) (Photos 7 and 8).

ANIMAL POPULATION AND HERD STRUCTURE

Livestock in Turco includes 93 230 llamas, 28 688 alpacas, 51 041 sheep and 531 cattle (Turco Participatory Municipal Development Plan, 1997). The structure of herds (Table 2) is similar to those elsewhere, such as Saucarí Province (Rodríguez, 1996).

Camelid reproduction behaviour is noteworthy on several counts. Ovulation is induced and occurs 26 hours after mating. Receptive females, when allowing themselves to be mounted, adopt a prone position; fertilized females reject the male's advances. Table 3 summarises the production traits of camelids. Most data are from experimental centres in Bolivia.

OBJECTIVES, CRITERIA AND SELECTION

PROCESSES

Most producers select llamas for meat and alpacas for fleece. Very few are interested in dual-purpose stock. Producers select Q'ara males (meat stock) that are tall and long-bodied and without congenital defects. Some choose animals of any colour; others prefer single-colour ones. They look for long necks and well-formed testicles.

Males are selected in two ways. The first is individual producers selecting sires to keep with the females in the herd. The second is group selection by the Tika Huta Camelid Research and Improvement Centre (IMCATH) which selects males from the herds of its members. These males are the members' contribution to the programme and are raised in Centros de Machaje (where male camelids are kept in isolation from females [Photo 9]). Members are responsible for grazing the animals; the time devoted to this depends on the number of animals contributed by each member.

Selection is based on the criteria described above,

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PHOTOS 7 and 8. Alpaca breeds: Huacaya (left) and Suri (right)

TABLE 2. STRUCTURE OF LLAMA AND ALPACA HERDS IN TURCO

	AGE	LLAMAS		ALPACAS	
		No.	%	No.	%
Crías	Under 1 year	469	18.3	152	25.1
Female yearlings	1 – 2 years	354	13.8	99	16.3
Male yearlings	1 – 2 years	309	12.1	58	9.6
Dams (females)	Over 2 years	1 317	51.5	283	46.7
Sires (males)	Over 2 years	108	4.3	14	2.3
Total		2 557	100.0	606	100.0

TABLE 3. BODY WEIGHT AND CAMELID MEAT AND FIBRE YIELDS

CHARACTERISTIC	LLAMA	ALPACA
Birth rate (%)	61.0	66.0
Birth weight (kg)	9.7	7.5
Pre-weaning weight gain (g/day)	181.0	120.0
Adult weight (kg)	84.1	54.9
Carcass yield (%)	52.1	48.7
Greasy fleece weight (kg)	1.1	1.8
Average fibre diameter (µ)	32.9	20.7
Average diameter of dehaired fibre (µ)	30.9	–

Source: Rodríguez and Cardozo, 1989; Cochi, 1999; and Charcas, 1997.

but care is taken that all males are single-colour. These males are used at stud. In the breeding season, females are tied and each is matched with a specific male. Members take turns using males. The number of males a member receives depends on the number of females in his herd. Each member has the use of the males until they have completed two services (usually 15 days).

After each service, the males are returned to the Centro de Machaje (Photo 10).

Forty-three percent of producers obtain males from other communities. Care is taken to ensure that the location is compatible with the site where they raise their animals. Another 19 percent either: (a) buy breeding males from their neighbours,
(b) choose a sire from their own herd, or (c) borrow or rent sires from the Centros de Machaje. Some producers use sires from the Centro de Machaje as well as their own *jañachos* to boost the herd's birth rate.

Most producers keep their males at stud for over three years; some keep them for two to five years, depending on how aggressive they are. One producer changed his sires every two years.

ANIMAL GENETIC RESOURCE CONSERVATION PROGRAMMES

The Ministry of Agriculture, Livestock and Rural Development is implementing a National Genetic Resource System for Agriculture and the Food Industry which includes a subsystem for camelids to "organize, establish and consolidate the camelid subsystem in

K. Tempelman

PHOTO 9. Q'ara male llamas raised in a Centro de Machaje of Chiluma, Turco region

order to ensure the conservation of its genetic potential and optimize its usefulness". The subsystem's main activities are: (a) introduction of genetic material (following quarantine), (b) on- and off-site conservation, (c) exchange of genetic material, (d) access to genetic resources, (e) inventorying, (f) characterization, (g) utilization, (h) documentation, and (i) development of new breeds.

PRODUCERS' KNOWLEDGE AND CONCERN ABOUT ANIMAL GENETIC RESOURCES

Family livestock management is based on traditional knowledge and information obtained at training courses. In all, 47 percent of survey respondents said that the husband knows most about stock-raising because he has attended courses. Wives spend the most time herding, and are helped by their husbands on occasion and by children on vacation. Wives are more knowledgeable about the animals' condition. When asked whether there was a producer who knew more about stock management than the others, 57 percent replied in the negative, but 43 percent said there was such a person and that he had acquired knowledge from training courses. On health, 82 percent of the producers said that the husband tended sick or injured animals; 12 percent said that the wife did and 6 percent said that veterinary care was entrusted to a trained individual.

ACQUISITION, TRANSMISSION, CENTRALIZATION, COMPILATION AND DISSEMINATION OF TRADITIONAL KNOWLEDGE

Information is transmitted verbally to younger family members when tasks are being performed, giving direct experience. Children help with the herd, ask questions and parents teach them. No formal mechanism exists within the community for centralizing traditional knowledge. Information about traditional livestock practices has been compiled by specialists. One such study was reported by Genin *et al.* (1995).

INTERACTION BETWEEN GOVERNMENT AND COMMUNITY STRUCTURES

IMCATH undertakes research in Turco in coordination with the Technical University of Oruro, provides technical assistance and implements a genetic improvement programme which has set up Centros de Machaje in six Ayllus. To improve the centre's participation, each community has designated a coordinator to work with IMCATH. The Camelid Project, which will soon be concluded, uses a revolving fund to provide support for rural micorentrepreneurs providing shearing services (Photo 11) and for two feedlots.

M. Mezzera

PHOTO 10. Q'ara male llama raised in a Centro de Machaje of Chiluma, Turco region

K. Templeman

PHOTO 11. Huacaya alpacas waiting to be sheared, Turco region

KNOWLEDGE ABOUT POLICIES THAT AFFECT DAY-TO-DAY ACTIVITIES

Producers know the laws and policies that affect their business; they receive information from their political representative in the Prefecture, community organizations and in seminars and workshops. Radio is an important source of information.

PROMOTION OF THE USE OF NON-CAMELID SPECIES AND PERCEIVED THREATS

Producers said that there is a tendency to promote camelids and to avoid sheep, whose grazing habits and hooves damage the pastures. Producers see a threat in the proliferation of foxes and pumas that are protected in Sajama National Park. Park officials inform the population about regulations protecting wild animals

the proliferation of foxes and pumas that are protected in Sajama National Park. Park officials inform the population about regulations protecting wild animals and distribute pamphlets accordingly.

SUPPORT FOR RESEARCH, DEVELOPMENT, EDUCATION AND PRODUCER OUTREACH ACTIVITIES

Very little research, training or outreach work is ongoing in the area. IMCATH does some and executes a genetic improvement programme in coordination with the Technical University of Oruro. The Oruro Development Corporation, through the Farmers Self-Help Project and later through that project's consolidation programme, carried out training and outreach over a number of years; along with ORSTOM of France and the IBTA.

VALUATION OF ANIMAL GENETIC RESOURCES AND

K. Tempelman

PHOTO 12. Ear-marking of llama couple during the annual and traditional *marcación* ceremony (Sajama Province)

KNOWLEDGE OF BEHAVIOURAL AND AESTHETIC SELECTION CRITERIA

Ninety-four percent of producers say that camelids are their most valuable possession and only livelihood. A producer left without stock or with few animals, has to seek work, usually in the city. The only respondent not interested in his animals was a young man who wanted to move to town. Producers are unfamiliar with selection criteria based on behavioural and aesthetic traits but 76 percent prefer docile animals. Others prefer normal animals because very docile ones are too lazy.

Producers associate phenotypic traits with meat production. Most prefer tall, long-bodied, long-necked, good-sized Q'ara llamas of any colour. Some said that white animals are easier to see at a distance. It is important for animals to be broad-chested. For alpacas, they prefer good-sized, single-colour animals (especially white, black and grey) with wool-covered faces and feet.

DEGREE OF PRODUCER SATISFACTION WITH THEIR EXISTING GENETIC RESOURCE MANAGEMENT SYSTEMS

In all, 47 percent of producers were not fully satisfied with the way they manage their herds; 35 percent were not satisfied, and 12 percent were only somewhat satisfied. They would like most of all to improve forage production and pasture management. After that, they would like to monitor stock health better and make genetic improvements. Few mentioned irrigation, or weaning.

ATTACHMENT TO TRADITIONAL KNOWLEDGE,

DISSEMINATION OF INFORMATION, AND WILLINGNESS TO USE MODERN TECHNIQUES

Producers did not insist that traditional knowledge was irreplaceable; it complements modern techniques. Traditional disease-control systems are used when veterinary care is unavailable or too expensive. In some areas, there are better techniques than traditional practice, such as cultivation of grasses, selection of breeding stock, reduction of inbreeding, sanitation and health care. Herders will adopt new techniques which increase their earnings.

FUTURE DEVELOPMENT OF THE SYSTEM AND NECESSARY INPUTS

In Turco, 76 percent of producers hope to see specialization in efficient meat production. Some (18 percent) would be interested in a dual-purpose system (meat and fibre), especially if the price of camelid wool rises. Most felt that the main way to increase their herds' meat yields is to boost forage production and upgrade pasture management. Some felt that genetic improvement was important, as was irrigation and health and sanitation cover. Almost all felt that they needed more training to run an efficient meat production system (Photo 13).

In addition, they wanted training in animal health, forage production, pasture upgrading/management, genetic improvement, marketing and irrigation.

OUTLOOK FOR CAMELID PRODUCTION IN THE TURCO REGION

Neither government agencies nor NGOs are very active

K. Tempelman

PHOTO 13. The production of dried llama meat is an important source of income

OUTLOOK FOR CAMELID PRODUCTION IN THE TURCO REGION

Neither government agencies nor NGOs are very active in the conservation and improvement of animal genetic resources. A programme needs to begin as soon as possible to promote the conservation, management, development and sustainable use of South American camelid genetic resources and to focus primarily on *in situ* conservation, inventorying, characterization and utilization. This programme should be compatible with the maintenance of genetic diversity and with the producers' interests and economic needs.

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Map below:

Location of the central Peruvian Andes

MANAGEMENT OF SHEEP GENETIC RESOURCES IN THE CENTRAL ANDES OF PERU

E.R. Flores, J.A. Cruz and M. López

SUMMARY

The peasant communities of the central Andes have developed a system for exchanging genetic material, counteracting the degradation of their natural resources and using earnings from their livestock to improve their social well-being. They have a range of organizational models, genetic material, habitats and strategies for coping with the prevailing level of uncertainty and with the lack of information services and specialized technical assistance. This system has been evolving and has reached the point where it is an essential referent and framework for the analysis and design of sheep improvement policies.

The study is based on a project to improve livestock and natural resources implemented by the peasant community of Pasco region, since 1995, sponsored by the Foundation for Agrarian Development of the La Molina National Agrarian University; on the research findings of the Small Ruminant Collaborative Research Support Programme executed by the University of California in the 1980s; and on interviews, annual and technical reports prepared by the Boards of the peasant communities.

Mixed livestock systems involving sheep, camelids and cattle are common in the central Peruvian Andes, sheep are the most important livestock economically. The central Andes include 5.2 million hectares of pasture and 4.6 million sheep. Communities manage over 80 percent of the small ruminants and pasturelands (INEI, 1996). Low temperatures, frost and drought, make crop growing risky, and livestock is the area's main economic activity.

Peasant communities have devised systems for managing their herds' genetic resources and implement them with very little State support. Traditional organizations are a mixture of organizational and management systems, multicommunal and communal enterprises, communal cooperatives and farms, livestock departments, livestock committees, and family and individual farms. This complex mixture has been analysed to determine how these organizations use the genetic resources at their disposal and to put their role in upgrading livestock production into perspective.

THE ECOSYSTEM

This is a high mountain ecosystem (3 000 – 5 000 metres) of very humid, tropical, sub-alpine plains and rainy tundra-tropical alpine zones. The main plant communities are *pajonales* (stands of low-quality grasses), puna turf and *bofedales* (a type of wetlands) (Flores, 1991). *Pajonales* are made up of relatively tall species of *Festuca*, *Calamagrostis* and *Stipa*; puna turf is formed by low-growing species of *Agrostis*, *Dissanthelium* and *Werneria*. *Bofedales*, are composed of vegetation characteristic of soil that is waterlogged for much of the year; the dominant plants are *Distichia,*

E. Flores

PHOTO 1. Typical central Andes landscape composed of a combination of various types of *pajonal*, puna turf and *bofedal* vegetation.

Hipochaeris and *Plantago* (Photo 1).

In sub-alpine plains, the mean annual maximum temperature is 6 ºC and the mean annual low is 3.8 ºC. Annual precipitation ranges from 1 255 mm to 584 mm. Potential evapotranspiration ranges from one-fourth to one-half of mean annual precipitation. In the rainy tundra-tropical alpine zones, the mean annual temperature is 3.2 ºC, and total precipitation ranges from 1 020 mm to 688 mm per year. Evapotranspiration is between one-eighth and one-fourth of annual precipitation (Holdridge, 1982).

Acidic, sandy soils that are high in organic matter and low in phosphorus predominate. Most soils are Regosols, Andosols, Cambisols, Calcisols, Vertisols and Kastanozems. Steep slopes, the climate and intensive grazing heighten the risk of erosion and desertification; less than 3 percent of the land is suitable for crops (INRENA, 1996).

HISTORY OF INTERACTION BETWEEN PEOPLE, ANIMALS AND THE ENVIRONMENT

Most sheep belong to peasant communities, organizations created by the Spaniards to facilitate tax collection and speed the flow of manpower to the government. Initially, communities kept camelids which were gradually replaced by cattle and sheep (Recharte *et al.*, 2002); this triggered a reduction in native species, a loss of biodiversity and a decline in the flexibility needed to respond to the constraints of high mountain ecosystems.

Originally, communities were patterned on the ancient Andean Ayllu (Delran, 1981). After 1570 the Ayllu became a *reducción*. Between independence in 1821 and about 1920, these became "indigenous communities" (Pardo-Figueroa, 1995), which were often stripped of their land by large landholders and local chieftains, and the courts handed down rulings that obliged them to fall back on their own resources to defend their rights. Communities pooled their productive land to marshal the funds needed to stand up for themselves. Resources that could have been invested in livestock were diverted, limiting many communal livestock operations' ability to apply improved management.

The Constitution of 1920 laid the groundwork for recognition and registration of the land titles of indigenous communities (Pardo-Figueroa, 1995). The name was changed to "peasant community" as part of the 1969 agrarian reform. The 1979 Constitution established the term "communal and multicommunal enterprise" and promoted the formation of economic

units within them (Pardo-Figueroa, 1995). The 1987 Peasant Communities Act empowers communities to conduct business activities as Communal and Multicommunal Enterprises (Aliaga, 1995).

The communal assemblies of peasant communities have authorized the use of organizational arrangements, including multicommunal and communal enterprises, to increase their livestock production systems' sustainability (Table 1). Communities provide land and commune members provide animals and labour. Individual farmers have maintained their operations or formed groups to set up family farms and livestock committees to manage their resources more efficiently. A community may use two or more models within its territory.

The highest production indices are in community enterprises and the lowest among commune members who work community lands on an individual basis (Bryant *et al.*, 1989). This is attributable to factors summarized in Table 2.

TABLE 1. PRINCIPAL CHARACTERISTICS OF COMMUNAL PRODUCTION SYSTEMS IN THE CENTRAL ANDES

TYPE	ENTERPRISES		INDIVIDUAL FARMERS
	Multicommunal	Communal	
Legally-constituted corporate entities	Pachacutec and Túpac Amaru SAIS (social farming associations)	Communal enterprises, Communal cooperatives, Communal farms, Livestock department	Commune member, Family farm, Livestock committees
Landowner	Several communities	A community	A community
Area (in hectares)	100 000 – 200 000	500 – 14 000	50 – 400
Members	Communities	Commune member	Commune member
Number of households	20 000 – 25 000	200 – 3 000	1 – 30
Number of sheep	40 000 – 60 000	350 – 5 000	60 – 200
Breeds	Corriedale, Junín and Merino	Corriedale, Corriedale x Criollo	Criollo and crosses
Main destination for products	Market and social investment	Social investment	Own consumption and market

TABLE 2. PRODUCTION INDICES AND STATUS OF GRAZING LANDS IN THE CENTRAL PERUVIAN ANDEAN SHEEP PRODUCTION SYSTEMS

UNIT	MULTICOMMUNAL/COMMUNAL COOPERATIVES	COMMUNAL FARMS/FAMILY FARMS	INDIVIDUAL FARMERS
Recommended stocking rate (sheep/ha/year)	1.0	0.5	0.2
Current stocking rate (sheep/ha/year)	1.5	3.0	5.0
Live weight (kg)	38.0	35.0	30.0
Fleece weight (kg)	2.5	1.8	0.9
Carcass weight (kg)	16.0	14.0	10.0
Carcass yield (%)	42.0	40.0	33.0
Lambing rate (%)	88.0	75.0	60.0
Weaning rate (%)	78.0	62.0	40.0
Condition of grazing lands	Fair	Poor	Very poor

E. Flores

PHOTO 2. Contrast between a pasture in good condition (right) maintained by a communal enterprise and a pasture in poor condition (left) being used by individual farmers

THE ROLE OF GENETIC RESOURCES IN THE ECONOMY AND IN ENSURING FOOD SECURITY

Rural communities use livestock for consumption and as a medium of exchange; they also use livestock or wool as loan collateral and in-kind loan repayments, and to a lesser extent, in cultural, recreational and tourism activities. In multicommunal and communal enterprises, sales decisions are based on technical criteria and market demand. With individual farmers, consumption and sales tend to occur on culturally significant dates, when cash is needed, or when an animal is ill or killed in an accident.

Most livestock are sold to traders. Barter is common between farmers. Cash-based, intermediated commercial transactions are more common in organized production systems. More developed systems, such as communal enterprises, command the best prices; their wool may sell for as much as 66 percent more than that of individuals.

Livestock products can be major sources of protein, calories and micronutrients, but their use is restricted by low income levels, mothers' misconceptions regarding nutritional value, and the frequent need to sell livestock to get money (Flores, 2002). Animal products provide 14 percent of the energy requirements of children under five, but meat accounts for only 1 percent because mothers associate it with parasitic diseases (Villasante *et al.*, 1997). Chronic malnutrition and iron deficiencies in children under five and in women during their childbearing years are very frequent (55 percent) in livestock-producing areas of the Andean highlands (CIED, 1996).

Communal and multicommunal enterprises produce more, use more efficient techniques, and assign more of their food output to social programmes than the rest of the production system. Individual farmers use 23 percent of excess stock for home consumption and the rest for sale; communal enterprises consume 6 percent of their excess, 42 percent is for fellow members, and 52 percent for sale (Villasante *et al.*, 1997).

Degradation of grazing lands is more common on individually-held farms (Lozada, 1991); communal enterprises have been more successful than individuals in managing their grasslands, although both use community land (Photo 2). This highlights the need to design mechanisms for promoting communal organizations to help enhance the contribution that they make to the region's social development.

LOCAL BREEDS

Over 20 breeds have been introduced to Peru without any genetic plan; very little is known about their performance or ultimate use. There is much more information about the Criollo and its crossbreeds, Corriedale and Junín (Photo 3), that have been used in Peru on an ongoing basis and exhibit persistence and adaptation to the environment (INIA, 2003).

Criollo sheep are descended from stock introduced in the sixteenth and seventeenth centuries. The original breeds were Merino and the coarser-wool Churra and Lacha from northern Spain (Calle, 1968). The Criollo is known for hardiness, a lower degree of breeding seasonality and as a good grazer. Fleeces weigh 1.5 kg on average, and live-weights vary between 20 kg and 30 kg for adult ewes and 23.0 kg and 40.5 kg for males (Cabrera *et al.*, 1990). This breed, which accounts for 60 percent of the country's sheep, is kept mainly by individual peasant farmers (Photo 4).

Corriedale was created through absorptive crossbreeding of Criollo sheep with Corriedales (Calle,


K. Tempelman

PHOTO 3. Junín sheep raised at the multicommunal Túpac Amaru SAIS in the Junín region


E. Flores

PHOTO 4. This picture of a flock of Criollo sheep grazing on degraded rangelands illustrates the high degree of variability exhibited by the breed.

1999). It is a well-muscled, dual-purpose animal. Calle (1999) reports ram weights of 45 kg to 58 kg, with fleeces averaging 4 kg, and, for ewes, 40 kg to 42 kg, with fleeces between 2.8 kg and 3.5 kg. The fleece is of good quality. This breed makes up 13 percent of the country's sheep and is chiefly kept by multicommunal and communal enterprises and some private breeders. Because of its strength, hardiness and successful adaptation to the high Andean environment, it is of key importance in improvement programmes.

Junín sheep were developed in central Peru out of Criollo crossed with various breeds including the Corriedale, Romney Marsh, Columbia, Panama and Warhill (Villarroel and Gamarra, 1978). They have long, sturdy legs, are bare-faced, have varying degrees of pigmentation in their nostrils and hooves, and produce a high yield of clean wool measuring from 23 to 25 microns in diameter and of 12 cm in length for rams and of 9 cm in the case of lambs. Adult rams weigh, on average, 74 kg and ewes 45 kg. The main nucleus of this breed is held by the multicommunal Túpac Amaru SAIS in the Junín region (Photo 5); it represents 2 percent of the country's sheep herd.

HERD FORMATION AND SELECTION CRITERIA AND PROCESSES

The basis on which herds are formed and the selection


E. Flores

PHOTO 5. Flock of Junín sheep in ryegrass and clover pastures cultivated by the Túpac Amaru SAIS

K. Templeman

PHOTO 6. Criollo sheep being herded in the central Peruvian Andes

criteria and methods used are closely related to the community organizational model, community directors' management capacity and the level of technical assistance from the State, universities, non-governmental organizations and other institutions (Flores, 1996).

Number and structure of herds: multicommunal and communal enterprises are able to maintain genetic pyramids and breeder flocks to supply their needs and to sell or lend to other community members and organizations. Some have participatory breed improvement programmes based on open-nucleus schemes in partnership with universities and other communities (Mueller *et al.*, 2002). The number of replacement lambs varies between 20 and 25 percent, and the number of rams is around 10 percent.

The State sometimes makes large purchases from them to assist less organized communities. They receive genetic material of exotic breeds via State-sponsored imports or may import stock on their own initiative. The biggest import for communal enterprises, of more than 100 000 Corriedales from Australia, was by the State in the 1970s. Once the State began to deal with communities on an equal footing with the private sector in the 1990s, some communal enterprises started to import small lots of Corriedales from the Magellan region of Chile and New Zealand.

Individual farmers obtain breeding stock from cooperatives and communal farms; farmers do not keep replacement rams, but buy or borrow them from communal enterprises within the same community. The percentages of replacement female yearlings (20 percent) and rams (8.5 percent) do not differ substantially from those in communal enterprises.

SELECTION AND BREEDING CRITERIA

Multicommunal and communal enterprises use technical phenotypic selection criteria, relying on visual assessments of live weight, the animals' conformation

and fleece quality, with Corriedale and Junín serving as the standard of comparison (Blackwell, 1985). Mating is seasonal and controlled; artificial insemination with fresh semen may be used. Monitoring and registry systems are not well developed and, where they exist, are applied only to breeder flocks.

These organizations use rating systems to classify sheep for management and selection based on the formation of herds using categories and stock classifications with separate categories for ewes, rams, female yearlings, male yearlings, castrated rams and lambs. Stock are usually grouped into five categories: Super (S), A, B, C and "rejected" (R). Classification is done and adjusted before shearing. Males in categories S and A are used for breeding, while those in categories B are sold to family farms and small-scale producers. Ewes in the R category may be used occasionally in industrial programmes, where they are crossed with Hampshire Down.

With individual farms mating is ongoing and unmonitored. Males of different breeds mate indiscriminately with Criollo and crossbred ewes. Selection criteria are based on visual assessments of size, age, type of wool and lambing performance. These producers may buy, lease or borrow sires from communal and multicommunal enterprises. Improved stock are then mated with unrelated animals to "freshen up" the bloodlines. The result is disorderly crossbreeding which makes it difficult to quantify the effects of differing degrees of crossing or to make further improvements.

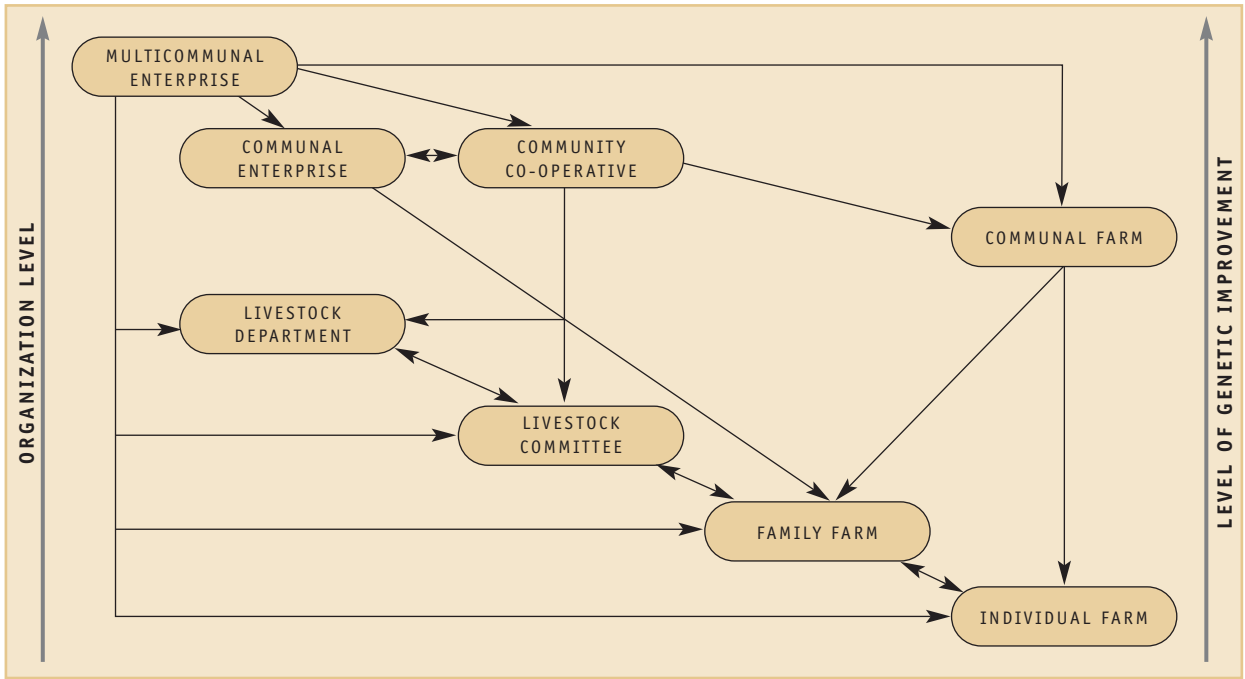
EVALUATION OF TRADITIONAL MANAGEMENT SYSTEMS

Peasant communities use several models to manage their resources more efficiently and increase their production systems' stability. Using such models, they exchange genetic resources, experiences and technology in an effort to raise their production indices (Figure 1).

MULTICOMMUNAL ENTERPRISES, COMMUNAL ENTERPRISES AND COMMUNITY COOPERATIVES

These help to improve the herds' genetic resources by maintaining sound breeder stocks of Corriedale, Junín and Merino. Farmers are very keen to adopt new,

FIGURE 1. GENERAL SCHEME OF GENETIC RESOURCE EXCHANGE IN SHEEP PRODUCTION SYSTEMS IN THE CENTRAL ANDES OF PERU



K. Templeman

PHOTO 7. Individual farms often keep livestock species other than sheep, such as alpacas, to averse risk

affordable technologies and do not care whether these are generated on a participatory basis or come from experimental stations (Mueller *et al.*, 1999). The State usually chooses them as sources for the purchase and supply of breeding stock to less developed peasant organizations. Support is frequently provided to communal farms, livestock departments, family farms and individual farmers in the form of breeding stock, training and technical assistance. When their activities produce sufficient profits these units may set up social programmes to help households buy school supplies and assist the elderly. Since they usually keep their pastures in good condition, their lands can be sources of native-plant germplasm for use in the replanting of degraded areas.

COMMUNAL FARMS, LIVESTOCK DEPARTMENTS AND LIVESTOCK COMMITTEES

Communal organizational models are using absorptive crossing of Criollo with Corriedales; they are socially-oriented and devote profits to educational and health-care infrastructure. They are highly risk-averse and but open to new technologies which are affordable, profitable and have been generated on a participatory basis. Their pastures are in fair-to-poor condition, depending on the level of management.

FAMILY AND INDIVIDUAL FARMS

Family and individual farms hold the Criollo in high esteem and maintain an ample pool, contributing to breed conservation. They are more risk-averse than other components and keep mixed herds of camelids (Photo 7), cattle and smaller animals, such as guinea pig, rabbits and poultry. The coloured Criollo fleeces are prized for making clothes, costumes and craftwork. Their pastures are generally in very poor condition, due to high stocking rates.

PRODUCERS' ROLE AND STATE INVOLVEMENT

Stock-raising communities play a central role in conserving the Criollo breed, preserving local breeds, establishing breeder herds, providing breeder stock and furnishing social assistance to their members. They work with the Sate to resolve poverty-related problems.

They play a key role in developing genetic improvement programmes, and supplying the State with stock for development programmes. Community initiatives are subject to constraints: they do not receive subsidies, tax exemptions, or any sort of tax credit for what they spend on infrastructure and social development programmes. Experimental stations focus on export crops rather than subsistence livestock.

The State should review its livestock policies for the Andean highlands and build up the institutional capacity of producer organizations and peasant communities to conduct genetic resource conservation and improvement. Technology development and transfer should be upgraded through participatory research (Photo 8). Training needs improvement in community-defined priority areas such as health care, pasture management, livestock management aimed at conservation, and genetic upgrading.

Farmers who manage their resources efficiently, even within communal land use, could be trained as promoters and serve as examples for others. They would be ideal candidates to provide animals to form cooperative nucleus herds and improvement programmes, working with technically sophisticated livestock committees and family farms (Photo 9). Breeding and animal husbandry centres to improve Criollo stock could be set up and associations for breeders of Criollo and other local sheep breeds formed to increase the efficiency of genetic resource management. In this new framework, universities, non-governmental organizations and international agencies can play a crucial role in ensuring success.

OUTLOOK

This system for exchanging genetic material, counteracting the degradation of their natural resources and using earnings from their livestock to improve their social well-being is characteristic of the central Andean highlands. It could serve as a model to improve traditional management and organizational systems in other areas; notably because it includes traditional elements and the necessary entrepreneurial components. The State should resume the role it played previously and begin to design policies to build up peasant communities' institutional capacity for improved management of the animal genetic resources and natural pastures that serve as the mainstay for their livestock activities.

K. Tempelman

PHOTO 8. Farmers' participation in the generation of technology is a crucial factor in facilitating its rapid adoption

E. Flores

PHOTO 9. Gathering of farming communities in Pasco region, exchanging experiences to improve traditional management techniques

K. Tempelman

PHOTO 10. Typical landscape in the Central Peruvian Andes

K. Tempelman

PHOTO 11. Criollo sheep owned by an individual farmer in the municipality of Vicco (central Peruvian Andes)

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7 Schwäbisch Hällisches Landschwein, **GERMANY**

8 Management, use and conservation of local zebu cattle genetic resources in traditional livestock farming systems in **TAJIKISTAN**

CHAPTER 3
LIVESTOCK REARING IN **TEMPERATE CONDITIONS**

Livestock rearing systems in southwest Germany are conditioned by a continental climate. The Schwäbisch Hällisches Landschwein pig breed is native to China. It was introduced in the Hohenlohe region in Germany in the early nineteenth century and adapted rapidly to local conditions. The breed was the most important source of income for the region's farmers in the 1950s, but nearly disappeared in the 1960s when commercial pig breeds dominated the local markets. Convinced of this pig breed's added value, farmers in the region organized themselves to save the breed. The present case study is a success story showing how a group of motivated farmers managed to revitalize the breed through a structured and communal approach.

Local zebus are the most suitable cattle in Tajikistan's mountains and are vital to the daily lives of households in more remote areas. Recently uncontrolled introduction of exotic breeds and indiscriminate cross-breeding has been the trend. The crossbreeds are less resistant to local diseases, have lower fertility rates and the quality of their products does not match that of zebus. Local zebu breed diversity is diminishing and the breed is risking extinction. The question is how to save this breed from being lost and how to safeguard those whose future depends on it.

Map below:

Location of the Hohenlohe region in Germany

SCHWÄBISCH HÄLLISCHES LANDSCHWEIN, GERMANY

R. Bühler and B. Hamilton

SUMMARY

Schwäbisch Hällisches Landschwein fell out of favour and almost became extinct. Interested farmers formed a breeders association which has succeeded in reinstating the breed and finding specialist markets for its products.

The case of the Schwäbisch Hällisches Landschwein (SHL) breed in the Hohenlohe region of Germany is an example of the successful revitalization of an almost extinct breed by the perseverance of regional farmers implementing a well-structured plan.

This breed comprised 99 percent of the Hohenlohe regional market until 1959, but later became a "breed at risk" when a combination of government policy and economic trends favoured industrial production methods, replacing the local breed with lean pigs from the Netherlands, thereby leaving small-scale farmers without support and without livelihood. The move to industrialized production had multilevel implications. Meat quality was compromised; animal welfare was ignored; small farms could no longer compete on the market and stopped raising the local pigs; and, as a result, traditional knowledge and the preservation of agrobiodiversity were endangered.

However, some local pigs were still kept on smaller farms and, in 1984, a group of farmers in the Hohenlohe region who still valued local animal genetic resources and the traditional qualities of the SHL breed met and established a community of interest. Thus the movement for the revitalization of this breed was born.

R. Bauer

PHOTO 1. Schwäbisch Hällisches Landschwein in their habitat

Subsequent action entailed precise characterization of the original genotype and extensive gathering of information. These factors were then applied in selecting pigs from the remaining gene pool that were suitable for the establishment of an official breeding line and registration and coding. The Schwäbisch Hällisches Landschwein Breeders Association was


R. Bauer


R. Bauer

PHOTO 2 and 3. Butcheries selling pork products from the SHL breed in the Hohenlohe region

subsequently founded, uniting the small-scale farmers of the region in the cause. The association promoted the SHL breed in particular and initiated activities to raise public awareness of the importance of conservation of local animal genetic resources. New markets for pork products from the SHL breed were created and guidelines controlling quality were implemented. The revitalization of the breed united the local small farmers, provided them with sustainable livelihoods and encouraged preservation of local traditions.

The association gained the support of local farmers who participated actively in lobbying and grew into an organization of more than 500 members. A financially and politically independent farm bureau was established and eventually, in 1998, European Union legislation for the protection of the breed was passed.

The success of the revitalization of the SHL breed shows that by raising public awareness, pushing for legislation, and organization at the grassroots level, local farmers have the power to revitalize a breed at risk, promote conservation of local animal genetic resources and regain their traditional livelihoods by influencing economic trends and making subsequent relevant changes.

R. Bauer

PHOTO 4. Panoramic view of the Hohenlohe region, home to the SHL

R. Bauer

PHOTO 5. Back to traditional SHL farming

Map below:

Local zebu cattle habitat

MANAGEMENT, USE AND CONSERVATION OF LOCAL ZEBU CATTLE GENETIC RESOURCES IN TRADITIONAL LIVESTOCK FARMING SYSTEMS IN TAJIKISTAN

Dadajon Ergashev, Arunas Svitojus and Lina Baltrenaite

SUMMARY

Tajik zebus, which are small, hardy and resistant to theileriosis, are the only cattle capable of surviving in the country's rocky mountains and are the main food resource of communities there. They mainly graze, often in transhumant systems. After decollectivization, farming systems collapsed and livestock breeding systems were no longer functional. In a short period the number of cattle in the country fell by half. Recently crossing with exotic breeds has reduced the number of pure zebu. Management strategies based on sound breeding programmes with farmer participation are needed. One possibility is to establish an open nucleus which would allow controlled selection and preserve genetic variability.

The dual-purpose zebu is distinguished from other cattle in Tajikistan by its adaptation to the country's climate, the high fat content of its milk, excellent meat and its resistance to tick-borne theileriosis. The breed is small, has a low feed conversion ratio and its meat and milk production are low, but it is prolific with low infertility rates and synchronized calving seasons. They are the only cattle capable of surviving in the country's rocky mountains and are the main food resource of communities there, especially in the more remote areas. All products from zebu production, such as milk, meat, hides and manure are used for home consumption. The zebu also provides draught power.

HISTORY OF LIVESTOCK REARING IN TAJIKISTAN

After the domestication of cattle in Asia the main selection criterion was their ability to produce food under local conditions. In valleys, farmers raise dairy cattle, keep chickens and rabbits or rear silkworms. Beef cattle, sheep, goats, yaks and chickens are more common in submontane and mountainous areas.

Beef accounts for half the meat produced in the country, mutton and goat 20 percent, chicken 15 percent, pork 10 percent and others the remaining 5 percent. Under the communist regime, collective farms provided meat and milk to processing industries at prices set by the state. Following independence in September 1991, the private sector set the market prices. Largely unprepared for the political transition; during a civil war which erupted in May 1992 and lasted five years, the country plunged into a deep economic and political crisis. Farming systems collapsed and livestock breeding systems were no longer functional, resulting in low productivity. In this short period, the number of cattle in the country fell by half.

Tajikistan, in southwest Central Asia, covers about 143 000 km^2. Its surface is dominated by rocky mountains, mostly of volcanic origin. It has five

geological regions: the Sugd in northern Tajikistan; the Fergana depression; Gissaro-Alay in central Tajikistan; the Tajik depression; and Pamir. Tajikistan has about 6.5 million inhabitants. Population density is rising because of a rapidly rising birth rate. More than 9 million ha are suitable for agriculture but only 8 percent of this is irrigated. More than half of the land is state owned, with 4.5 million ha allocated to natural reserves and 500 000 ha to forests. Slightly less than 200 000 ha are owned by the private sector and approximately 40 000 ha belong to the population.

PASTURE RESOURCES

The Pamir, notorious for its extremely harsh climate, occupies about 45 percent of the country. Pastures make up the main part of the useable land. Their productivity is low and their natural recovery rate cannot keep up with intense utilization. Changing migration routes and inappropriate grazing management, especially of local zebu cattle, are leading to overexploitation and causing rapid land degradation. Local zebu cattle are decreasing in number, but their current density still exceeds the pastures' capacity to recover naturally.

Because of widespread pesticide use between 1960 and 1990, soils were severely contaminated. On several farms abnormal pesticides levels are still found in local meat.

BREED CHARACTERISTICS

The local zebu resulted from natural crossing between pure zebus and Central Asian cattle during the human migrations in Central Asia. Zebu cattle are found in southern Kyrgyzstan, Turkmenistan and Uzbekistan; those in Tajikistan are smaller. Local zebus are characterized by a hump on their backs, pendant ears, large wrinkles under the dewlap, a long narrow skull and a short, swollen forehead. The breed is genetically adapted to hot, dry climates and is resistant to theileriosis. Their coat is usually brown or black. Females weigh 200 kg and males about 315 kg. Milk yields vary between 400 and 800 litres per year with a fat content up to 6 percent. No research is being carried out on the breed. Zebu cattle are spread throughout the regions of Sogd, Khatlon, Gbao, the Hissar valley and Rasht.

RURAL COMMUNITIES AND ZEBU CATTLE

Local zebu cattle are a main food and income resource for rural households in mountainous areas.

Women make cheese and use whey for shampoo. Dung is used for heating and cooking; in spring it is used as manure. Draught zebus allow farmers to cultivate their land. Hides are mainly used for making lampshades. Zebus are farmers' savings; they are sold for cash and serve as dowry or as gifts during ceremonial events. Zebu cattle are easy to keep and do not require herding; they usually wander to pastures by themselves and return home on their own.

BIODIVERSITY LOSS AND CONSERVATION OF LOCAL ZEBU CATTLE

Tajikistan has indigenous asses, cattle, goats, horses, sheep and yaks. In recent years there has been a wide circulation of exotic cattle such as Holstein-Friesians and Brown Swiss which has led to cross-breeding and a reduction in the number of pure-bred local cattle. Genetic material is being lost at an alarming rate.

D. Ergashev

PHOTO 1. Zebu cattle are used for work in the field

D. Ergashev

PHOTO 2. Local zebu cattle

Susceptibility to diseases is increasing and fertility rates and product quality are falling. Considering the unique characteristics of zebu cattle and their contribution to local food security, their conservation should be prioritized.

Farmers need to organize to establish management strategies based on sound breeding programmes. One possibility is to establish an open nucleus which would allow controlled selection and preserve genetic variability. In the long term, a gene bank of semen, oocytes and DNA samples is needed. However, the success of biotechnology depends upon the availability of adequate human resources and funding, neither of which is currently available.

In-depth research is needed to improve the knowledge of the local zebu cattle's genome and might clarify how genes are inherited and identify those that ensure environmental resilience.

RECOMMENDATIONS

D. Ergashev

PHOTO 3. Zebu cattle migrating to mountain pastures

Tajikistan needs an updated database to describe the status and characteristics of its zebu cattle. Lack of overall coordination is obstructing activities to support their further development, use and conservation.

Policy-makers could provide support to zebu raisers at various levels.

> Promote zebu cattle and products, among the general public.
> At national and regional levels, networks among the various stakeholders involved in raising livestock, and specifically local zebu cattle, should be established to:
  - facilitate the development of conservation strategies based on cooperation;
  - discuss conservation options including the establishing of an open nucleus;
  - establish sustainable monitoring systems to record the status of livestock populations.
> Invest in capacity building and training, in breeding strategies.
> Enhance coordination among the various organizations in Central Asia that currently develop and implement subregional projects and programmes related to animal genetic resources.

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9 Indigenous chickens: an important part of rural livelihoods in the **LAO PEOPLE'S DEMOCRATIC REPUBLIC**

10 Tamberma's Somba cattle breed at risk of extinction in **TOGO**

11 Co duck genetic resources: the pillar of traditional mixed farming systems in **VIETNAM**

CHAPTER 4
SPECIFIC FEATURES OF RAISING LIVESTOCK IN **HUMID TROPICAL AREAS**

Tropical humid ecosystems are typified by a pronounced dry season that can last up to six months, combined with a single rainy season. Annual rainfall varies between 800 and 2000 mm. The natural vegetation is mostly monsoon forest.

Case studies from Laos and Viet Nam demonstrate the efficiency of traditionally integrated and closed production systems, focusing on the integration of rice cultivation with poultry and aquaculture. The study in Togo depicts a slightly more complex system, integrating ruminants (large and small) with chickens and crops such as sorghum and groundnuts.

The by-products of rice contribute largely to improving the quality of the feed for local chickens and ducks in Southeast Asia. In northern Togo, however, it is not customary to use crop by-products. An important common feature of the livestock described in these case studies is their resistance to disease.

Map below:

Study areas of indigenous chicken farming, Laos

INDIGENOUS CHICKENS: AN IMPORTANT PART OF RURAL LIVELIHOODS IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

Bounthong Bouahom, Soukanh Keonouchanh and Somchan Khamphavong

SUMMARY

Local chickens are kept for subsistence, sport and income. Flocks are small and raised on scavenging; productivity is low. Chick mortality is particularly high, because of diseases and poor feeding. Most are indigenous breeds, but these are threatened by expansion of industrial commercial hybrids. Conservation of local genetic resources should be supported and communities assisted to find sustainable ways to improve chicken performance including better health, feeding and husbandry. Areas for improvement include chick rearing protein supplementation and egg production.

ECOSYSTEM CHARACTERIZATION

This case study looks at how rural communities manage chickens in two ecologically distinct zones: the lowland, tropical, moist, deciduous forests of Savannakhet and Champassack and the highland tropical, dry forests of Luang Prabang province.

INDIGENOUS CHICKENS IN THE LOWLANDS

Climate and biophysical characteristics. Savannakhet has a moist tropical climate with annual rainfall between 1 500 and 2 000 mm. The floodplain and levees have recent, shallow, acidic, alluvial deposits with low organic matter and low fertility. Young alluvial soils on the floodplain are more fertile than older terraces, but are subject to flooding. Altitude ranges from 100 to 200 metres and slopes are less than 8 percent. Land is primarily used for rainfed rice, irrigated rice, vegetables and livestock.

Lowland farming systems. In the Mekong corridor, farmers grow rice in the rainy season; irrigation, allows a second crop; 90 000 ha (or 15 percent) of the rice is irrigated. Livestock and crops are complementary:

B. Bouahom

PHOTO 1. Indigenous chickens in their natural habitat

farmers keep buffaloes, cattle, pigs and poultry for draught, meat, income, sport and savings. Indigenous chickens are important in the livelihoods of the rural poor. Birds and eggs are for home consumption, but sold when cash is needed. During the day chickens scavenge for earthworms, insects, termites, kitchen

wastes and agricultural and industrial residues. At night they are fed rice bran or broken rice.

INDIGENOUS CHICKENS IN THE HIGHLANDS

The mountainous northern region, above 800 metres, has a moist to dry subtropical climate with an annual rainfall between 1 500 and 2 000 mm. It has a cooler dry season and greater annual temperature variations than the rest of the country. Slopes range from 30 to 60 percent. Crop production is for subsistence. Incomes are low with poverty and food insecurity. Rural credit is rarely available. Households are vulnerable to natural disasters, crop failures and ill health. Rural infrastructure and access to goods and services are poor. Livestock feed conversion and production are low, because animals are raised under poor conditions. Rugged terrain and poor soils leaves little scope for intensive agriculture and limits animal production based on large- and medium-sized species.

Highland farming systems. Highland farmers use slash-and-burn. Traditionally, several years of cultivation were followed by long fallows, but increasing population pressure has shortened fallow cycles, leading to land degradation. As in the lowlands, indigenous chickens scavenge, but the variety of feeds is wider and includes earthworms, termites, kitchen wastes, agricultural residues, feed from the forest such as insects, other arthropods, soil vegetation and fungi. Farmers may use rice bran and broken rice as a supplement for their chickens.

LOCAL CHICKEN BREEDS

In both areas five types of indigenous chickens were identified.

Kai Ou is the largest indigenous chicken; cocks weigh about 2.7 kg and hens 1.6 kg; they are mainly raised in the Hmong villages of Luang Prabang province. Body feathers are predominantly black, but red feathers can be found around the neck and wings. Kai Ou has the lowest egg production of indigenous breeds with only 55 eggs per year. The hens' hatching capacity is relatively low (67 percent).

Black bone chickens, originally from China, are raised in Luang Prabang and Oudomxay. They are believed to have qualities that can extend life expectancy and can be sold at a high price. Its numbers are below 1 000 head so it at risk of extinction. Two distinct types are recorded. The less common is small with an entirely black skin covered with white feathers and its meat is also black. The second is larger with dark brown to black plumage. The weight of a mature cock is 2 to 2.3 kg, while hens weigh 1.5 kg. Average annual egg production is 76 eggs per hen per year with a hatching capacity of 80 percent.

Kai Horn Chou chickens are widely distributed and are phenotypically very similar to Kai Chae, but distinguished by a greater body size and a pea comb. Cocks weigh 1.3 to 1.7 kg, hens between 1.2 and 1.5 kg. Hens produce 70 eggs per year on average and have a hatching capacity of about 75 percent.

B. Bouahom

PHOTO 2. Kai Ou Rooster

B. Bouahom

PHOTO 3. Kai Ou Hen

Kai Yolk. Fighting cocks come from this breed. Farmers in Champassack and Savannakhet prefer Kai Yolk chickens; Yolk meaning tall in Lao. The Kai Yolk is relatively large, well adapted to the lowland ecosystem and has good feed conversion. Mature cocks weigh 1.5 to 1.8 kg and hens between 1.3 and 1.5 kg. Hens only produce 56 eggs per year, with a hatching capacity of about 70 percent.

Kai Chae chickens are widely distributed; they are small and known for the colour patterns of their feathers. Two types can be distinguished – one with white and the other with red wattles. Mature cocks weigh under 1 kg and mature hens between 0.8 and 0.9 kg. These chickens are well adapted to the environment and easy to raise. Hens have a relatively high annual egg production of about 78 eggs, while their hatching capacity is 80 percent. Their mothering qualities are excellent. The breed is famous for its high-quality meat.

GENERAL CHARACTERISTICS OF INDIGENOUS CHICKENS

The average flock composition is 25 to 30 percent of mature cocks and hens, 30 to 33 percent of young chickens and 40 to 45 percent of chicks. The sex ratio is high, ranging from 2.5 to 3:1 so farmers keep a surplus of males. Since feed supply is limited, hens often suffer from insufficient feeding, leading to lower egg yields.

Egg production is 55 to 78 eggs per hen annually. Hens lay during five distinct periods per year, during which they produce 11 to 14 eggs. Egg weights range from 35 to 40 g. Chickens begin laying at 30 weeks, at a body weight of 1.2 kg. Hens of indigenous breeds take

B. Bouahom

PHOTO 4. Black Bone Rooster

B. Bouahom

PHOTO 5. Black Bone Hen

B. Bouahom

PHOTO 6. Kai Horn Chou Rooster

B. Bouahom

PHOTO 7. Kai Horn Chou Hen


B. Bouahom

PHOTO 8. Kai Yolk Rooster


B. Bouahom

PHOTO 10. Kai Chae Rooster


B. Bouahom

PHOTO 9. Kai Yolk Hen


B. Bouahom

PHOTO 11. Kai Chae Hen

more time to rear their chicks, lowering egg production. Some indigenous breeds are notoriously poor mothers.

Mortality is primarily due to disease and poor feed; under two months it reaches 75 percent; in young chickens and more mature birds it ranges from 25 to 35 percent, depending on the region. The main diseases are Fowl cholera and Newcastle disease which mainly occur at the beginning of the rainy season in May and in winter.

Chicken pens are simple and vary from small cages to permanent houses; often chickens roost in trees. Farmers usually give supplementary feed: rice bran, broken rice, maize and cassava. Manufactured feed is rarely used. The price of indigenous chickens is about 50 percent higher than industrial broilers. In some areas, farmers organize a market which is small and not commercial. Consumers prefer chickens aged between four and five months but rural farmers sell or eat them at seven to nine months or even older. Farmers in peri-urban areas adapt sales to consumer demand.

According to the Department of Livestock and Fisheries (2004), the poultry population is about 20 million head: 95 percent are indigenous chickens. The other 5 percent includes ducks, geese and turkeys, as well as exotic ducks and chickens in the broiler and layer industries.

FARMER INVOLVEMENT

Rural farmers keep 10 to 20 chickens. Local ethnoveterinary practices are common. Medicinal plants are applied to the wounds of fighting cocks. Hot peppers are sometimes burned to cure birds through

B. Bouahom

PHOTO 12. Backyard chicken farming

B. Bouahom

PHOTO 13. Child playing with indigenous fighting cock

inhalation. Women and children give feed and look for nests. Men make chicken pens and select cocks for fighting.

For breeding, farmers use birds that best suit their goals and select on phenotype (or "nice" appearance). Nice-looking birds are relatively large, with brightly coloured feathers and strong, preferably yellow legs. This last characteristic is specifically important when selecting cocks. Farmers provide chickens to relatives and friends for breeding. Usually one or two cocks are kept for mating. In some areas, farmers will not buy or transport cooked chickens or their parts from elsewhere to prevent the transmission of diseases to their own chickens.

Indigenous chickens are particularly important in livelihoods of rural people, in more than 80 percent of the population, and in traditional weddings wherein the bride and groom share an egg as a symbol of love and solidarity. Poor farmers (with an income, equivalent in kind, under 85 000 kips at 2001 prices – about US$ 10 per person per month) cannot afford large ruminants or pigs. Poultry should be promoted to help them get out of poverty. Better use of local chickens is needed, as indiscriminate cross-breeding between indigenous breeds, and with exotic breeds, is becoming widespread.

INVOLVEMENT OF THE GOVERNMENT AND OTHER PARTIES

The Department of Livestock and Fisheries, at national, provincial and district levels formulates policies and provides support services such as vaccination against the main diseases. Fowl cholera and Newcastle disease vaccines are produced locally. Vaccination covers about 25 to 30 percent of indigenous chickens but is unsuccessful in remote highland areas because of insufficient cooling and a lack of electricity. About 6 000 Village Veterinary Workers cover 60 percent of villages. More intense and regular interaction between government agencies, NGOs and rural communities is required. Some NGOs provide technical support, mainly advice on management, and assistance with vaccination programmes.

The National Agriculture and Forestry Research Institute deals with livestock. The National Agriculture and Forestry Extension Service is responsible for agricultural development including chickens. In 1996, the Lao People's Democratic Republic ratified the Convention on Biological Diversity.

Livestock development lags far behind the crop sector, despite their importance. Large gaps exist in the understanding of the roles, values and characteristics of local animal genetic resources, which impairs their management. Little is known about production performance and potential; understanding of diversity within livestock species is poor. More information on both issues is necessary to plan the sector's development. Financial support for animal genetic work is limited. Donors are more interested in wildlife than

FAO/18178/H. Wagner

PHOTO 14. Village veterinary worker vaccinating indigenous chicken

domestic animal diversity-related projects. The Agricultural Promotion Bank can provide credit to farmers, but the amounts they can borrow are extremely limited.

RECOMMENDATIONS

To improve indigenous chicken production, community-based management strategies for local breeds have to be developed. This would need support from government agencies, policy-makers and NGOs. Possible actions could be the following:

> Introduction of husbandry and breeding techniques compatible with traditional practices to improve the efficiency of farming systems.

> Promotion of mixed farming and diversified production.

> Enhancing livestock yields through community-based capacity building in:
- *Housing*.
- *Feed quality*. Little is known about the nutritive value of local feeds.
- *Breeding stock selection* and the establishment of structured breeding strategies.
- *Veterinary* support services.

> Facilitating the exchange of experience and knowledge between farmers. Livestock fairs could be organized to increase farmer interaction.

> The following technical areas should be addressed with priority:
- egg production;
- formulation of management strategies to reduce the chick rearing period, possibly by supplementing chick feed with extra protein other than fish meal;
- vaccination against Fowl cholera and Newcastle disease;
- husbandry techniques.

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Map below:

Geographical distribution of the Somba bovine

TAMBERMA'S SOMBA CATTLE BREED AT RISK OF EXTINCTION IN TOGO

Bonfoh Bèdibètè, Adoméfa Kossi and Bassowa Habrè

SUMMARY

Somba cattle are small, hardy, trypanotolerant taurins which are traditionally reared in a mixed farming system. Pure somba are important in traditional ceremonies. For a time, development policy was to import larger West African taurins for "upgrading"; more recently farmers have begun to group herds and lease them to Peulh immigrants who have brought their zebus with them. The number of purebred Somba is falling sharply. Their conservation is desirable since they suit the production system, disease challenge and climate; they have original genetic characteristics for trypanotolerance.

Some authors think that sedentary groups in the Gulf of Guinea are not cattle raisers. However, the Tambermas of Togo and Benin co-exist with their livestock and share their castle-like dwellings. Livestock, in particular cattle, have a social and cultural role that is profoundly embedded in the people's spiritual life (N'Poh et N'Guissan, 1998).

Somba cattle have often been overlooked by development projects because they are small. Larger breeds such as the N'Dama and Baoulé were favoured and imported between 1954 and 1986 (Mawena, 1988). Decline, even extinction, is impending for the local Somba and Lagunaire breeds. The Somba is now threatened by zebu incursion and indiscriminate crossbreeding (Adoméfa *et al.*, 2002). The Somba has original genetic characteristics for trypanotolerance, it shows adaptability and good productivity under low input conditions and is interesting study material for genotype-environment interaction; it must be conserved for future generations.

This paper surveys the breed, production systems, zootechnical abilities and its genetic characteristics. It outlines its social and cultural role and indicates measures to be taken to ensure its conservation and development.

The Somba is from Atacora, a mountainous area in the North East of Togo of about 2 700 km^2, between 9° 38' N and 10° 38' N and 1° 30' E and 2° E. (Adanléhoussi *et al.*, 2003).

ENVIRONMENTAL CONDITIONS

This zone has a Sudanian climate, quasi semi-Saharan, with the Harmattan blowing from November to February. The rainy season is May to October. Annual average rainfall is 1 200 mm (Cornevin, 1973). Minimum temperatures are around 19 °C in January, with maximums of 30° C in April. Relative humidity ranges from 20 percent in January to 70 percent in August. Potential evaporation is 1 700 mm, so for much of the year crops can not be grown. The vegetation is a form of derived parkland savanna with useful trees like *Vitellaria paradoxa* and *Parkia biglobosa*. Long linear


K. Tempelman

PHOTO 1. Tamberma castle


B. Bonfoh

PHOTO 2. Somba cattle breed

forests, now gradually receding, grow along the rivers (Jeune Afrique Editions, 1981).

THE SOMBA OR TAMBERMA PEOPLE

The Somba is a sub-tribe of the Volta Nigerian group. In 1957, their number was estimated at 8 614 (Cornevin, 1973); in 2000, it was 16 300, with a density of 75 habitants per km^2 (Adoméfa *et al.*, 2002). Their picturesque, castle-like, two-storied dwellings are built close to each other on hills close to the Benin-Togo border, to the North of the Koumongou river (Photo 1).

TAMBERMA ANIMAL HUSBANDRY

The Tamberma are agropastoralists by tradition. Creation and accumulation of capital heritage is based on chickens, their primary livestock. Poultry are sold or exchanged for sheep or goats which may then be commercialized to buy cattle (N'Poh and N'Guissan, 1998).

THE SOMBA BREED

The Somba, typical of the tropical subhumid area, is a shorthorn derived from *Bos taurus* brachyceros, within which it belongs to the Savanna type (not the dwarf Lagoon type) (Meyer, 1998). It is thought to be the mother of the locally adapted cattle breeds in the Gulf of Guinea (Adoméfa *et al.*, 2002). The Somba is classified among hardy, trypanotolerant West African cattle. (Morkramer and Dékpo, 1984). The Somba varies from 0.90 up to 1 metre at shoulder height; adult weight is 172 ± 13 kg. It usually has a black-and-white coat (Photo 2), although some are entirely black, red, or red-and-white (Adanléhoussi *et al.*, 2003).

Indigenous breeds of the tsetse zone have a degree of tolerance to pathogenic trypanosomes. (Karbe *et al.*, 1981 and Karbe and Freitas, 1981). The Somba habitat is infested with *Glossina tachinoides* and *Glossina palpalis*. The trypanosomes are: *Trypanosoma vivax*, *T. brucei* and *T. congolense*. Ticks are mainly *Amblyoma variagetum*. Tick-transmitted diseases are Babesiosis and Theileriosis. Among the gastro-intestinal parasites, Filariae and Coccidia are predominant (Adoméfa *et al.*, 2002).

POPULATION AND HERD STRUCTURE

Somba cattle were estimated at 75 000 head in 1977; in 1997, there were 26 000 pure-breds in Togo and Benin (8 500 in Togo). Each household keeps 3.17 cows; the average holding is between 1.92 to 2.85 ha (Adoméfa *et al.*, 2002 and Moazani-Goudarzi *et al.*, 2001). Herd structure has 70 percent females of which 43 percent are cows, and 13 percent heifers. The cows' reproduction rate is below 80 percent. The percentage of bull calves and heifers versus the total number of cows is 72. This percentage is 115 for Zebus and 150 for crossbreds which seems to confirm that the breed is heading towards extinction (Adoméfa *et al.*, 2002).

ZOOTECHNICAL PERFORMANCE

First calving is between 3 and 5 years; 87 percent of calvings are between October and February. The

average calving interval is 18 months (Adanléhoussi *et al.*, 2003). Calving rates vary from 75 to 78 percent, despite a scarcity of bulls. Natural mortality is estimated at 3.4 percent yearly (Adoméfa *et al.*, 2002).

Daily milk production is estimated at 0.71 ± 0.18 litres per cow during 235 ± 25 days. Milk production, which can reach up to a litre per day, peaks when females are aged around 9. While active, a cow goes through 5 or 6 lactations (Adanléhoussi *et al.*, 2003). Lactoprotein studies show that Somba milk is suitable for cheese making (Moazani-Goudarzi *et al.*, 2001). Calves weigh 12 ± 3 kg at birth. During the first two years, calves gain 93 grams daily. Between 2 and 3 years, weight gain is about 104 grams/day. They are fully grown at the age of 6.

SOCIO – CULTURAL AND ECONOMIC QUALITIES OF THE SOMBA BREED

The size of a family's herd is a sign of its wealth. Livestock are for security and play a role in the community's spiritual life (N'Poh et N'Guissan, 1998). Eighty percent of animals are raised for socio-cultural purposes (52 percent for funerals and 28 percent as dowries), leaving only 20 percent for sale (N'Poh and N'Guissan, 1998). Hides are used to make dresses for folklore ceremonies (Cornevin, 1973).

MIXED FARMING

Crops grown are: sorghum, groundnuts, fonio (*Digitaria exilis*), millet and more recently, maize. Thirty-four percent of farmers use some form of crop residues as cattle feed (Adoméfa *et al.*, 2002 and N'Poh and N'Guissan, 1998). Manure is collected as fertilizer. Crops generate 16 000 CFA (32 US$) per farm per year, while cattle, which used to be capital savings, generate 40 000 CFA (80 US$) (Adoméfa *et al.*, 2002). Livestock are clearly the farmer's main source of income.

TRADITIONAL CONSERVATION AND GENETIC IMPROVEMENT STRATEGIES

The traditional breeding system of Tamberma is a way of protecting the Somba breed. They do not trade or slaughter cattle randomly; their main use is for rituals. They take good care of their cattle and follow other activities to meet their needs. Small stock is used for regular trade and consumption (N'Poh and N'Guissan, 1998).

SELECTION PROGRAMMES: MATING AND REPRODUCTION OF PURE-BREDS AND CROSS-BREEDS

Livestock graze freely, especially in the dry season. In an environment free of migrating cattle, mating took place naturally between animals from different herds which favoured the reduction of inbreeding. Reproduction was under control because the animals were housed overnight.

Nowadays 38 percent of households select Somba bulls for Somba cows (Adoméfa *et al.*, 2002), but with the zebu incursion, uncontrolled herds lead to cross-breeding. The breed's extinction is further exacerbated by ritual sacrifice. About 1.5 bulls are slaughtered in 27 percent of all households per year (Adanléhoussi *et al.*, 2003).

EVOLUTION OF TRADITIONAL BREEDING AND MANAGEMENT OF THE SOMBA BREED

Two decades ago all cattle were privately owned; now collectivization is a trend and two cattle raising systems are being used.

Traditional Somba system: Cattle are housed in the castle to reduce the risk of theft. A castle can house up to ten cows (Adanléhoussi *et al.*, 2003 and Adoméfa *et al.*, 2002). Adolescents used to herd them (N'Poh and N'Guissan, 1998). Mating took place at pasture within the herd and between herds. Milking was rare since milk is not part of the local diet.

Cattle raising through tenancy or lease to the Peulh: This system, which only appeared recently, consists of joining several herds and leasing them to Peulh (Fulani, cattle herders by tradition,) who migrated to Tamberma country and now look after large herds of cattle which mix with other breeds, notably zebu, introduced by the Peulh and mainly kept for milk which is important in their diet
(Photo 3). (Adoméfa *et al.*, 2002 and N'Poh et

N'Guissan, 1998).

TRANSMISSION OF INDIGENOUS KNOWLEDGE AND RESPONSIBILITIES FROM GENERATION TO GENERATION

Men look after cattle; women tend goats and poultry. The size of the Somba cow matches the castle where it is kept. A change in size would require a readjustment in terms of housing (N'Poh and N'Guissan, 1998). For dowries and ritual sacrifice, only the Somba breed is used. A Tamberma, on reaching a certain age, sacrifices a bull to his ancestors (N'Poh and N'Guissan, 1998).

CAUSES OF GENETIC EROSION OF THE SOMBA BREED

Uncontrolled grazing favours mating between Somba and zebus; using the best bulls for ritual purposes results in counterproductive selection (Adoméfa *et al.*, 2002). Next to savings, the Somba breed used to play a key role in maintaining the spiritual balance of a family. The need for money to satisfy demands related to education, medical care etc. has increased, and has influenced the original function of cattle keeping (N'Poh and N'Guissan, 1998).

INVOLVEMENT AND ACTIONS BY GOVERNMENT, UNIVERSITIES AND RESEARCH INSTITUTIONS

Larger villages have a veterinary post. Livestock services in Togo and Benin implemented, from 1997 to 2000, "The Somba cattle breed: characterization and research in view of its improvement" (Adoméfa *et al.*, 2002 and Moazani-Goudarzi *et al.*, 2001). The conclusions of this research have been put into practice throughout the Tamberma region; awareness-raising meetings on the risk of extinction of the Somba breed as well as promoting activities were organized. (Adoméfa *et al.*, promoting activities were organized. (Adoméfa *et al.*, 2002). In 2002, an international workshop on the Somba breed emphasized the urgency of conservation (Adoméfa *et al.*, 2002). Characterization of the Somba breed through molecular markers (Moazani-Goudarzi *et al.*, 2001) has been undertaken by the Institut National de Recherche Agronomique of France and showed the Somba to differ from other local breeds.

B. Bonfoh

PHOTO 3. Collective cattle herds grazing in Tamberma country

INTERACTION BETWEEN THE TAMBERMA COMMUNITY, THE GOVERNMENT AND OTHER PARTNERS

> A traditional professional organization in the Tamberma area coordinates interaction between farmers and enhances joint farming activities (N'Poh et N'Guissan, 1998).
> Associations have been set up to promote sanitary, educational and farming activities.
> In larger villages, pharmacies have been set up by The French Organisme de Solidarité Internationale who have established groups to improve wells dug by the government with the help of the FED.

Many of these groups are no longer operational since their approach to cattle raising clashed with the farmers' way of life and the techniques recommended by projects and NGOs (N'Poh et N'Guissan, 1998).

APPROPRIATE STRATEGIES TO IMPROVE THE MANAGEMENT OF THE SOMBA BREED WITHIN THE TAMBERMA FARMING SYSTEM

Farmers' concerns mainly relate to sanitary protection, cattle theft, the shortage of grazing and bush fire management. Those who have entrusted their livestock to third parties are vulnerable as they are exposed to different techniques and ways of managing their cattle. Theft has worsened by keeping them outside the castle. Approximately 5 percent of animals are stolen every year (Adoméfa *et al.*, 2002).

The following strategic actions could improve the management of the Somba breed within local farming systems:

> Improvement of feed, veterinary services and water availability.
> Better extension and enhancement of mixed farming.

> Breed improvement through open nucleus selection and characterization of breeds morphologically close to the Somba.

CONCLUSIONS

The main concerns relate to avoiding cross-breeding with zebu (Adoméfa *et al.*, 2002 and Moazani-Goudarzi *et al.*, 2001; Adoméfa *et al.*, 2002). A key question is: how to justify conserving and developing the Somba in its own environment? Conserving the breed fits the framework of sustainable agricultural production. Agrotourism should be underlined, as Tamberma castles are on the UNESCO World Heritage List since 2004. A programme of *in situ* conservation should ensure the breed's role in the economy and address its rapid decline through cross-breeding.

Somba are perceived to be less profitable than other breeds, therefore research on market outlets and economic incentives is needed (Adoméfa *et al.*, 2002). Appropriate management strategies will limit genetic drift and allow the setting up of selection programmes to preserve genetic variability. In collaboration with development partners, the Togolese Government has proposed to work out a specific project to achieve the conservation and sustainable development of the Somba breed.

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Map below:

Location of mixed farming systems as described in case study, Vietnam

CO DUCK GENETIC RESOURCES: THE PILLAR OF TRADITIONAL MIXED FARMING SYSTEMS IN VIET NAM

Nguyen Thi Minh and Nguyen Duc Trong

SUMMARY

Co ducks are traditionally related to rainfed rice farming and can forage nearly half of their feed requirements while maintaining high reproduction levels. No other breed could take on the Co ducks' role in rainfed rice areas. They are hardy and resistant to local diseases. In Ha Tay and the Mekong River delta Co ducks are still the main source of livelihood for a large number of poor farmers. To maintain Co duck numbers, a breeding system has been developed based on: selection, breeding and stabilizing of egg production; improvement of egg production and; supplying selected ducks to integrative systems in rural areas with the aim of conserving agricultural biodiversity and enhancing sustainable agriculture

The duck population of Viet Nam, nearly 64 million (General Statistics Office, 2002), is second only to China's. Duck-cum-rice and duck-cum-fish are common mixed farming systems. In the Mekong delta, where more than half of the country's ducks are, these systems are the most effective ways of farming. By integrating animals and crops, resources are more efficiently utilized; diversified production allows farmers to increase their income and provides a more balanced diet. This paper describes ducks in integrated farming systems in the provinces of Tien Giang, Dong Nai and Ha Tay and draws attention to their social and cultural importance in the lives of rural communities.

Viet Nam extends along the south-eastern coastline of Asia for 3 260 km, covering 330 541 km^2, with a population of 80 million at a growth rate of 1.5 percent per year and has about 220 persons per km^2. It stretches from 8°30′ to 23°30′ N, giving wide climatic variation; North Viet Nam, while in the tropical zone, has cold winters caused by monsoon influences; and subtropical features, while high mountainous areas have a temperate character. Annual humidity is about 80 percent and average annual rainfall 1 950 mm.

Viet Nam has 2 800 rivers; the water area is about 394 000 ha, of which 56 000 ha are lakes. A coastline of more than 3 000 km creates favourable conditions for transport and fishing. Natural calamities, such as storms, occur annually. Land resources are limited; with slightly less than 9.5 million ha of arable land – under 30 percent of the territory. Seventy-five percent of the country's surface is mountains.

The livestock sector, which contributes 20.5 percent of agricultural income (General Statistics Office, 2002), is in the hands of smallholders who raise pigs, cattle, buffaloes, goats, chickens and ducks. Animal production has developed steadily during the last decade. Farming integrates rice and other crops with livestock and aquaculture. To maximize benefits there must be simultaneous development of crop, fish and



N. Thi Minh

PHOTO 1 and 2. Interviewing duck farmers in Tien Giang

animal production. The efficiency of this integrated, closed production cycle is obvious. Animals provide draught and manure while crops and their by-products provide animals, including fish, with feed.

Duck rearing is popular as it is closely linked to paddy, and rice is the staple food. The Mekong delta has more than half the country's flock. In traditional systems ducks mainly feed on snails, small fish, shrimps, weeds and shed grain. They are reared extensively, in small groups, with few supplements, taking maximum advantage of available feed resources. In 1990 Viet Nam produced 23 000 tonnes of duck meat; by 2003, this was over 93 000 tonnes. In traditional systems ducks lay an average of 170 eggs per year.

Viet Nam can be divided into eight eco-agricultural zones: northeast, northwest, Red River delta, north central coast, south central coast, central highland, southeast and the Mekong River delta. Surveys were carried out in the provinces of Tien Giang, Dong Nai and Hay Tay, involving five districts and ten communities.

TIEN GIANG

1. Chau Thanh district with Nhi Binh, Long Dinh and Dien Hy communities.
2. Tan Phuoc district with Phuoc Lap community.
3. Cai Lay district with My Hanh Trung community.

DONG NAI

Long Thanh district with Long Phuoc and Phuoc Binh communities and the small town of Long Thanh.

HA TAY

Phu Xuyen district with Phuc Tien and Chuyen My communities.

Tien Giang in the Mekong delta has perfect conditions for traditional duck production. Floods occur from April to November. The main agricultural activities are rice, fish and duck production. Duck-fish-rice systems are popular. All ducks are of the Co type and the egg price is only VND 800 each (or US$ 0.05).

Dong Nai in the east of South Viet Nam, among rice fields and hills, has a climate similar to Tien Giang. It produces rice – harvested twice a year – cassava, sweet potatoes, nuts, beans, fruit, fish and ducks. Duck eggs fetch about VND 1 200 each.

Ha Tay is west of Hanoi. Farmers grow rice in the lowlands, and maize, cassava and potatoes in hilly areas. Temperatures range from 17.5 to 29.3 °C.

Phu Xuyen lowlands are water-rich. Until recently, Co duck was the major breed and mainly kept for eggs. Since the introduction of more productive exotic breeds and Muscovy ducks the existence of the Co duck is severely threatened. In the district only two farmers still keep Co ducks (1 050 in total). At the time of the survey egg prices were VND 1 050 each.

CO DUCKS AND THE SCAVENGING FEEDING SYSTEM


N. Thi Minh

PHOTO 3. Surveying duck farmers

M. Marzot

PHOTO 4. Rice field in the Mekong River delta

Arable land is scarce; integration of crop and livestock needs to be enhanced. Ducks grazing harvested rice fields, receiving a supplement of only 1 kg of paddy, produce a gain of 1 kg of body weight. In South Viet Nam rice is harvested the whole year round so this system can be applied continuously. Many poor farmers depend on ducks for income. With fish and rice, Co ducks are an integral component of traditional farming. They provide households with meat and eggs, their main source of protein. Surplus products are sold. The tradition of duck rearing has been handed down for generations in all three provinces.

FLOCK SIZE

In North Viet Nam most Co ducks are kept for eggs. Flocks vary from a few birds to several hundred. In South Viet Nam flocks are never less than 500 head. The male:female ratio in the north is 1:10; in the south it varies between 1:20 and 1:30. In both areas fertility rates are about 95 percent; even where the ratio between males and females is low (Table 1).

FEATHER COLOUR

The coat of Co ducks can vary from black to white; 80 percent are sparrow-coloured which is often categorized as the pure breed type.

TABLE 1. **FLOCK SIZE OF CO DUCKS**

No.	TRAITS	PROVINCE		
		Tien Giang	Dong Nai	Ha Tay
1	No. of communities surveyed	5	3	2
2	Number of Co ducks surveyed	47 850	14 300	1 150
	Flock size	550–15 200	1 300–2 000	400–750
	Average (bird/flock)	2 080	1 788	575
	Male:female	1:27.7	1:20	1:10

N. Thi Minh

PHOTO 5 and 6. During daytime Co ducks roam around freely scavenging for worms, insects etc.

APPEARANCE AND HABITS

Co ducks derive from wild ducks *(Anas platyrhynchos platyrhynchos)* (Dong, 1994; Minh, 2001; Ly *et al.*, 2001) and resemble their ancestors. They have a small body, a delicate head, witty eyes, a flattened beak and a long neck. Their body size and short legs allow them to walk briskly and thread their way through rice fields without difficulty. They forage well, have high egg yields, can survive hardship and are resistant to a number of diseases such as Duck plague and Duck cholera. Females not in their reproductive period can survive on a very poor diet. Once the reproductive season starts they recover rapidly and fully. Co ducks are gregarious; males are very possessive of their females and never share them with others and are indifferent towards females other than their own.

THE SCAVENGING FEEDING SYSTEM

Co ducks in Tien Giang and Dong Nai scavenge all day and eat a little paddy at night. In Ha Tay they are reared in semi-intensive systems with a feed supplement of 80 percent paddy and 20 percent concentrate.

Farmers prepare ducklings for the post-harvest season; a month before rice harvest they are released into the fields without being fed any supplements.

Figure 1 shows the dynamics of an integrated fish-duck-vegetable system.

REPRODUCTIVE CHARACTERISTICS OF CO DUCKS

Feed supplements in flocking systems vary from 60 to 65 kg of feed, while foraging Co ducks only need 35 to 37 kg to obtain the same egg production (Dong, 1994).

BENEFITS FROM CO DUCK REARING

Table 5 shows the economic benefits of Co duck production which vary significantly across regions, mainly because of differences in egg prices. The income from duck production remains noteworthy in all three

FIGURE 1. **INTEGRATED FISH-DUCK-VEGETABLE FARMING SYSTEM**

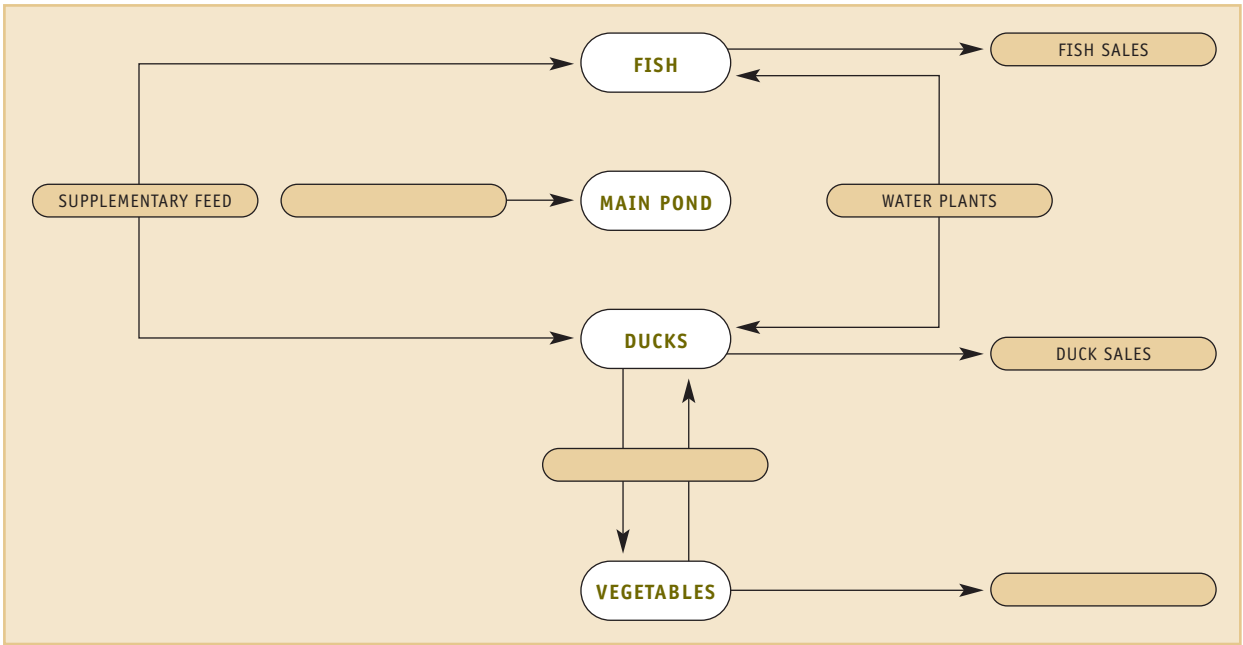

FIGURE 2. EGG LAYING DIAGRAM IN HERDING AND CONFINEMENT SYSTEMS

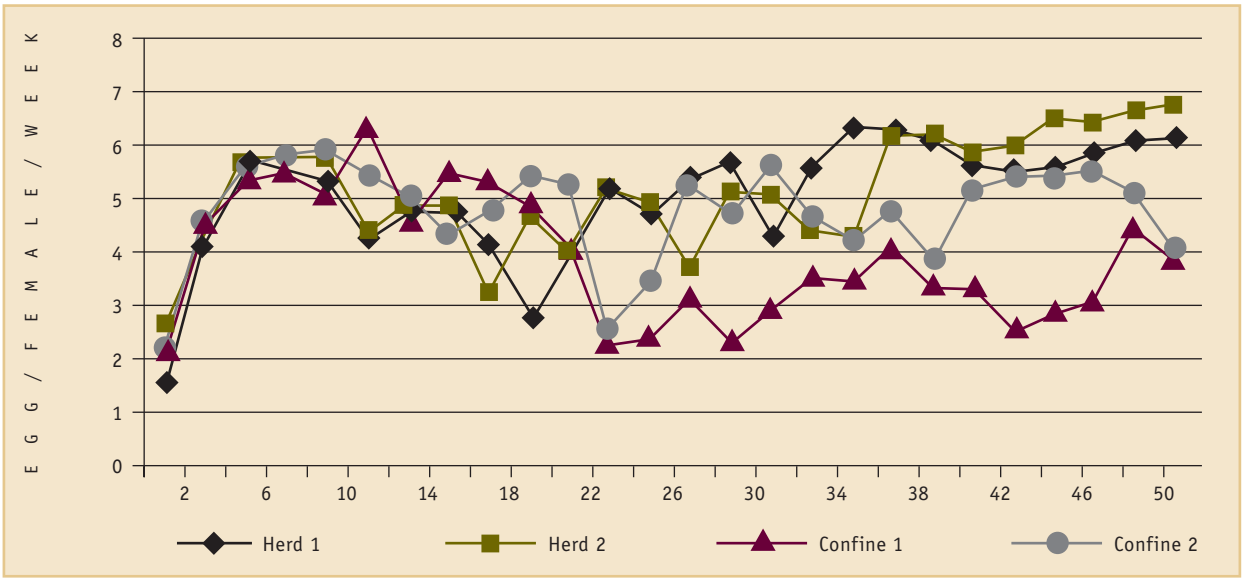

TABLE 2. COAT COLOUR OF CO DUCKS

COAT COLOUR (%)	TIEN GIANG	DONG NAI	HA TAY
Sparrow	85.0	82.4	89.0
Pink brown	7.0	9.3	5.5
Grey brown	6.5	5.3	4.5
White	1.0	2.1	0
Black and other	0.5	0.9	1.0

TABLE 3. CO DUCK PERFORMANCE IN TRADITIONAL FARMING SYSTEMS IN THE SURVEY AREAS

TRAITS	UNIT	PROVINCE		
		Tien Giang	Dong Nai	Ha Tay
Households rear ducks for:				
- meat	%	–	12.5	–
- eggs	%	95.7	12.5	100
- meat and eggs	%	–	75.0	–
- ducklings	%	4.3	–	–
System households rear ducks in:				
- duck-rice	%	95.7	62.5	–
- duck-fish	%	–	12.5	–
- duck-rice-fish	%	4.3	12.5	100
- duck-tree garden	%	–	12.5	–
Households where income from duck production is the:				
- main income	%	43.5	75.0	50.0
- sub-income	%	52.2	25.0	50.0
- commercial	%	4.3	–	–
Sexual maturity weight:				
- male	g	1 800	1 800	1 500
- female	g	1 600	1 600	1 300
Egg production/female/year	–		271.5	230.0

TABLE 4. SEVERAL REPRODUCTIVE CHARACTERISTICS OF CO DUCKS

CHARACTERISTICS	UNIT	QUANTITY	
		Male	Female
Day-old body weight	g	41.6 ± 2.7	40.1 ± 3.2
Body weight at eight weeks	g	1 052 ± 34.0	987 ± 28.5
Sexual maturity weight	g	1 500	1 300
Body length	cm	22.9	22.3
Chest circumference	cm	27.3	25.5
Breast length	cm	7.5	7.3
Leg height	cm	5.1	4.9
Fourth wing feather length	cm	8.0	8.6
Egg production/female/year		233.7 ± 3.7	
Survival rate at eight weeks	%	97.8	
Age at first egg	days	140–145	
Egg weight	g	64.4	
Fertility	%	95.2	
Hatchability	%	85– 90	
Malformed duckling	%	1–2	
Feed conversion	g/egg	190.6–224.1	
	g/b/d	122.5–140.0	

g/b/d: gram/bird/day

Source: Minh, 2000; 2001.

regions.

Profits were calculated with egg prices at the time of the survey. The smallest flock owner in Dong Nai (1 300 birds) can earn VND 663 000 per day. In comparison, flock owners in Tien Giang and Ha Tay would only earn VND 222 000 and 306 000 respectively, should they rear the same number of birds.

BREEDING SYSTEM OF CO DUCKS AT VILLAGE LEVEL

Co ducks are kept in flocks or confined. Eggs are collected daily and every five days are sold to hatcheries or exchanged for ducklings to restock the

TABLE 5. ECONOMIC BENEFITS FROM CO DUCK PRODUCTION

TRAITS	UNIT	TIEN GIANG PROVINCE	DONG NAI PROVINCE	HA TAY PROVINCE
Input				
Feed consumption	g/b/d	155.4	157.5	154.0
Cost	VND/b/d	373.0	378.0	426.6
Output				
Egg production	Egg/female/day	0.68	0.74	0.63
Egg unit price	VND/egg	800.0	1 200	1 050
By currency	VND/b/d	544.0	888.0	661.5
Benefit	VND/female/day	171.0	510.0	234.9

Paddy rice: VND 2 400/kg; concentration feed: VND 4 250/kg.
g/b/d: gram/bird/day

Source: Minh *et al.*, 2005.

laying flocks.

There are two main hatching methods; one uses artificial means and the other uses an apparatus. The artificial method is relatively rare: in the south, eggs are heated by other eggs, while in the north, warm rice or oil lamps are used to brood eggs. This technology is neither efficient nor hygienic and often results in broken eggs and low hatching. Home-made incubators with capacities from 8 000 to 14 000 eggs are used in all three provinces; these are easy to manage and improve hatching efficiency.

M. Marzot

PHOTO 7. As the sun is rising, a duck-rice farmer walks to his rice field

Day-old ducklings are either sold directly from the owner to the farmer or, often in more remote areas, via intermediaries. Sufficient day-old ducklings are sexed for breeding while the rest are sold or raised for meat. Farmers often select ducklings from high egg-yielding flocks. Eggs not needed for incubation are sold or used for "balut" eggs (incubated 18 to 19 days for human consumption).

SOCIAL AND CULTURAL ACTIVITIES

Co ducks figure in social and cultural activities; usually simple games, which are easy to organize, are enjoyed by farmers and are an important part of the daily lives of communities in rainfed rice areas. "Catching ducks" is often played during festivals: a pond, a healthy Co duck and a group of people are needed. The duck is released on the pond and the people have to catch it. The game is difficult, the duck dives extremely well and easily escapes; whoever catches the duck is the winner. During this event the noise of drums and cheering people is overwhelming. Farmers in Dong Nai play "duck neck with ring"; players are given a ring which they throw into a dense flock of Co ducks. If a ring slides over a duck's neck the player wins the duck. The final winner is the person who has "ringed" the largest number of ducks.

RECOMMENDATIONS

To maintain and develop traditional Co duck flocking systems, policy-makers should provide support to farmers in the following fields:

Promote the conservation of Co ducks to preserve agrobiodiversity and more importantly, to alleviate poverty. Farmers need to be informed about the competitive advantage of Co ducks over exotic breeds. In the market system, exotic breeds often raise expectations of higher profits among farmers who do not realize that the link between Co ducks and paddy results in high egg yields with low inputs. Farmers underestimate the importance of Co ducks in achieving sustainable development. Exotic ducks are being imported and even smuggled into Viet Nam which is causing a severe reduction in the number of pure Co ducks.

Facilitate the confinement of Co ducks and limit

M. Marzot

PHOTO 8. Duck-cum-rice: an effective integrated farming system in the provinces of the Mekong River Delta

egg and duckling distribution to reduce the danger of Avian influenza; continuous veterinary health control is imperative. If duck raising is prohibited, the fate of 1.5 million ducks in the Mekong River delta is at stake (VTV news, 4 April 2005). For farmers' livelihoods it can only be hoped that the existence of Co ducks and their traditional flocking system will not be drastically affected by the virus.

Increase veterinary health coverage. A veterinary network from central level to the rural communities is necessary. Ducks should be vaccinated periodically against Duck plague, Duck cholera and others.

Review government policies. The Government should look into the needs and expectations of farmers, then review and further develop its policies.

Most farmers expressed a need for:

> credit with low interest rates for recovering duck production;
> improvement of health care for ducks throughout the year;
> urgent measures to prevent Avian influenza and to help further development of the duck sector.

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12 Navajo-Churro sheep: an ancient breed in the new world, **USA**

13 Management, use and conservation of Karakul sheep in traditional livestock farming systems in **UZBEKISTAN**

CHAPTER 5

ARID AND SEMI-ARID ZONES: SYMBIOSIS BETWEEN LIVESTOCK KEEPERS, THEIR ANIMALS AND THE ENVIRONMENT

Over the centuries, the Navajo-churro and Karakul sheep breeds have adapted to a climate with long, hot, dry and windy summers, and cold, snowy and windy winters. Both breeds are exceptional foragers in arid and semi-arid zones and will go through a season of scarce food or graze marginal land where ordinary sheep would not survive. They contribute to weed control and fire suppression and recycle nutrients into the soil through hoof action. The Navajo-churro sheep, raised by the Navajos in New Mexico, spend less time grazing than commercial breeds and therefore have less negative impact on the sparse vegetation. Karakul sheep are known as Uzbekistan's "ecological pelt" because their grazing habits are supposedly less damaging to the environment than those of other breeds.

As reflected by initiatives such as the establishment of a specialized research institute for Karakul sheep or the collection of semen from Navajo-churro rams by the National Animal Germplasm Program, both sheep breeds are being recognized for their unique characteristics and for their adaptability to their habitat. Activities in favour of the Navajo-churro breed have expanded from simply preserving the breed to restoring its natural habitat and developing communities to safeguard the culture with which the breed is interdependent. The key to the success of the various activities undertaken to conserve the Navajo-churro sheep is the continuous involvement of Native Americans.

As for the conservation of the Karakul sheep, there are some major challenges. More than 30 percent of Uzbekistan's desert rangelands have been seriously degraded through overgrazing, causing economic and environmental problems. Management, preservation and control of natural resources, as well as reorganization and economic reform of Karakul sheep production, are still essential issues for the government to address.

Map below:

The Navajo Sheep Project has its base in the Navajo Reservation in New Mexico, the United States of America

NAVAJO-CHURRO SHEEP: AN ANCIENT BREED IN THE NEW WORLD, USA

Donald E. Bixby

SUMMARY

Churro sheep became the mainstay of the Navajo economy for meat, fibre and income. Their numbers were greatly reduced during the late nineteenth to mid-twentieth centuries, largely by government policies and action; they were also subject to crossing with exotic breeds which reduced hardiness and produced fleece unsuited to artisanal weaving. Starting in 1977, the Navajo Sheep Project assembled survivors of the breed and multiplied them while selecting for traditional breed characteristics in collaboration with a network of breeders. The Navajo-Churro Sheep Association now maintains its own registry. The Project has increased the participation of Native Americans and moved its base to the Navajo reservation in New Mexico.

The Navajo-churro, the oldest North American livestock breed, stems from Spanish sheep introduced over 400 years ago. The "churro", small rugged animals, fine boned and long legged, with a coarse, dense fleece, were integrated into the agriculture of missions, and Spanish colonists. Native labour learnt animal husbandry and textile skills which, with the sheep, spread rapidly and the indigenous population changed from hunting and gathering to shepherding and weaving. Sheep provided a dependable source of food and fibre for the nomadic Navajos. Weaving produced practical items, such as blankets, rugs and garments, and became an important expression of artistic creativity and spiritualism.

The churro adapted to an arid climate with hot, dry, windy summers and cold, snowy, windy winters. A double-coated fleece of long coarse hair, helped to shed rain, dust and snow, while a downy undercoat provided protection against cold. The long, open, nearly greaseless fleece was ideal for hand spinning. Some rams have four to six horns and were considered to have spiritual power. Ewes may have multiple horns, two horns or be polled. Mature rams weigh 77 kg and ewes 45 kg and produce vigorous lambs each season. The sheep prosper on sparse vegetation. Together with intense

D.E. Bixby

PHOTO 1. Side view of a Navajo-churro ram belonging to Tim Johnson.

natural selection for hardiness, reproductive efficiency and foraging ability, Native Americans selected sheep for a wide range of fleece colours, which energized the patterns of the tapestries that were developed as hallmarks of individual artisans or of their tribe. Weaving was done by women, apart from the men in the Hopi tribes.

During the "golden age" of New Mexico's sheep industry (1788 – 1846), master weavers from Mexico promoted their skills, and trade in textiles and livestock was significant. In 1807, Zebulon Pike reported that a flock of Navajo sheep could number 20 000. South-western churros grazed up the Chihuahua and Santa Fe trails and travelled to California. In the mid-nineteenth century hundreds of thousands of Navajo sheep grazed in New Mexico and Arizona. By the 1860s, Native American livestock were savaged by the military as part of the government campaign to resettle their lands (i.e. westward expansion).

In the late nineteenth and early twentieth century, the Bureau of Indian Affairs introduced "improved" rams of British origin aiming to produce an improved grade of white fleece and increase carcass quality Cross-bred fleece was coarse and too short and crimped for hand weaving, and the increased lanolin held a lot of dirt. Cross-breeds did not thrive on range, fell short of market requirements and began to lose the hardiness of purebred Navajo.

During the 1930s, livestock reduction government programmes to increase prices by reducing supply were especially well implemented among Native Americans. Thousands of sheep were shot and left to rot. The annihilation was an enormous economic and cultural disaster and a genetic loss to the sheep. By 1952, the Navajos had only 36 percent of the livestock held in 1930 and had been forced into austere poverty, which still persists.

While the plight of the Navajo people was of little apparent concern, the federal government became interested in Navajo sheep and established the South-western Range and Sheep Breeding Laboratory in 1935, at Fort Wingate, New Mexico. The laboratory was

D.E. Bixby

PHOTO 2. Entrants proudly present their Navajo-churro sheep for judging at Sheep Is Life Celebrations. This breed comes in a rainbow of colours that are prized by Navajo weavers.

stocked with 800 ewes and 20 rams of "old-type" Navajo sheep. Research focused on the characteristics of the breed for wool production and quality. Titles of the published papers indicate a strong emphasis on studies of cross-breeding. The laboratory was closed in 1965.

By the 1970s fewer than 500 Navajo sheep could be found in the entire country. Traditional weaving skills among Native Americans were disappearing, and those who still practised the art were using Karakul fleece from Pakistan.

Dr Lyle McNeal, of Utah State University, founded the Navajo Sheep Project in 1977; the first goal was to increase their numbers. A breeding flock was gathered including some descended from Fort Wingate stock, then selected for traditional breed characteristics. Other breeders joined the effort. With the Navajo Sheep Project, and cooperation with a network of breeders, the breed was brought back from the brink of extinction. The goals of the Project expanded to restoring the breed, its natural habitat and development of the culture with which it is interdependent. Outreach education helps to improve sheep and wool resources for Navajo sheep producers. Nearly half of all Navajo on the reservation are involved in livestock production. Most flock owners use management practices developed by their forebearers, but are eager to learn new ways. The Project has increased the participation of Native Americans and moved its base to the Navajo reservation in New Mexico.

A group of Navajo women formed *Diné be' iiná* Inc., a non-profit organization which promotes the return of the Navajo-churro sheep, that once was the foundation of the *Diné* (the people), their culture and economy. "Sheep is Life" honours the role that sheep play in Navajo spirituality, philosophy and daily life; this annual event offers a range of workshops and free events for the whole family: sheep and wool marketing workshops, sheepdog demonstrations, livestock health care clinics, grazing management for arid lands and marketing strategies.

D.E. Bixby

PHOTO 3. Twelve-year-old Althea Theresa Johns proudly displays her weaving featuring traditional yei figures.

American Livestock Breeds Conservancy (ALBC) supports the Navajo Sheep Project. An important task was the analysis of breeding records and the publication of a flock-book. The Navajo-Churro Sheep Association now maintains its own registry and serves breeders across the country. It issues a regular newsletter for communication among breeders and sponsors an annual national show and sale.

Training and workshops on the reservation have returned fleeces to Native American artists and sheep to Native American flocks; this has been a powerful tool for economic and community development. A tribal leader stated: "It's not about making money. Raising animals is about disciplining children, teaching them responsibility and planning for the future. Navajo values and family systems are dependent on sheep". The number of breeders is increasing and is scattered from Vermont to Washington, from North Carolina to Arizona. The breed represents a conservation success story.

D.E. Bixby

PHOTO 4. Master weaver Roy Kady displays a handsome shoulder blanket designed and woven by TahNibaa Natani, an accomplished weaver in her own right.

FOOD AS WELL AS FIBRE

The Navajo like the Churro for its excellent flavour, its low fat content, its small size and its ease of home slaughter. The meat can easily be consumed before spoilage, by an extended family. All parts are used; Navajos prefer mutton to lamb. Churro sheep are sacred, so eating them is a great privilege and honour. Mutton is reserved for special occasions and as part of selection. Churros are good milkers and sometimes used to make cheese.

Aggressive marketing from was done from 1990 to 2000. Sheep that thrive on natural vegetation are useful for weed control, fire suppression and recycling nutrients. When the Navajo people have healing or blessing ceremonies, they prefer churro and sometimes four-horned sheep that are perceived to have more strength to give to the rituals.

NAVAJO-CHURRO SHEEP IN THE US DEPARTMENT OF AGRICULTURE NATIONAL ANIMAL GERMPLASM PROGRAM (NAGP)

The five laws of genetic conservation are set out in Fowler and Mooney's *Shattering* (1990):

> *Agricultural diversity can only be safeguarded through the use of diverse strategies*. A strategy of ALBC is to collect and cryopreserve genetic materials that can be used to rescue or enhance a threatened breed.

> *What is saved depends on who is consulted. How much is saved depends on how many people are involved*. For this reason ALBC has been firm in its resolve to involve as many breeders as possible in the collection of materials for the gene bank.

> *Diversity will not be saved unless it is used*.

> *Diversity cannot be saved without saving the community in which it was developed*. Reintroducing Navajo-churro sheep into the traditional Navajo

weaving culture meets the need for using the resource and supporting the community in which it was developed.

> *The need for diversity is never-ending*. Therefore, our efforts to preserve this diversity can never cease.

A recent focus of activity for NAGP is collection of semen; involving Native Americans in this project was a priority. Staff visited the wider Navajo sheep area, consulted local breeders and developed a continuing relationship between leaders of the Navajo Nation and the National Animal Germplasm Program.

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Map below:

Habitat of Karakul sheep

MANAGEMENT, USE AND CONSERVATION OF KARAKUL SHEEP IN TRADITIONAL LIVESTOCK FARMING SYSTEMS IN UZBEKISTAN

Yusup Ibragimov, Arunas Svitojus, Surat Yusupov and Lina Baltrenaite

SUMMARY

Karakul are well adapted to the sparse desert pastures, the transhumant production system and climate of the Uzbek desert. Removal of many new-born lambs for pelts allows them to survive on scanty feed. Under the Soviet Union selection was for size rather than for pelt quality. With decollectivization, breeding support and the marketing system for pelts collapsed; herders are still coming to terms with the market economy. Support in marketing is needed. There is a need to build up regional networks among the stakeholders involved in Karakul sheep production to facilitate development of conservation strategies.

In 2000, ruminant livestock in Uzbekistan included 5.3 million cattle and 9 million sheep and goats. About half of the sheep were Karakul, which are believed to be native to Uzbekistan and whose history goes back over a thousand years. The Karakul, which evolved through centuries of selection in its natural habitat, is highly adapted to climate and local management. Previously, their coat was predominantly black because sheep were selected for the quality of their pelt. During the Soviet period however, the selection criterion was size, causing colour variety to increase.

Karakul sheep have been economically important for centuries; they provide meat, milk and wool, and their pelts are highly valued. With the country's shift to a market economy, their production, processing and marketing was privatized and reorganized; new companies specialized in processing high-quality pelts have since entered the market.

Natural pasture is the breed's major feed. Their grazing area covers about 17.5 million ha, including 3 million ha of shifting sands. More than 30 percent of desert range is seriously overgrazed. The management, preservation and control of natural resources and the reorganization and economic reform of Karakul sheep are important issues for the government.

CLIMATE AND TOPOGRAPHY

Y. Ibragimov

PHOTO 1. Karakul sheep products at the market

Uzbekistan, with a population of 26 million, lies between the Syrdarya and Amudarya rivers and borders with Kazakhstan, Kyrgyzstan, Tajikistan, Afghanistan and Turkmenistan. It covers 458 000 km^2 and is divided into 12 provinces with Tashkent as its capital. Deserts cover the west and northwest of the country, while the south and southwest consist of foothills and mountains. The climate is dry and continental, with long, dry, hot summers, cool, wet autumns, and cold winters with thaws. Strong, cold air masses sweep through the country in winter. The country is divided into four belts: the foothill plains, the moderately high mountains, the high mountains and the desert. The desert is the zone of irrigated farming and the habitat of Karakul sheep. Annual precipitation varies between 100 and 250 mm and average annual temperature is about 15 °C. The desert is mostly natural grazing. Its surface layers are mainly loose soils or consolidated sands. Carbonates are uniformly spread in the top layer of the soil and are underlain by a gypsum layer. Groundwater is usually very deep.

STOCK REARING

Dairy cattle are found on irrigated cropland; beef cattle on mountain pastures; Karakul in deserts; other sheep breeds and horses belong to the foothills and mountains around the Fergana valley. Pigs and poultry are raised industrially near urban centres.

There are thee main types of livestock system:

> state-run agricultural cooperatives;
> *shirkat* farms: cooperatives which have replaced collective farms;
> *dehkan* or family farms.

Sixty-five percent of sheep and goats are on *dehkan* farms. Of Karakul sheep, 55 percent are in cooperative structures and 40 percent on *dehkan* farms.

Karakuls for pelts are kept in arid zones, while those raised for meat and wool are kept on the foothills in the Fergana valley. In better pastures the common sheep breeds are the dual-purpose Jaidara and Gizzar; their live weight is 63 and 75 kg respectively, while fleece weight ranges between 2 and 2.5 kg.; the country has more than 3 million of these breeds.

PASTURE RESOURCES

Karakul sheep migrate seasonally and according to feed availability on 18 million ha of grazing lands, 14 percent of which have no fresh water sources. They graze four types of pasture: shrub grass, subshrub-ephemeral, ephemeral-ephemeroidal and salty grass vegetation.

> **Shrub grass** occupies 9 million ha; its yield is 200 - 700 kg of dry matter/ha. It provides grazing the whole year round; in spring they graze green fodder; in summer, dry fodder and dry salty vegetation; in autumn they find shrub-subshrubs and small grasses.
> **Subshrub grass** covers nearly 7 million ha and is in all regions where Karakul sheep are kept.
> **Ephemeral-ephemeroidal pastures** are found in

Y. Ibragimov

PHOTO 2. Karakul ram: Nishan ecotype

Y. Ibragimov

PHOTO 3. Karakul ram: Tandin ecotype

arid lands of the foothills and plains.

> **Salty grass vegetation** has a growing period of 200 to 236 days. Seed-heads and leaves are its most nutritive parts.

Pastures and land in the Karakul zone are state-owned, but are used by *shirkat* farms on a long lease. The state is responsible for the rehabilitation of low producing lands, for guaranteeing water supply and for the maintenance and repair of water sources. In the Kizilkum valley the vegetation is diverse and year-round grazing is possible. Especially developed are sand-loving plants such as *Calligonum*, *Ammodendron*, *Haloxylon persicum*, and *Aristida karelini*, the most valuable fodder. In Zeravshan and Lackaday there are large zones of desert grazing where Karakul sheep and goats are raised.

HISTORY AND BREED CHARACTERISTICS

Karakuls, considered to be the oldest domesticated sheep breed, are named after a village in the emirate of Bokhara which has a high altitude, sparse desert vegetation and a limited water supply. There is archaeological evidence of the existence of Persian lambskin as early as 1 400 BC and carvings of a Karakul type have been found on Babylonian temples. Over time, Karakul herding spread through Central Asia, including Kazakhstan, Turkmenistan and Afghanistan. In the twentieth century, Karakul sheep were sold to Russia, Ukraine, Moldova, Southwest Africa and Argentina. They were introduced to the USA between 1908 and 1929, but United States breeders introduced other breeds into the bloodlines which resulted in inferior pelts and eventually the industry and the flocks were dispersed.

Karakul sheep tolerate extremes of heat and cold, from 46 to -36 °C, but need access to dry cover and should be kept out of marshy pastures. They forage up to 35 km each day and are the only sheep capable of drinking the very salty water found in most pastures in Uzbekistan. Karakul is supposedly less damaging to the environment than other sheep. They are resistant to internal parasites and Foot rot. They respond to good feed and care, but are excellent foragers and will go through a season of scant food or graze marginal land where ordinary sheep would not survive. Karakul sheep possess a strong flocking instinct, but are likely to scatter or fight a dog trying to herd them. Karakul sheep breed out of season, making three lambings in two years possible. Single lambs are the rule, although twins do occur. Ewes are very protective and attentive, resulting in high lamb survival.

KARAKUL SHEEP TYPES

Karakul sheep differ radically in conformation from other breeds; they are of medium size and of the fat broad-tailed type. Rams average 100 kg and ewes about 65 kg. They stand tall, with a long, narrow body. The top line is highest at the loin with the rump long and sloping, blending into a low-set broad-tail. The head is long and narrow, slightly indented between the eyes

Y. Ibragimov

PHOTO 4. Female Karakul sheep

Y. Ibragimov

PHOTO 5. Karakul rams


Y. Ibragimov

PHOTO 6. Pasturing Karakul sheep

and often exhibiting a Roman nose. Their long ears always point down and slightly forwards and vary from a long U-shape to a small V-shape. The long neck is carried semi-erect. The legs are medium to long, and light in bone. Rams can be polled or horned; horns vary from short to large with outwardly curved spirals. Ewes are generally polled. Wattles are not unusual. The breed consists of groups that are genetically related but have different phenotypes. Sheep of 15 different colours, 30 shades, four wool wave types and more than 20 wave forms can be distinguished.

PRODUCTION AND TRADE

Karakul are known as a "fur" sheep, but in Uzbekistan they produce 3.5 million tonnes of milk, 0.8 million tonnes of meat, 16 000 tonnes of wool and 700 000 pelts annually. These are consumed locally and sold to state and private procurement organizations. Before the breakdown of the Soviet Union most pelts were sold to the Red Army. After decollectivization there were no marketing structures and thereafter not even 6 percent of pelts were exported.

PELT CHARACTERISTICS

Most lambs are born coal-black with lustrous wavy curls, with face, ears and legs usually showing smooth, sleek hair. As the lambs grow, the curls open and lose their pattern. The colour begins to turn brownish or bluish-grey, becoming greyer with age. Other colours include a wide range of shades: silver, blue, grey, golden, reddish-brown, white with flecks of other colours that include a wide range of shades: silver-blues, greys, golden-tans, reddish-browns, white with flecks and occasionally pure white. Many adults have a double coat – a fine down undercoat, covered by a coat of guard hair. The best performing sheep have a glossy fleece as their lamb coat, but there is a great variability in the fleece type of both coats, from "horse tail" coarse to silky soft. Karakul sheep produce a light, high-volume, strong-fibre fleece that at its best is long and lustrous, usually with no crimp. Long-stapled (on average 15 to 30 cm per year), the fleece has a low grease content and is easily spun with little preparation. It produces a superior carpet yarn, is often used for rugs, saddle blankets, outer garments and wall-hangings. It has excellent felting ability and is the wool from which the art of felting evolved.

Texture is the most important characteristic of broadtail (foetal lamb) and Karakul pelts. The most valued qualities, durability, silkiness and shape of curls, are all concentrated in black Karakul sheep. To preserve the gloss and curl of the fur, the lamb must be killed within a few days of birth. In the fur trade it is desirable that curls be distributed uniformly. Pelts are matched for size of curl, pattern, lustre and other qualities. Broadtail pelts have no true curls, the hair is shorter than that of the Karakul, with a wavy, flat pattern. This texture is often described as “watered


Y. Ibragimov

PHOTO 7. Karakul lambs are highly valued for their glossy and curly fur

silk" or "moiré". The qualities of the pelts vary according to the age at which the lambs are slaughtered. This may be 30 (galach), 14 (karakulcha), 10 (Karakul / karakulcha) or 0 (Karakul) days after birth.

RURAL COMMUNITIES AND KARAKUL SHEEP

Karakul sheep are the main source of livelihood for more than two million people in Uzbekistan and provide employment where there are no sources of income. The whole family is involved in sheep raising; children for herding, women for processing milk, wool and pelts and men for lambing, slaughtering, shearing and protecting sheep from predators. Large numbers of people are leaving the villages for the city so Karakul rearing has ceased in some areas. Sheep numbers are declining rapidly and problems such as soil erosion have increased. Karakul sheep supply 20 percent of the country's meat. In the past, pelts contributed an even larger share to Uzbekistan's gross domestic product.

Sheep milk is important for nursing children and is made into butter and cheese. Meat is dried on sand and can be conserved for a long period. Fat is processed into tallow. Wool and pelts are used for pullovers, carpets and ropes. Dung is used for heating and cooking. Karakul sheep are the family's savings, sold when cash is needed and exchanged for other goods.

INVOLVEMENT OF THE GOVERNMENT AND OTHER PARTIES

The Uzbek Scientific Institute of Astrakhan Sheep Breeding has, over many years, selected a large number of drought and heat-resistant fodders. Research on pastures and breeding Karakul sheep has begun in collaboration with the International Centre for Agricultural Research in the Dry Areas (ICARDA.) The Uzbek Research Institute for Karakul Sheep sets priorities for research on production, breeding and the conservation and breeding of forages in desert and semi-desert regions. The livestock farming central board, the veterinary and scientific production centre of the Ministry of Agricultural and Water Resources, meat- and milk-related institutions and companies, breeding associations, scientific institutions of livestock raising,

Courtesy of Y. Ibragimov

PHOTO 8 and 9. With the country's shift to a market economy, private high-quality pelts processing companies have emerged, absorbing the largest share of the profit margins in the value chain at the expense of the Karakul sheep farmers. To preserve the gloss and curl of the fur, the lamb must be killed within a few days of birth

Karakul sheep breeders and veterinarians all work on policy development and livestock production.

The disintegration of the Soviet Union severely disrupted the Karakul sheep production chain. Inputs were difficult to obtain, breeding support schemes disappeared and prices stagnated. From the mid-1990s, ICARDA and national research organizations collaborated to understand the socio-economic processes and changes brought about by the new economic reforms. The results of this work, including much information on the effect of decollectivization on the livestock sector and Uzbekistan's grazing lands are described by Gintzburger *et al.* (2003). They developed strategies to overcome the production problems faced by farmers. Major activities were framed into the following research components:

> markets and socio-economics of production systems;
> on-farm interventions for productivity improvement;
> efficient livestock production through adequate flock management integrating nutrition, reproduction, breeding and animal health.

RECOMMENDATIONS

Conservation of a breed without further development or with no expected future use is not sustainable. Before farmers can support the conservation of a breed they

need to know how their efforts will be rewarded. Policy-makers can especially assist farmers by the following:

> Promote the Karakul sheep, and especially its products, in Uzbekistan and abroad.
> Build up regional networks among the stakeholders involved in Karakul sheep production to:
  - facilitate development of conservation strategies based on sound cooperation;
  - discuss *in situ* and *ex situ* conservation options and study their feasibility, including the possibility of establishing an open nucleus;
  - establish sustainable monitoring systems to keep records of the status of domestic animal populations in the region.
> Consider investments in capacity building and training to strengthen human resources, particularly in breeding strategies.
> Enhance coordination among the various organizations in Central Asia that currently develop and implement subregional projects and programmes related to animal genetic resources.

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CHAPTER 6
PRESERVING AND DEVELOPING UNIQUE ANIMAL GENETIC RESOURCES FOR

HOW COMMUNITIES MANAGE LOCAL ANIMAL GENETIC RESOURCES

The thirteen case studies cover five climatic zones; seven out of the nine ruminant production systems are wholly or partially mobile (transhumant); i. e. where people with their animals move between two distinct seasonal pasture areas, usually at considerable distance or altitude from each other. The Nepali buffalo, Somba cattle, Basotho ponies, swine and poultry are associated with sedentary agricultural, or agropastoral systems. Livestock breeds in traditional systems are very often multipurpose rather than specialized. Large ruminants provide milk, meat, draught, transport, dung (which may be used as fuel), hides and in some cases (camelids, yaks) fibres.

MOBILE, EXTENSIVE PRODUCTION SYSTEMS

Few, if any, extensive livestock production takes place on land of good agricultural potential nowadays. The case studies are all in areas where the climate, the soils or both are not conducive to crop production and stock-rearing is the most obvious way to gain a living. Mobile herding requires detailed knowledge of the terrain and considerable stock management skills; it also requires recognition (official or traditional) of grazing rights and migration routes as well as cooperation among herder groups.

Farmers will select and keep animals that provide products best meeting their needs so that the production potential of the animals is maximized under the given circumstances. In the areas of the case studies, the climatic and environmental conditions are harsh and feed is scarce and of low quality, but the animals raised in these areas are physiologically adapted to such conditions. With appropriate management, based on local knowledge transmitted from generation to generation, they can live and produce in harmony with people and the environment.

Neuquén goats are reared, under cold, semi-arid conditions, in a traditional transhumance system, although families are now settled while herds continue to migrate on their transhumance circuit. Land development and forestry now hamper transit routes and resting sites. Border closure has limited their migration range and trading possibilities. Bhutanese yaks are raised at very high altitudes where other livestock do not thrive. They follow traditional transhumance, but they have also had their range limited by border closure. Bolivian camelids are raised in a high altitude, cold semi-arid zone where they have advantages over exotic species and are managed in a transhumant system. Sheep in the Central Peruvian Andes are raised in a high mountain ecosystem of very humid, tropical, sub-alpine plains and rainy tundra-tropical alpine zones. Tajik zebu are found in semi-arid areas of Central Asia and may be in sedentary systems or move to summer pastures; when Tajikistan was in the USSR livestock were collectivized; decollectivization has upset livestock production systems

which are still in the process of stabilization. Navajo-churro sheep are being revived as a breed after near extinction and management systems may be evolving, but their owners mainly keep to traditional mobile methods which suit harsh, semi-arid conditions. Karakul sheep are kept in transhumant systems under desert to semi-desert conditions; the slaughter of many lambs immediately after birth for high-value pelts reduces the overall nutritional needs of the flock and help survival on very sparse pastures; decollectivization has again disrupted livestock services and infrastructure.

In most of the extensive systems herd size is relatively large; mating may be poorly controlled as in the case of yaks in Bhutan and zebus in Tajikistan, or controlled to various degrees as in the cases of Peruvian sheep, goats and camelids.

SEDENTARY PRODUCTION SYSTEMS

Livestock are a component of many sedentary farming systems; often a very important one. In smallholder subsistence farming, where much of the crops are consumed domestically, livestock often provide the main cash income as well as being a means of commercializing crop residues and any available grazing, while also serving as savings. In subsistence, low external input systems use hardy local breeds. Where farming intensifies and free grazing becomes scarce, stall-feeding may be necessary; in that case higher yielding breeds may become attractive, especially for cattle where there is a good demand for fresh milk – as in the Nepal study.

Basotho ponies are raised on grass, in cool, subtropical mountain conditions. Buffaloes in the Hills of Nepal are stall-fed in subtropical hills within cropping systems and utilize large quantities of crop residues. Schwäbisch Hällisches Landschwein are raised under European commercial conditions. Somba cattle are kept under lowland tropical conditions, with a severe trypanosomiasis challenge, in an agropastoral system. Indigenous chickens in Laos are scavengers, kept in small family flocks, within a tropical crop-based farming system. Co ducks are raised within tropical crop production systems and are particularly successful as gleaners and scavengers in rice-based, lowland systems where they may be kept in large flocks. Somba cattle are kept in herds of up to ten; mating is uncontrolled.

UTILIZATION OF LIVESTOCK AND LIVESTOCK PRODUCTS

The ways in which traditional producers use livestock and livestock products vary considerable but are usually geared to obtaining subsistence and as good an income as possible. In most systems dairy products are mainly consumed domestically while stock, eggs and fibres will be sold to obtain necessities and supplement income. In many cases livestock are savings and in some cases have social significance.

The study on Neuquén goats states that, "levels of on-farm consumption should be determined" and does are milked and goats sheared. Sale of kids is obviously important. Cereals are no longer grown; grain is bought, presumably from income from livestock. The yak rearing system in Bhutan uses much of its production for domestic consumption, but trades yak products with lower areas and hires yaks for transport; most of its cereals will have to be bought. Bolivian camelids are raised at very high altitudes where few crops are grown; stock on the hoof and dried meat are sold and camelids are important for sacrifices. The paper on sheep in Peru does not mention crops, but it is obvious that the various groups and communities are commercial producers of sheep and sheep products and also use them as collateral for loans. Tajik zebus are

P. Gyamtsho

PHOTO 1. A typical yak herd in Laya

reared in a system which is still readjusting after decollectivization and marketing of livestock products has been disrupted. The paper on Navajo-churro sheep does not describe the system, but implies that marketing of craft products and meat is one aim; the sheep also have sacrificial importance. Karakul sheep are raised for pelts in an area where crop production is impossible; pelts are commercialized and the other sheep products are either used domestically or traded; decollectivization and changes in fashion have caused problems in pelt marketing.

Basotho ponies are used as transport within various farming systems but are becoming important for trekking, which should raise income. Buffaloes in the Nepal Hills are kept within crop-based systems for milk, much of which is used domestically, but there are collection and marketing systems, and dung and cull stock are by-products; the exotic buffaloes are mainly kept by richer households. Lao chickens are mainly used for domestic consumption but surplus birds are sold; they are also kept for sport. Somba cattle are kept within a crop-based farming system; they are kept for prestige and sacrificial purposes and as savings; small-stock and poultry are important for capital building and domestic use. Co duck rearing is very well integrated with crop production, especially in lowland areas where rice is grown year round; they are mainly kept for sale of eggs or ducks.

HOW ANIMAL GENETIC RESOURCES INTERACT WITH THEIR ENVIRONMENT

The breeds have, in most cases, developed through the ages along with the production system or, as in the Americas, date from distant importations. Several studies mention the nefarious effect of "improved" breeds on the hardiness and sustainability of local livestock in extensive or low input systems despite it being known for a very long time (except by development projects) that "high yielding" stock are only productive under high levels of nutrition, management and sometimes housing. The Tajikistan and Uzbekistan studies mention the effects of introduction of exotic stock during the Soviet era when many external inputs were used. Once these countries became independent, the subsidies and technical support were no longer available and marketing systems collapsed. Livestock numbers fell drastically and exotic breeds were no longer profitable – farmers and herders are now moving back to traditional breeds.

LOCAL KNOWLEDGE AND GOOD PRACTICES

R. Cardellino

PHOTO 2. Basotho ponies in their environment

K Templeman

PHOTO 3. Goat herders migrating with their animals from summer to winter pasture in Northern Neuquén province (Argentina)

Passing on knowledge is essential to generate new ideas and solutions so that farmers can develop and conserve their animal genetic resources and improve their livelihoods. This can be achieved by connecting farmers with others who have similar problems. With government support, networks can be developed to exchange information, techniques, methodologies and experience. Potential tools of communication could be newsletters and, where financially and technically viable, national or regional workshops organized and virtual interaction enhanced.

Several authors consider training and coaching as a crucial part of a coordinated livestock improvement strategy, especially on the sustainable utilization of local animal genetic resources. The development objectives of such a strategy should take into account all stress elements present in the production environment, while the linkages between livestock, forests, grazing resources and wildlife conservation should be highlighted. Farmer field schools could be a possible way to teach farmers about their production environment and the interaction between its various components since they allow farmers to learn by doing, by being involved in experimentation, discussion and decision-making. This strengthens their role in the researcher-extensionist-farmer chain and also improves the sense of ownership of rural communities in technological packages and new knowledge and skills.

In most systems, transfer of traditional knowledge and expertise has been handed down through hands-on experience within families; in mobile systems this requires, in addition to stock-rearing and breeding skills, intimate knowledge of migration routes, the pastoral resources along these and the grazing and water rights of the groups involved. In many studies this is still ongoing, but the Neuquén goat study indicates that sedentarization of families and increased scholarization is hampering knowledge transfer. The Tajikistan and Uzbekistan studies show how collectivization destroyed traditional knowledge. The skills of Somba cattle raisers are diminishing as they hire out their livestock. Training, which is mentioned in most studies, is better suited to informing farmers of technical innovations and modern techniques than for passing on folk knowledge.

HOW COMMUNITIES COPE WITH THREATS TO THEIR LOCAL ANIMAL GENETIC

RESOURCES

Some of the major threats mentioned in the studies are summarized below. Some are internal problems of the systems, but others, notably land tenure and grazing rights, are often external and pastoral communities have little control over them.

Breeding problems. Poorly controlled mating is mentioned in several studies; in the mixed farming systems families often have only a few animals so these may be herded communally or, especially in the non-cropping season, allowed to graze at will. Communal watering points are another meeting place of herds. Pastoral families generally have larger numbers of livestock and take care in herding them; the pastoral studies frequently mention care taken in controlling mating, although the broken and mountainous nature of the yak pastures in Bhutan make supervision difficult. Access to good genitors is mentioned in several studies. This is a serious problem for traditional breeds; pastoralists exchange stock to avoid inbreeding, but in most studies there is little mention of really active selection. The problem is particularly serious with traditional breeds raised under harsh conditions on unsupplemented grazing and often with a severe disease and parasite challenge; stock selected on stations and government farms are notoriously unsuited in such cases. The Peruvian study shows how this problem can be tackled if pastoralists collaborate. Crossbreeding with introduced breeds is a threat in some cases; in the harsher environments it may be a slight threat, but it is more serious elsewhere. In the studies the presence of exotic stock in marginal areas of subsistence stock-rearing is usually due to misguided attempts by development agencies who assume that exotic breeds are superior to native ones, even under smallholder or pastoral conditions.

Problems of access to pastoral resources. The maintenance of traditional breeds depends largely on the sustainability of the system in which they are kept. Access or land tenure problems are common in the studies involving ruminants. They are especially dangerous for mobile systems which depend on year-round access to grazing land and water as well as to traditional migration routes between seasonal pastures. Legislation on pastoral land tenure or grazing rights may be unclear and is often at odds with the traditional perceived rights to grazing resources and to passage. Clearing of grazing land for crops, or change of land use to forestry, usually without the pastoralists' consent, not only causes loss of grazing area, but fragments grazing lands and causes problems of access to migration routes and water. In many cases the land so "developed" is very marginal for agriculture and crop production proves unsustainable; mining is another potent source of destruction of grazing resources, including water supplies. In sedentary, smallholder, mixed farming systems population pressure is, as in the Nepal example, so high that there is little natural grazing or browse left. This leads to livestock being kept at the homestead and stall-fed. Because of the labour and costs of stall-feeding, it is likely that farmers will change their breeds to those more responsive to their degree of intensification. This leads to the loss of the original, hardy, free-range stock. Local disputes may be resolved by discussion and negotiation, but most of these problems are outside the competence of the herding or farming communities and require to be addressed through policy decisions at regional or national level.

Mismanagement of pastoral resources. Many of the studies mention pasture degradation due to poor management and overstocking. The only serious attempts to tackle the problem are described in the Peruvian study where herders manage their pastures cooperatively. Under the conditions of the studies mismanagement is often due to lack of clear title to grazing rights which discourages pastoralists from investing in management and development of infrastructure. Pastoral populations are often poor and tend to maximise herd numbers in the hope of increasing output as well as accumulating capital; where access to grazing is open or communal there is little incentive to limit herd size since others will increase their holdings to exploit or overexploit the available herbage. Mobile systems with seasonal grazing of pastures are generally much less damaging

to pastoral resources (provided that others do not exploit them in the off season) than are sedentary systems. It follows that attempts to improve or rehabilitate grazing lands will be futile until these underlying problems of tenure and responsibility are resolved. The same applies to proposals to give herders training in better management.

Political change. Several studies mention the effects of political changes on the maintenance of genetic resources. Closure to livestock movement, and sometimes trade, of the borders between Bhutan and China and between Argentina and Chile have restricted access to traditional sources of genitors. Decollectivization in Central Asian states, as exemplified by the Tajik and Uzbek studies, led to the collapse of management, breeding systems as well as veterinary services and organized marketing.

Markets. Many studies mention marketing problems. Pastoralists and many farmers are in relatively isolated areas and only sell sporadically and in small quantities so they can be at the mercy of middlemen where there are no established and regulated markets in their neighbourhood. Traditional producers increasingly face problems of quality and quality control. Urban populations now prefer young and tender meat which is difficult to produce off poor, unsupplemented pasture. Traditional meat and dairy products, however flavoursome, do not always meet modern standards of hygiene and small rural producers are often unable to provide certification of acceptable quality. Changes in fashions may affect breeds producing fibre and pelts; wool markets worldwide have been poor for years; cashmere prices fluctuate with fashion changes; the catastrophic fall in the market for Karakul pelts in the early nineteen-nineties, while partly due to decollectivization, was also strongly influenced by a campaign against fur-wearing in western countries. A serious potential threat to the marketing of produce from traditional breeds (and therefore to their survival) is the increasing opening of markets to imports of poultry, meat and dairy products as more and more countries join the World Trade Organization. In many cases, especially for large coastal conurbations, it will be cheaper and easier to import from countries which are large-scale, modern producers than to collect scattered supplies of varying quality from distant inland pastures with mediocre transport infrastructure.

Threats due to changing life-styles As more pastoral people have access to education there may be an increasing migration to urban employment with its access to other facilities and diversions. There is also a trend towards settling herding families so that they can have access to education and other social services; this is desirable, where practical, so long as the herds continue to migrate.

LONG-TERM SOLUTIONS AND SUSTAINABILITY OF STRATEGIES

Livestock keepers, and especially transhumant, mobile pastoralists, are often marginalized by policies arising from their own governments. These policies, in which

M. Mezzera

PHOTO 4. Q'ara male llama raised in a Centro de Machaje of Chiluma, Turco region (Bolivia)

R. Cardellino

PHOTO 5. Basotho pony and his owner

they still have no say, are often developed without acknowledging their way of life or their contribution to the country's economy. Policies favouring exotic livestock breeds; those supporting foreign industrial investments such as mining; and changing land tenure for the regeneration of forests or wildlife conservation, severely threaten the sustainability of the farming systems described. As demonstrated by the Drivers of Change framework, policy changes can have far-reaching impacts such as the permanent loss of livestock diversity and local knowledge, social disruption, health problems and economic losses.

MAINTENANCE OF LOCAL BREEDS

Livestock keepers in marginal areas raise livestock mainly to provide food for their families; to raise cash for other expenses, including education and purchase of cereals and other foods; to provide transport and traction and to serve as savings. Secondary products such as dung, hides and wool are used to meet other needs – fuel for cooking or clothing. Should there be a surplus of any of these products, then farmers will generally sell them to supplement their income and, whenever possible, to increase their economic returns through other farming alternatives. Their breeds are generally multi-purpose. Farmers select and keep animals that provide products best meeting their needs so that the production potential of the animals is maximized under local conditions. In the areas of the case studies, the climatic and environmental conditions are harsh and feed is scarce and of low quality. However, the animals raised in these areas are physiologically adapted to such conditions and, with appropriate management, based on local knowledge transmitted from generation to generation, can live and produce in harmony with people and the environment. It follows that national policies must emphasize the use of traditional local breeds in marginal areas and prescribe the use of introduced exotic stock in development projects in other areas. In order to preserve and maintain these traditional breeds assistance should be provided in training herders and farmers in breed improvement, as well as devising ways to provide hardy genitors for pastoral conditions.

LAND TENURE AND LANDSCAPE MANAGEMENT

Extensive grasslands have a great value, beyond providing livelihoods for those who graze them and the meat and livestock products which they yield.

- They are major sites for wildlife and for the *in situ* conservation of plant and animal resources.
- They contain a wide range of pastoral plants, most not yet cultivated, as well as the relatives of cultivated pasture plants: these are of interest since new fodders and cultivars may be needed as global warming progresses.
- They contain many plants of economic importance including plants of interest to traditional and conventional medicine; flavourings and aromatics which are harvested from the wild but which are increasingly being cultivated.
- Grasslands are, in many cases, important for recreation, sport and tourism.
- Because of their vast extent they are important catchment areas, so proper management of the pastoral vegetation is necessary to ensure maximum retention of precipitation. The grasslands of the Hindu-Kush-Himalaya, along with the contiguous Tibet-Qinghai Plateau are extremely important in this respect since many of the rivers on which Asia depends have their origin there (including the Yellow River, Salween, Indus - including the Punjab rivers, Ganges, Brahmaputra and the Syr Daya).

The overall management of extensive grazing lands should be done within a wide framework on a very large, landscape scale so that it is effective in dealing with the whole range of pastoral resources and products, covers the migration territories of transhumant groups as well as conserving wildlife and catchments. In traditional areas pastoralists are often in small, often poorly organized groups. Better planning and management is only likely to succeed if the pastoral population is assisted to organize itself into large groups which can enter into dialogue with one another and with the authorities, not only to participate but to play a leading role in the planning and management processes. The

general public benefits from the proper management of catchments, landscapes for wildlife, tourism, conservation of biodiversity, recreation and hunting, but the management costs fall on the pastoralists – be they traditional or commercial. In many areas commercial stock-rearing off extensive grassland is in economic difficulties and the people of traditional systems are mostly poor to very poor. How can those who manage grasslands be encouraged to do so for the general good and how can they be recompensed for adjusting management to even more environmentally friendly ways?

MARKET OPPORTUNITIES

Most farmers will find it worthwhile to invest in the improvement and conservation of their local livestock breeds if new market opportunities arise. Identification of new markets and marketing strategies are particularly important to provide them with the necessary incentive to continue raising their indigenous breeds rather than changing to a greater input with high production breeds. Another reason for promoting the improvement and conservation of local livestock is to preserve the characteristics of their products. For activities, such as weaving, it is important that the quality of the wool sold on the market is stable. Through cross-breeding it would be possible to improve the fineness of the wool of local sheep breeds. However, the consumer, i.e. the weaver, would not be able to process this wool, which would, objectively be of a higher quality. In areas where tourism is developing rapidly, alternative income-generating activities such as handicrafts and ecotourism could be further explored.

GIVING FARMING COMMUNITIES THE OPPORTUNITY TO DECIDE ABOUT THEIR FUTURE

Governments should seek to involve indigenous and local communities more actively, and to apply their knowledge and technologies when developing national livestock programmes for the improvement, sustainable use and conservation of domestic animal diversity. More specifically, many authors mentioned that governments need to include the participation of indigenous and local communities when developing policies for the specifically, many authors mentioned that governments need to include the participation of indigenous and local communities when developing policies for the conservation and sustainable use of animal genetic resources, the access to these resources, the sharing of benefits and the designation and management of protected areas. The experience and knowledge of these farming communities, and their respect towards their animals and the environment, are essential to developing sound policies. A first step to facilitate the participation of these communities in policy development is to translate livestock breeding policy and guidelines into understandable documents for farmers.

AWARENESS RAISING AND CAPACITY BUILDING

Passing on lessons is considered essential to generate new ideas and solutions so that farmers can develop and conserve their animal genetic resources and ultimately improve their livelihoods. This can be achieved by connecting farmers with others who have similar problems. With government support, networks can be developed to exchange information, techniques, methodologies and experience. Potential tools of communication could be newsletters and, if financially and technically viable, national or regional workshops organized and virtual interaction enhanced.

As part of a coordinated livestock improvement strategy, various authors feel that training and coaching are crucial, especially to increase farmers' knowledge about the sustainable utilization of local animal genetic resources. The development objectives of such a strategy should take into account all stress elements present in the production environment and the linkages between livestock, forests, grazing lands and wildlife conservation should be highlighted. Farmer field schools could be a possible way to teach farmers about their production environment and the interaction between its various components. Field schools offer farmers an opportunity to learn by doing, by being involved in experimentation, discussion and decision-making. This strengthens their role in the researcher-extensionist-farmer chain and also improves the sense of ownership of rural communities in

technological packages and new knowledge and skills.

CONSERVATION

A precondition for *in situ* conservation of local animal genetic resources is for farmers to be convinced about the potential of their animals and the need for their products and services. Farmers will not conserve a breed without targeted incentives. In developed countries this incentive might be sentimental (conserve the breed because of its beauty, its uniqueness), but this is hardly the case for farmers in developing countries who often strive for improvement and conservation at the same time. Farmers significantly contribute to the conservation of domestic animal diversity through the use and further development of their local breeds.

Several authors pointed out that strategies such as cryopreservation and associated reproductive technologies are necessary for the conservation of genetic livestock material. The costs of these types of technologies depend on local circumstances, availability of technology, labour and local facilities. Therefore, it is important for decision-makers to reconsider the balance between objectives, costs and technical and practical feasibility in conservation programmes (Hiemstra *et al.*, 2005.)

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K Tempelman

PHOTO 6. Alpaca herd in the Central Andes of Peru.

G L O S S A R Y

Adaptation: a genetically determined characteristic that enhances an organism's ability to cope with its environment.

Adaptation traits: complex of traits related to reproduction and survival of the individual in a particular production environment. Adaptation traits contribute to individual fitness and to the evolution of animal genetic resources. By definition, these traits are also important for the ability of the animal genetic resource to be sustained in the production environment.

Adaptive fitness: a genetically determined complex of characteristics that enhance a breed's ability to reproduce and survive in a particular production environment.

Agricultural biological diversity or agrobiodiversity: that component of biodiversity that contributes to food and agriculture production. The term agricultural biodiversity encompasses within-species, species and ecosystem diversity.

Agro-ecological zone: an area of agricultural land, generally smaller than a region but considerably larger than a farm, with a definable combination of climate, relief, altitude, edaphic conditions and natural vegetation.

Animal gene-bank: the physical location where collections of genetic material in the form of semen, ova, embryos and/or tissue samples are stored.

Biological diversity or biodiversity: the variety of life in all its forms, levels and combinations, encompassing genetic diversity, species diversity and ecosystem diversity.

Breed: either a subspecific group of livestock with definable and identifiable external characteristics that enable it to be separated by visual appraisal from other similarly defined groups within the same species, or a group for which geographic and/or cultural separation from phenotypically similar groups has led to acceptance of its separate identity.

Breed at risk: a breed that may become extinct if the factors causing its decline in numbers are not eliminated or mitigated. Breeds may be in danger of becoming extinct for a variety of reasons. Risk of extinction may result from, inter alia: low population size; direct and indirect impacts of policy at the farm, country or international level; lack of proper breed organization; or lack of adaptation to market demands. Breeds are categorized as to their risk status on the basis of, inter alia, the actual numbers of male and/or female breeding individuals and the percentage of purebred females.

Characterization of animal genetic resources: all activities associated with the description of animal genetic resources (AnGR) aimed at better knowledge of these resources and their state. Characterization by a country of its AnGR will incorporate development of necessary descriptors for use and identification of the country's sovereign AnGR; and baseline and advanced surveying of these populations, including their enumeration and visual description, their comparative genetic description in one or more production environments, their valuation, and ongoing monitoring of those AnGR at risk.

Community-based management of AnGR: decisions on breeding policies based on a participatory approach by the communities (see Management of farm animal genetic resources).

Conservation of farm animal genetic resources: refers to all human activities including strategies, plans, policies and actions undertaken to ensure that the diversity of farm AnGR is being maintained to contribute to food and agricultural production and productivity, now and in the future.

Cross-breeding: mating between animals of different breeds.

Cryopreservation: the preservation of germplasm resources in a dormant state by storage at ultra-low temperatures, often in liquid nitrogen.

Domestic animal diversity: the spectrum of genetic differences within each breed, and across all breeds within each domestic animal species, together with the species differences of interest for food and agriculture production.

Ecotourism: travel undertaken to witness the unique natural or ecological quality of particular sites or regions, including the provision of services to facilitate such travel.

Ethnoveterinary medicine: deals with the folk beliefs, knowledge, skills, methods and practices pertaining to the health care of animals.

Exotic breed: exotic breeds are maintained in a different area from the one in which they were developed. Exotic breeds comprise both recently introduced breeds and continually imported breeds.

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***Ex situ* conservation of farm animal genetic diversity:** all conservation of genetic material within living animals, but outside the environment in which it developed *(ex situ in vivo)*, or external to the living animal in an artificial environment, usually under cryogenic conditions, including, inter alia, the cryoconservation of semen, oocytes, embryos, cells or tissues *(ex situ in vitro)*. Note that *ex situ* conservation and *ex situ* preservation are considered here to be synonymous.

Extinct breed: when it is no longer possible to recreate the breed population. This situation becomes absolute when there are no breeding males or breeding females remaining. In reality, extinction may be realized well before the loss of the last animal, gamete or embryo.

Farm animal genetic resources: those animal species that are used, or may be used, for the production of food and agriculture, and the populations within each of them. These populations within each species can be classified as wild and feral populations, landraces and primary populations, standardized breeds, selected lines, varieties, strains and any conserved genetic material, and are all currently categorized as breeds.

Farming system: a contiguous population of farms that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate. Farming systems include all activities, both agricultural (cropping, pasture, livestock; any horticultural, silvicultural and aquacultural elements; providing also for processing and marketing of commodities) and non-agricultural, under the control of farm household units. Generally, consideration of farming systems should account for all inputs and outputs of each element of the system.
Farm categories *(by size)*
Subsistence: less than 50 percent of production is marketed.
Smallholder: small family farms with more than 50 percent of production marketed.
Small-scale-commercial: medium family farms with more than 50 percent of production marketed.
Large-scale-commercial: large farms or companies with all production marketed.

Feed conversion ratio (FCR): In animal husbandry, feed conversion ratio (FCR), or feed conversion rate, is a measure of an animal's efficiency in converting feed mass into increased body mass. Specifically FCR is the mass of the food eaten divided by the body mass gain, all over a specified period of time. FCR is dimensionless, i.e. there are no measurement units associated with FCR. Animals like ducks have a low FCR and are therefore considered efficient users of feed.

Feed supplement: prepared animal feed that supplements the basic farm-produced feed with organic or inorganic substances.

Food security: exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

Gene pool: the sum of all genetic information in a breeding population at a given time.

Genotype: the genetic constitution of an organism.

Inbreeding: mating between animals with one or more ancestors in common and with a higher degree of relationship than the average of the population.

***In situ* conservation of farm animal genetic diversity:** all measures to maintain live animal breeding populations, including those involved in active breeding programmes in the agro-ecosystem where they either developed or are now normally found, together with husbandry activities that are undertaken to ensure the continued contribution of these resources to sustainable food and agricultural production, now and in the future.

Knowledge
Local knowledge: a collection of ideas and assumptions that are used to guide, control and explain actions within a specific setting, based on particular value systems (religious and mythical beliefs) and epistemology.
Traditional knowledge: that which is comprised of proven ancient, original and distinctive customs, conventions and routines. It also embodies a static view of culture having its origin in ancient history.
The difference between traditional knowledge (TK) and local knowledge (LK) is that the first is static, while the second is dynamic in nature. This means that LK continually changes and is reinterpreted and modelled by contemporary daily experiences and activities.
Indigenous knowledge: that which tends to emphasize the

G L O S S A R Y

knowledge internal to a particular setting differing from LK, which focuses on the locality in which the knowledge is used and embraces exogenous knowledge that entered the local community over time.

Livelihood: a combination of the resources used and the activities undertaken in order to live. The resources might consist of individual skills and abilities (human capital), land, savings and equipment (natural, financial and physical capital, respectively) and formal support groups or informal networks that assist in the activities being undertaken (social capital).

Management of farm animal genetic resources: encompasses all technical, policy, and logistical operations involved in understanding (characterization), using and developing (utilization), maintaining (conservation), accessing and sharing the benefits of animal genetic resources.

Mixed farming system: a farming system conducted by households or by enterprises where crop cultivation and livestock rearing together form integrated components of a single farming system. They include the livestock systems of landless smallholders that rely on the crop cultivation of neighbouring farms.

Monitoring of AnGR: collection of information to assess the population size and structure, as the basis for an early warning system to prevent disappearance or extinction.

Phenotype: the visible appearance of an animal (with respect to one or more traits) that reflects the reaction of a given genotype within a given environment.

Population: a defined group of interbreeding organisms.

Poverty: a pronounced deprivation of well-being related to lack of material income or consumption, low levels of education and health, vulnerability and exposure to risk, voicelessness and powerlessness.

Selection: a system for either isolating or identifying specific genotypes in a population, resulting in a choice of which animals will be used for reproduction.

Shifting cultivation: a method of cultivation in which several crop years are followed by several fallow years with the land not under management during the fallow. The shifting cultivation may involve shifts around a permanent homestead or village site, or the entire living area may shift location to fields in a totally different area.

Species: a class of individuals capable of interbreeding and producing fertile offspring, but which is reproductively isolated from other such groups having many characteristics in common. In the hierarchy of biological classification species is the category below genus; species is the basic unit of biological classification.

Sustainable development: the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in the agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially responsible.

Utilization of farm animal genetic resources: the use and development of animal genetic resources for the production of food and agriculture. The use in production systems of AnGR that already possess high levels of adaptive fitness to the environments concerned, and the deployment of sound genetic principles, will facilitate sustainable development of the AnGR and the sustainable intensification of the production systems themselves. The wise use of AnGR is possible without depleting domestic animal diversity. Development of AnGR includes a broad mix of ongoing activities that must be well planned and executed for success, and compounded over time, hence with high value. It requires careful definition of breeding objectives, and the planning, establishment and maintenance of effective and efficient animal recording and breeding strategies.

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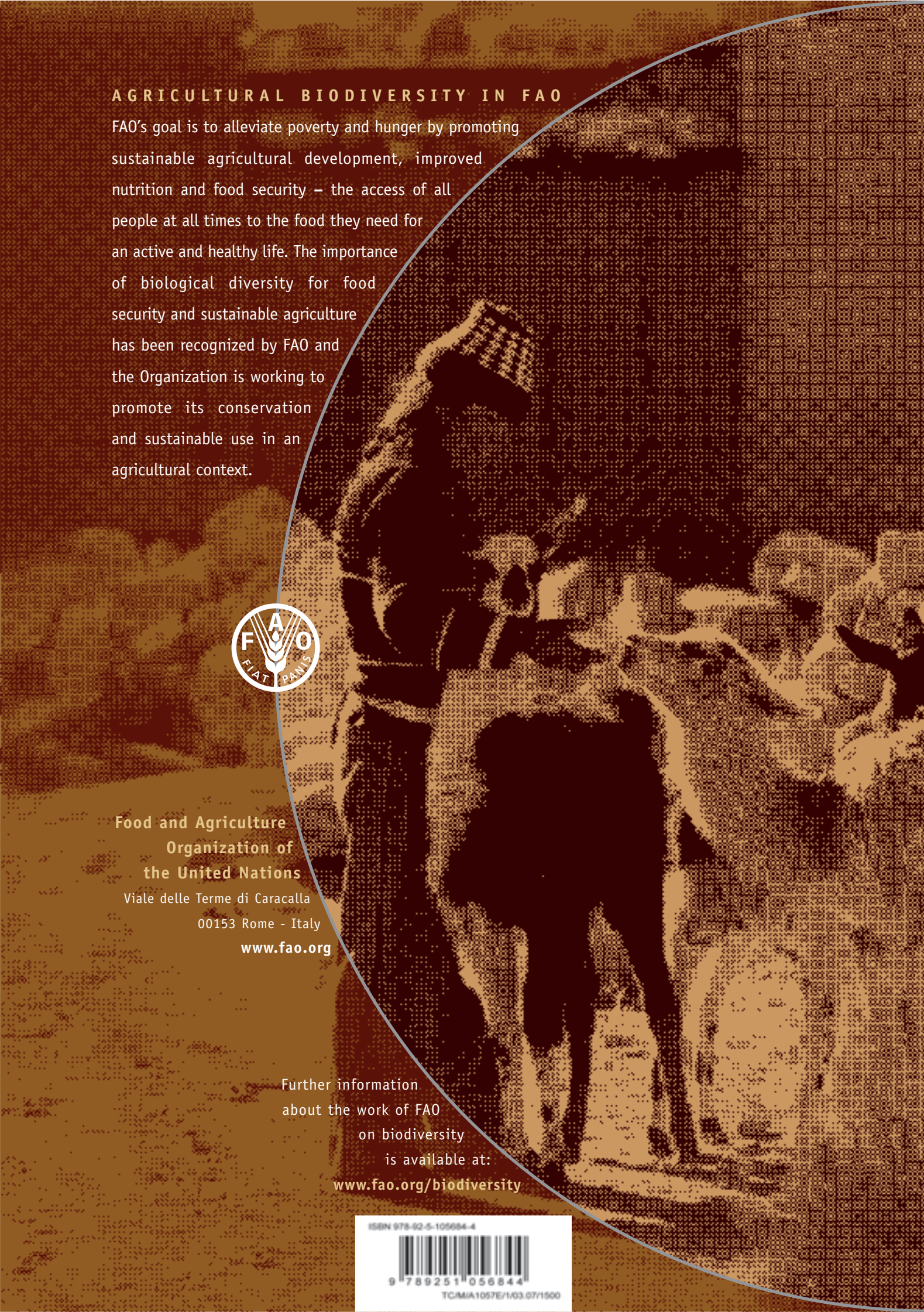

AGRICULTURAL BIODIVERSITY IN FAO

FAO's goal is to alleviate poverty and hunger by promoting sustainable agricultural development, improved nutrition and food security – the access of all people at all times to the food they need for an active and healthy life. The importance of biological diversity for food security and sustainable agriculture has been recognized by FAO and the Organization is working to promote its conservation and sustainable use in an agricultural context.

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Further information about the work of FAO on biodiversity is available at:

www.fao.org/biodiversity

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