

AT THE CROSSROADS BETWEEN EAST AND WEST
IN THREE HOSPITABLE COUNTRIES
AGRICULTURE AND BREEDING WERE DEVELOPED SINCE THE NEOLITHIC
COPING WITH THE RHYTHMS OF THE SEASON
A TREASURY OF GENETIC RESOURCES IS MAINTAINED IN GARDENS
TO MAKE BREAD, CHEESE AND WINE

PASTORALISTS AND FARMERS MANAGE THE LANDSCAPES

RURAL PEOPLE KNOW AND USE WILD PLANTS AND ANIMALS

COMBINING BIODIVERSITY, HEALTHY ECOSYSTEMS AND SMALLHOLDERS' DEDICATION:
A PATHWAY INTO THE FUTURE

Երկրագործներն ու անասնապահները կառավարում են իրենց
հողակտորները

Otlaq istifadəçiləri və fermerlər landsaftı idarə edirlər

მიწას მწყემსები და ფერმერები განაგებენ

7

INTRODUCTION

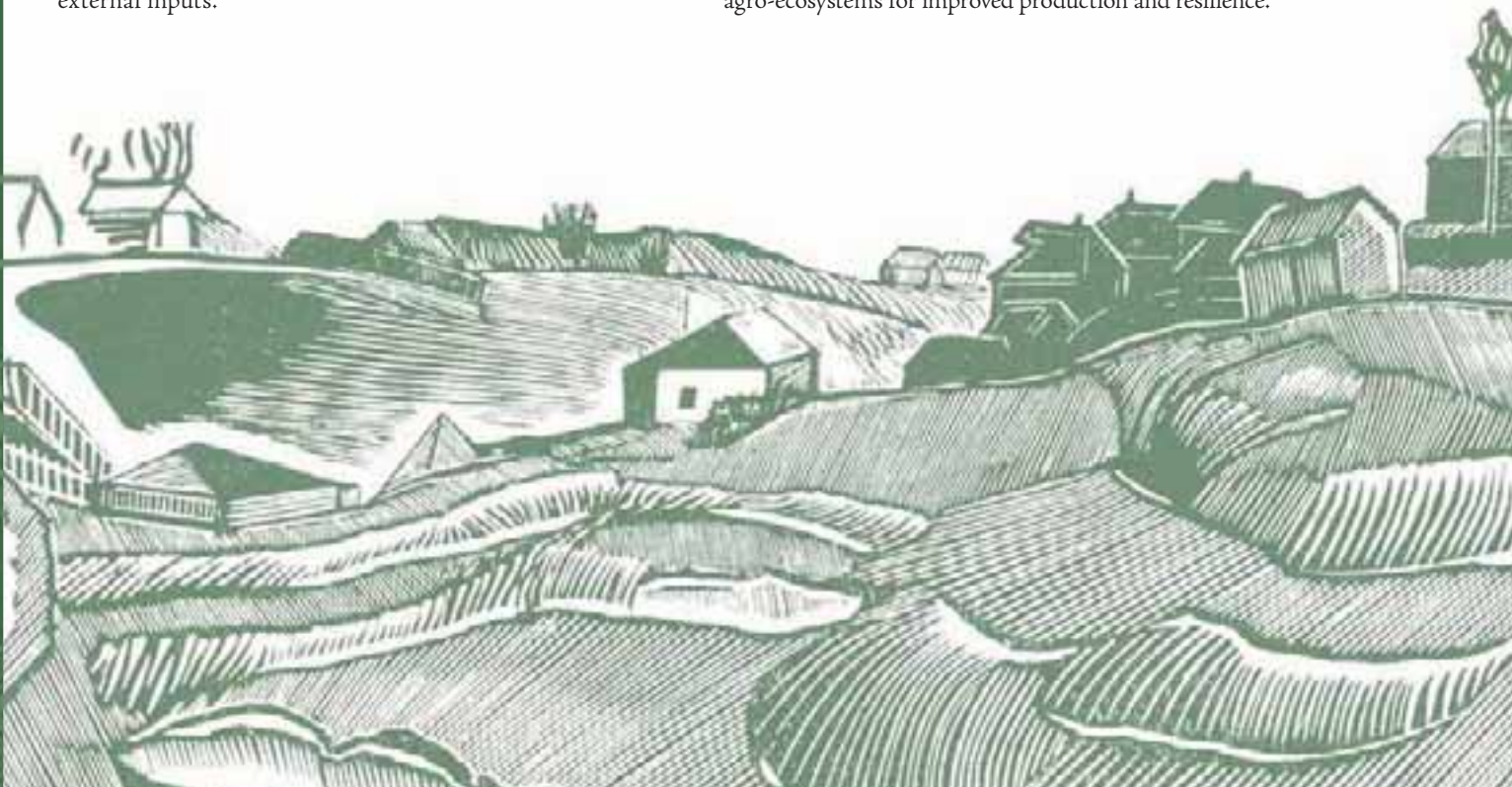
PASTORALISM AND AGRICULTURE IN THE SOUTHERN CAUCASUS WERE SUBJECT TO INTENSIFICATION IN THE TWENTIETH CENTURY, FOLLOWED BY A WAVE OF DRASTIC CHANGES AFTER 1989. AS A RESULT, THE TERRITORY IS A COMBINATION OF LARGELY HOMOGENEOUS LANDSCAPES CHARACTERIZED BY INTENSIVE AGRICULTURE, ESPECIALLY IN THE PLAINS, VALLEYS AND FOOTHILLS, AND OF A VARIETY OF TRADITIONALLY MANAGED LANDSCAPES, PRESERVED MAINLY IN PERIPHERAL AND MOUNTAINOUS AREAS.

*A*gro-ecological management entails a paradigm shift where agro-ecosystems are designed and managed in a manner that optimizes nutrient and energy flows below and above ground.

Farmers' and pastoralists' knowledge of ecological processes can replace either excessive dependence on, or the lack of, external inputs.

An understanding of ecological and biodiversity management can unlock new potentials and provide goods and services to both the natural and human environments.

Ecosystem services (e.g. pollination, predation and soil nutrient cycling) are as valuable as agricultural products in providing public goods. Conserving these ecological processes allows managing agro-ecosystems for improved production and resilience.





Ecological behaviour by farmers, such as promoting nutrient cycling and maintaining pollinators, is fundamental to maintain a balance between agricultural production and ecosystem services

THE ROLE OF PEOPLE

Farmers and pastoralists are the custodians of traditional landscapes. Their management practices (such as breeding of local livestock adapted to feed on local poor-quality pastures) could continue to provide food while making a sustainable use of marginal and fragile resources. But changing needs might encourage practices that only bring short-term benefits. The intensification of agriculture mainly based on uncontrolled use of fertilizers, spread of monocultures and heavy machinery

might result in increasing eutrophication, loss of species-rich habitats and loss of landscape heterogeneity. The starting-point for maintaining good landscape management is to reinforce and develop specific agriculture and environment education programmes for all levels of society (including producers, consumers, policy-makers and the private and public sectors) that reconcile food production and the maintenance of natural resources.



Dr Eteri Didmanidze of the Georgian National Museum. International support should be granted to local institutions in order to develop a more interdisciplinary and holistic approach to agricultural science according to agro-ecological principles. Below: butterflies at the Georgian National Museum: *Colias caucasica* Stgr. (left) and *Allancastria caucasica* Led. (right)





Microscopic examination of beetles by Giorgi Chaladze, an entomology student at the Institute of Zoology in Tbilisi

THE ROLE OF SCIENCE

A wealth of information has been developed by scientists to respond to the need to produce sufficient food while maintaining the natural resource base. However, a large part of this information does not leave the research centres to influence farmers' decisions and daily practices. When science builds on local technical knowledge it can contribute to food security while enhancing natural ecosystems and agricultural production. For example, the Research Institute for Buffalo Breeding in Azerbaijan promotes modern technologies for selecting local buffalo breeds, and provides recommendations

for the maintenance of their habitat, directly involving local communities in their daily work and practices to maintain their culture and landscape management practices with which the breed is interdependent.

A collective effort is needed to reorient research and agricultural development towards agro-ecological principles that should lead to another type of science, one that is more holistic and understands dynamic complexity, ecology and landscape management.



Laboratory assistant Nino Miruashvili with the collection of hedgehogs from the Institute of Zoology in Tbilisi

THE ROLE OF DATA

For this book, reliable average and historical data have been used that are considered significant in analysing the condition of a territory: temperature, rainfall, soil characteristics, wild and domesticated species and agronomic practices. Yet this is not enough to understand and appreciate fully the enormous diversity within the territory and among farms. Farmers' knowledge of the basic mechanisms underlying soil fertility, plant growth, biological pest control and animal breeding needs to be analysed and combined with scientific data. Therefore, in order to make the best use of the landscape and its biodiversity, it is necessary to move much closer to farmers. Data have to exit from academic realms and zoom in on the territory and, more important, into the thinking of farmers and rural communities in order to support their decisions.

Efficient and locally adapted information related to the water requirements of plants and to soil fertility needs to be made

urgently available to farmers at site-specific or village level in a practical form, in order to support their daily decisions and farming practices so that they can maintain a sustainable and secure agriculture production. In return, the data and information produced by farmers should be better valued and used by scientists. Farmers can provide help in monitoring landscape conditions. They can help in the development of theories and inform scientists. Their traditional ecological knowledge is essential to develop agricultural practices adapted to new challenges.

The role of policy-makers in adding value to data contained in traditional knowledge and in ensuring that data information is produced for the direct benefit of those people managing the land is essential. Personalized support schemes tailored to specific farms' conditions should be developed to reward agricultural practices combining production with ecosystem services.



Personalized support schemes tailored to specific farms' conditions, including grazing systems, should be developed to reward agricultural practices combining production with ecosystem services



Grasslands cover vast areas of fragile ecosystems that are not suited to agricultural production but provide a significant amount of good feed for nomadic cattle and sheep

MANAGEMENT OF GRASSLANDS

Grasslands cover on average 65 percent of the Southern Caucasus' total agricultural area. They can be found at altitudes of 3 500 m down to sea level and pastoralists have developed strategies to maximize milk, meat, wool, dung and transport from these fragile environments, which are not suited to agricultural intensification.

In Azerbaijan, more than 3 million head of sheep, goats and young cattle are taken every year to summer pastures to graze for 100 to 120 days from May to September. In winter, flocks and herds graze on the lowlands and southern slopes, in desert environments or are kept in stables to protect them from wolves and the cold weather.

Winter pastures, with a total area of 1.7 million ha, are considered an indispensable cheap fodder resource for nomadic cattle and sheep.

In addition to grazing, grasslands are used for hay production and to protect mountain slopes. Currently, many movements between seasonal grasslands are being reduced or eliminated. Herd composition is being restructured along commercial lines; pollution, overgrazing and agriculture intensification are affecting traditional management practices.

Over 80 percent of grasslands in Georgia and more than 86 percent of natural pastures and hayfields in Armenia are degraded. Some 50 percent of total pastures and rangeland in Azerbaijan are subject to erosion processes. Winter pastures and their genetic resources are unprotected.

There are no policies regulating overgrazing and bad management practices such as the cultivation of fragile soils. Regulating norms and agreements specifically for grassland use should be developed, promoting clear rules for summer and



Hundreds of species are preserved in the natural grasslands of the Southern Caucasus and good farming practices help to maintain such biodiversity

winter grazing and supporting mobility as a strategy to make the best use of summer and winter grasslands. Policies should build on pastoral knowledge and community management of grasslands to sustain animal production, to improve quality and quantity of forage production, to maintain its rich biodiversity, and to protect fragile soils. These policies should plan for a period of at least 15 years and seek a balance between animal production and grassland protection.

LOCAL FORAGE LEGUMES OF GLOBAL IMPORTANCE

Farmers and pastoralists do not limit themselves to managing natural grasslands, but they also cultivate forages, and especially legumes, as part of their cropping systems. At present, several legume species that originated in the Caucasus are cultivated in other ecosystems around the world.

The benefits of these species have been examined not only in regions traditionally reliant on forage legumes (e.g. in Australasia) but also in countries (e.g. in Europe) where the use of nitrogen (N) fertilizer is the norm. Forage legumes that originated in the Southern Caucasus are much appreciated for their biological role; their capacity to fix large amounts of N in the soil; their role in crop rotations; their contribution, as cover crops, to soil protection; and their plasticity in adapting to droughts, floods and extreme weather conditions.

The role of forage legumes in animal diets and the high protein content of these plants are important components of sustainable and secure animal production systems. Alfalfa (see Chapter 4), sainfoin and *Lathyrus* have played and will play an essential role in human development and civilizations, in animal diets and in the maintenance of landscapes.

Sainfoin (*Onobrychis sativa* Lam.)

Armenian	<i>Korngan</i>
Azeri	<i>Khasha</i>
Georgian	<i>Espartseti</i>

Sainfoin is a productive legume suited to calcareous dryland soils. It is rich in proteins (16.4 percent) and in minerals. It responds to irrigation on shallow soils. Condensed tannins in its leaves prevent bloating in ruminants and improve their protein metabolism efficiency.

Sainfoin is the most productive fodder in high rainfall mountains, foothills and plains where irrigation is scarce. In foothill zones, sainfoin is sown both in autumn and spring. In rainfed conditions, it gives two hay cuts a year, each yielding 5–6 tonnes/ha dried hay. Sainfoin is a good crop before cereals and potatoes. Both the Southern Caucasus and the Near East are considered the cradles of sainfoin cultivation.

In Armenia, sainfoin cultivation began centuries ago. There are references to sainfoin in *Haybousak* by Ghevond Alishan, as well as in the songs of the Armenian mediaeval philosopher Grigor Narekatsi. For centuries, sainfoin has been cultivated in natural specific conditions, resulting in generation of a local variety of a valuable economic and biological nature. According to A. Matevosyan, there are 21 wild varieties of sainfoin in Armenia. According to Aydin Asgarov, there are 22 or 23 species in Azerbaijan.

Onobrychis transcaucasia Grossh. (Transcaucasian sainfoin) is considered to be one of the oldest forage crops in the world. It grows in the wild everywhere, especially on dry slopes of the middle mountainous zone. There are known to be many different populations, and it is a polymorphous variety. Many wild varieties of sainfoin are also of a certain economic interest

for further breeding given their precocity, winter-resistance, drought-resistance and the fact that the “sainfoin flower mosquito”, which damages cultivated plants, does not harm the sainfoin wild varieties *O. cadmea* Boiss., *O. oxytropoides* Bunge, *O. vaginalis* CAM and *O. biebersteinii* G. Sir. Given the global importance of this species for forage production, the creation and protection of a seed collection of sainfoin in the Southern Caucasus is an international issue.

Lathyrus (*Lathyrus* spp.)

Armenian	<i>Tapolor, Gulur</i>
Azeri	<i>Gululje</i>
Georgian	<i>Tsulispira</i>

Lathyrus grows in the mountains and is one of the best forage species in the Southern Caucasus. It is preferred by ovines and horses rather than by bovines. *Lathyrus* is an indicator of soil fertility. Because of its deep roots, it can grow in both dry and heavy soils. It is a perennial species that produces abundant nectar and good honey.

L. sativus L. (white pea) is a drought- and cold-resistant spring crop good for green forage, silage and its seed flour, which is a preferred feed for pigs and poultry.

One of the best forage species is *L. tuberosus* L. (sweet pea) (called *Catvi-tciank*, *Tap-volor* in Armenia, *Kokuyumru gululje* in Azerbaijan and *Tero* in Georgia), a perennial species found throughout the Southern Caucasus up to 1 000 m. Bees appreciate *L. tuberosus* L. for its rich nectar and pigs eat its root tubercula, which are the size of walnuts, black and characteristic of this species.

The tubercula (called *Glandes terrestres*) contain an essential oil similar to that of roses, which can be extracted by distillation.



The Southern Caucasus is the cradle of several legume species of important economic and biological value that are cultivated in all Australasia and Europe. Therefore, the creation and protection of seed collections of these species should be an international issue



In the Southern Caucasus there are over 400 species of grasses and legumes. This great biodiversity is of global importance but today only a few species are studied and cultivated. Among the species that would deserve more research: from left to right (above): *Bromus inermis*, *Phleum hirsutum*, *Bromus erectus*; from left to right (below): *Trifolium badium*, *Poa alpina*, *Festuca nigrescens*





From left to right (above): *Avenella flexuosa*, *Brizia media*, *Deschampsia cespitosa*, *Sesleria albicans*.
 From left to right (below): *Phleum rhaeticum*, *Cynosurus cristatus*, *Trifolium alpinum*
 [Source: Bozzo, F. et al., 2004. Site-specific grasses and herbs. Rome, FAO.]





MANAGEMENT OF POLLINATORS TO MAINTAIN THE PRODUCTION OF THE ECOSYSTEM

by Barbara Gemmill-Herren

GLOBAL VALUE OF POLLINATION SERVICES

Pollination is a much overlooked and undervalued ecosystem service all over the world, yet one that is critically important to the natural world and to food production for human livelihoods. While foraging for food for themselves and their offspring, pollinators such as bees and moths, and a wide variety of other species, inadvertently provide a service that directly links wild ecosystems with agricultural systems, demonstrating why biodiversity conservation underpins human welfare.

The vast majority of flowering plants will only produce viable seed or fruit if an insect or other animal visits their flowers and moves pollen from the anthers to the stigma of a flower of the same species. Without this service, many interconnected species

and processes functioning within an ecosystem would collapse. Pollination services shape plant communities and determine fruit and seed availability, providing tremendously important food. The diversity of pollinators and pollination systems is striking. Most of the approximately 20 000 species of bees (Hymenoptera: Apidae) are effective pollinators and, together with moths, flies, wasps, beetles, bugs and butterflies, make up the majority of pollinating species.

Notably, arid and mountain ecosystems often have highly diverse pollinator communities as well, with finely tuned adaptations to ensure that pollination is effective even when climatic conditions are erratic.



Beehives in Kotayk Marz in Tsaghkadzor village. Pollinators represent a natural service that can effectively contribute to agricultural production, all the more so in the current conditions of rising input prices and climate change. <<Left: Caucasian bee on blossoming almond

VALUE OF POLLINATION SERVICES

In agro-ecosystems, pollinators are essential for orchard, horticultural and forage production, as well as the production of seed for many root and fibre crops. Eighty-seven of the leading global food crops are dependent on pollination services provided by animals out of a total of 113 food crops, and 35 percent of all food production globally comes from crops dependent on pollinators. For human nutrition, the benefits of pollination include not just abundance of fruits, nuts and seeds, but also their variety and quality. In many countries, quality is vitally important, because well-shaped fruit – the result of good pollination – fetches much higher prices in the market.

Pollination is one ecosystem service that until recently was considered to be poorly documented from an economic standpoint, and had few hard figures to justify its value. But

that has been rectified with a recent careful assessment of the contribution of animal pollination services to the global economy, which places the total economic value of pollination worldwide at EUR153 billion, representing 9.5 percent of the value of the world agricultural production used for human food in 2005. Those crops that depend on pollination services are high value, averaging values of EUR761 per tonne, against EUR151 per tonne for those crops that do not depend on animal pollination.

These figures do not include the contribution of pollinators to crop seed production (which can contribute considerably to seed yields), nor to pasture and forage crops. Nor do these figures include the value of pollinators to maintaining the structure and functioning of wild ecosystems – as yet these are all uncalculated.



THREATS TO POLLINATION SERVICES

Pollination services have been little appreciated until recently, since they are provided by nature at essentially no cost. As evidence, pollination has not been addressed by the agronomy sector, nor treated as a critical agricultural input, together with fertilizers, pest control and water management. Yet as intensive agriculture, with large-scale cropping patterns and inputs of pesticides, has become the norm in developed countries, serious impacts have been seen in the declines of pollinator populations to service crops. Other pollinator groups are also showing serious declines – in particular, butterflies and nectar-loving birds and bats. The ratio of threatened vertebrate pollinators to the total numbers of vertebrates in each genus is extremely high, which indicates that the world's nectar-feeding wildlife may be as vulnerable as carnivores to human-induced extinction pressure. The key threats to pollinators are no different from those to biodiversity in general: habitat fragmentation, intensification of land use, use of agrochemicals toxic to beneficial organisms, climate change and alien invasive species.

ACTIONS TO ENSURE CONTINUED PRODUCTIVITY OF THE SERVICES

As the process of securing effective pollinators to “service” large agricultural fields is proving difficult to engineer, there is renewed interest in helping nature provide pollination services. The international community has identified the importance of pollinators with the establishment of the International Pollinators Initiative in 2000 by the CBD, facilitated and coordinated by FAO. Four areas for action on behalf of the conservation and sustainable use of pollinators have been identified: (i) assessment and better knowledge management; (ii) identification of best adaptive practices in managing ecosystems to promote pollinators; (iii) capacity building so that these practices can be applied; and (iv) greater awareness and policy to support the role of pollinators.

Some recognized pro-pollinator practices include conservation of patches of wild habitat – such as forests or structurally diverse grasslands – in agricultural landscapes. A five-year global project beginning in 2009, funded by the United Nations

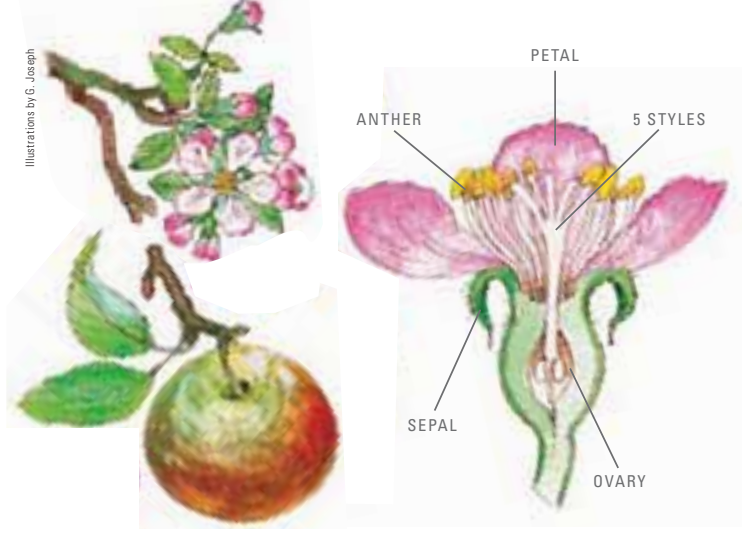


Coleopters on a rose in Suvelan village. In the Southern Caucasus, the value of pollination for pastures and forage crops may rival the value of crop production. The value of pollination worldwide has been estimated at EUR153 billion/year

Environment Programme (UNEP) Global Environment Facility (GEF) and coordinated by FAO, will be able to explore and test, in multiple agro-ecosystems and ecologies, the practices that will prevent the loss of pollination services provided by wild indigenous pollinators. Regional initiatives in other areas – including Europe, North America and Oceania – have similar objectives. Most solutions designed to make modern agriculture more biodiversity-friendly will need to be developed within a supportive policy framework. Merely getting the idea of pollinators into the awareness of policy-makers is a challenge; pollinators are largely insects, which are more often perceived as being unpleasant rather than beneficial.

The process of pollination is subtle, and has often not been understood by farmers, much less by the general public. Public awareness and supportive policies are easier to build around charismatic animals; with pollinator conservation, new ground needs to be broken in conveying to the public that it is the links and interactions between living things that are endangered, not the individual species *per se*. However, most of the policies and practices that will serve to benefit pollinators are not stand-alone measures. Increasing diversity on farms, introducing areas of habitat that foster beneficial insects, linking habitats and reducing the application of toxic agrochemicals also have multiple benefits for other ecosystem services in agriculture.





Pollinators such as bees are important to promote growth and provide local genetic material in order to increase the production of fruits. Flowering branch, fruit and median section of apple flower (left). Queen bee on a typical cage used for its transportation (right)

POLLINATION IN THE CAUCASUS

In the Southern Caucasus, it is impossible to separate meadows and orchards from bees. Many plants need to be pollinated in order to produce fruit, and local genetic material has evolved together with local bees. Small farmers need honey as a source of food and wax to be used during the long winters but they also need bees in order to obtain good fruit production. The many fruit trees in the Rosaceae family with important centres of origin and domestication in this region – for example, cherries, plums, pears and apples – depend heavily on abundant visitation by insect pollinators at the time of flowering in order to achieve good yields. By visiting the flowers, pollinators (mostly bees) move pollen from the anthers on the flowers of one tree to the styles of the flowers on another.

The Caucasian bee

Honey bees (*Apis mellifera* L.) are one of the most well-known, popular and economically beneficial insects. For thousands of years, human beings have plundered honey bee colonies to obtain honey, bee larvae and beeswax. The Southern Caucasus has its own honey bee race, the Caucasian honey bee *A. mellifera caucasica*, which is widespread in the region.

Interest in this species was aroused by the Russian researcher A. Boutlerov, who published an essay about it in 1877, highlighting its pacific attitude.

The Caucasian bee has many characteristics that make it one of the most popular throughout the world: the length of its proboscis and wings; honey and wax production; high queen fertility; resistance to low temperatures and to diseases; lack of aggressiveness; high nectar collection capacity even in rainy and foggy weather; active defence of the hive; low feed consumption during the winter rest; and acceptance of queen coexistence. The production rate of the Caucasian bee is the highest among bee species. It is, however, slow to build up its population in the spring, and is thus particularly effective for crops that flower abundantly in the summer months.

In addition to indigenous races of honey bees, the Caucasus is rich in other species of bees – for example, many species of bumblebees are found here. Bumblebees are particularly well adapted to pollinating trees and crops that flower early in the season, and to tolerating the low temperatures of high mountainous regions.



The Caucasian bee is highly productive, resistant to low temperatures and diseases and is non-aggressive. It is well adapted to the Caucasian climate, as its pollination is particularly effective for crops that flower in summer months

SPECIES POLLINATED BY THE CAUCASIAN BEE AND HONEY PRODUCTION		
Scientific name	Common name	Honey production (kg/ha)
<i>Robinia pseudoacacia</i>	Black locust	1 600
<i>Acacia</i>	Acacia	1 000
<i>Tilia caucasica</i>	Lime tree (linden)	1 000
<i>Castanea sativa</i>	Chestnut	300
<i>Melilotus officinalis</i>	Clover, yellow sweet	170
<i>Medicago</i>	Alfalfa	300
<i>Elaeagnus</i>	Russian olive	80
<i>Symphytum caucasicum</i>	Caucasian comfrey	70
<i>Prunus armeniaca</i>	Wild apricot	5
<i>Prunus persica</i>	Peach	1
<i>Prunus divaricata</i>	Cherry-plum	1–40
<i>Prunus amygdalus</i>	Almond	25
<i>Prunus spinosa</i>	Sloe	20
<i>Laurocerasus officinalis</i>	Cherry laurel	20
<i>Pyrus caucasica, P. communis</i>	Pear	15
<i>Malus domestica</i>	Apple	15



Transhumant beekeeping, in addition to honey production, has an important ecological role in enhancing pollination of wild plants and trees

Transhumant beekeepers

Bee transhumance is a particular feature of Armenia and Georgia. Beekeepers start the bee pollination season in the valleys and then move towards the hillsides and mountains, in order to make the most of precocious flowering in mild areas and late flowering in colder areas.

Pollination is carried out by separating the type of honey by area of pollination, and thereby yielding a product with specific characteristics. Experienced beekeepers have noted that bees are more likely to pollinate wild varieties of pears and apples than other varieties. This, they believe, is because of the faster desiccation of the nectar of the plants that have been selected by breeders.

The acacia tree is one of the bees' favourite trees; it produces large quantities of honey per ha (about 1 000 kg). The honey is yellow, transparent and sweet. The best honey is aromatic and yellow and comes from the lime tree, while another popular variety is chestnut honey. Nectar for bees also comes from herbaceous plants: clover, medick, melilot and rye-grass. The honey harvested from white clover is aromatic and yellowish; that from red clover is darker (almost ochre); and honey from sainfoin is described locally as transparent "as a tear". Specialization is so driven that individual plant species are pollinated by expert nomadic beekeepers who thus secure a very low but highly specialized production (e.g. only 1 kg/ha is produced of rare peach honey or of wild plum honey) that is much appreciated at markets.



Beekeeping is an important source of income. Beekeepers from Yeniol village are depicted, preparing the beehives for the winter

TRADITIONAL BEEKEEPING IN AZERBAIJAN

by Yagub Guliev

Honey bees do not only produce honey, but play a vital role in the balance of nature, especially in the pollination of agricultural and horticultural crops and in home gardens. Pollination is important for the viability of many pastoral enterprises, market gardens, orchards and seed industries. Collecting honey from wild bee colonies is still practised

by aboriginal societies in many parts of the world. At some point, humans began to domesticate wild bees in artificial hives made of hollow logs, wooden boxes and pots.

Beekeeping in woven baskets is still practised in Azerbaijan. Here, the species universally managed by beekeepers are the Caucasian bee and local Gabagtapa bee.

Beekeeping is very popular in rural areas to diversify income sources. Early forms of honey collecting entailed destruction of the entire colony when the honey was harvested until a revolution in beekeeping practices occurred in the nineteenth century through the invention and perfection of the movable comb, thanks to Langstroth. The majority of beekeepers in Azerbaijan

currently use a simple machine for extracting honey from the comb by means of centrifugal force.

Apiarists in Azerbaijan are not particularly mobile in general, with bee populations moving and mingling within a small geographic range from lowlands to mountains. Beekeepers do not migrate to the highlands.



For centuries pastoralists have selected and maintained livestock breeds adapted to the local climate, steep mountain slopes and local grasslands. Domesticated animals and pasture species have coevolved

MANAGEMENT OF LIVESTOCK

Over the centuries, pastoralists have developed local livestock breeds that are exceptional foragers of Caucasian native flora and can survive through a season of scarce food or graze marginal land where improved breeds would not survive. In the Southern Caucasus, domesticated animals and pasture species have coevolved and plant species more appreciated by animals have dominated.

Pastoralists have also contributed to maintaining good landscape conditions through weed control, fire suppression and recycling of nutrients into the soil through hoof action and manure. The strong interdependence between people, animals and their habitat has contributed to shaping today's landscape.

The structure of the herd (number of young animals, milking animals, female and male) is normally regulated according to feeding resources and land tenure rights. Livestock traditionally belong to individual families but graze on private land as well as on communal meadows. Communities still regulate grazing rights.

The extinction of local breeds selected for specific environments in the Southern Caucasus will not only seriously damage farmers and pastoralists who depend upon them, but also seriously damage the gene pool that could provide important genetic material to the entire world. Major efforts are needed to inventory, understand and protect this biodiversity. It is also urgent to mobilize scientists and policy-makers to preserve local breeds in gene banks and to integrate them as important components of modern, diversified and sustainable farming systems.

This book describes a few examples of animal genetic resources found in the Southern Caucasus.

CATTLE

Georgian mountain cattle

Georgian mountain cattle are an old breed selected for milk production. Like most traditional breeds, they also provide meat and draught power.

The breed is maintained on the southern mountain slopes and in the mountainous Ajara region where temperatures are extremely low (falling between -25 and -30 °C); winters are snowy and last from five to seven months; feeding resources are scarce and of very poor quality – only this breed can survive and produce milk.

Georgian mountain cattle are extremely agile and can graze on steep slopes (30–35 percent) where rural farmers have to use a rope tied together around their waists to avoid slipping when mowing and cultivating the land. The cattle breed is very small with an average withers height of 98–100 cm. The main milk production period of this breed is during grazing from May to October.

Generally milk yields are low, but with improved feeding and care can average 2 000 litres/year with 4.2 percent fat. The milk is characterized by small-diameter fat globules, which indicate its dietary characteristics. Its high fat percentage is maintained when total milk production is increased.

The strong constitution, endurance, high milk fat content and meat quality of this breed should be recognized in order to promote the sustainable use of fragile and harsh mountain grasslands but, lamentably, the existence of Georgian mountain cattle is endangered.



Megruli red cattle

Megruli red cattle are a multipurpose breed. They were developed by the Kvaratskhelia brothers in the Samegrelo region in about 1860. They spend the summer in alpine mountain pastures, but in winter they pasture on the Kolkheti bogs without supplementary food. They are permanently in the open air, have a strong constitution and good working characteristics. The breed only exists in Georgia and is endangered.

Caucasian brown/grey cattle

One of the most significant achievements of zootechnical science in the twentieth century could be considered the establishment of Caucasian nut brown cattle, based on the joint work of scientists from Caucasian countries. The breed has been raised by crossing Armenian, Azerbaijani, Georgian and Dagestan local cattle mainly with Swiss breeds.



In the southern parts of Georgia, where the Caucasian brown breed is mainly found, there are extensive grasslands that provide a stable food base. The characteristics of the basic breeds are successfully combined in these cattle: the Swiss brown breed offers large live-weight productivity, while the local breed contributes high milk fat and adaptation to local conditions.

Nowadays, the Caucasian brown breed exceeds 95 percent of total livestock in the country, but its productive indicators do not correspond to breed standards. This is partly because zootechnical registration is poorly maintained and artificial insemination does not exist. Moreover, since there are no breeding farms to produce improved bulls, cows are inseminated by free insemination of young bulls of unknown origin that will eventually cause the deterioration of the Caucasian brown breed. Record-keeping in Armenia and Azerbaijan is better organized and collaboration and joint work are required in order to improve the productivity of this breed.



Pastoralists contribute to maintaining the landscape through weed control, fire suppression and manure management. <<Left: *Megruli red calf and Caucasian brown cow*

Georgian buffalo

Buffaloes are bred in the lowlands and in mountainous regions. They feed well on poor pastures and on marshes, cane and low-quality hay, on which cattle cannot survive and produce. Buffaloes produce on average between 1 300 and 1 500 kg milk/year with 7.8 percent fat but can produce up to 3 000 kg depending on the quality of feeding resources available. The best-quality sour milk and cheese are made from buffalo milk. The meat of the grown buffalo is rough and fibrous and not comparable with cattle meat, whereas the meat of young buffaloes does not differ greatly from that of cattle. The king of Kakheti, Giorgi XII, was called “Eater of young buffaloes”, because he liked their meat so much. It is important to preserve local breeds since:

- ❁ they are resistant to leucosis, piroplasmosis, brucellosis and foot-and-mouth disease;
- ❁ they are adaptable to temperature fluctuations and low oxygen conditions in mountainous areas;
- ❁ they are good users of steep and low-quality pastures;
- ❁ their milk and milk products have specific taste features;
- ❁ they have specific culinary meat traits.

These characteristics of the local gene pool herd have been established by selection carried out over a long period by farmers and pastoralists and are a source for genetic completion.



Livestock graze both on private and communal grasslands and farmers have to regulate grazing periods in order to prevent degradation

Azerbaijan buffalo

by Akif Farajov

Buffaloes roam over the subtropical, boggy, marshy river areas of Azerbaijan. The buffalo is an irreplaceable domestic animal for its productivity in the adverse climatic conditions of the Aran (lowland) region. The animal was not studied on a scientific basis until 1930 and the breed was the result of popular selection.

The main reason for the spread of buffalo breeding was the availability of natural feeding resources (reedy areas, boggy zones, water basins and lakes), and the opportunity to feed non-milked buffaloes on grasslands throughout the year.

Approximately 102 000 family farms are involved in buffalo breeding in Azerbaijan. Ninety-five percent of them keep one to three buffaloes, 3.8 percent keep five to ten and 1.2 percent keep more than ten. In 2005, Azerbaijan provided for the establishment of private pedigree buffalo farmers in the state programme of socio-economic development for the region.

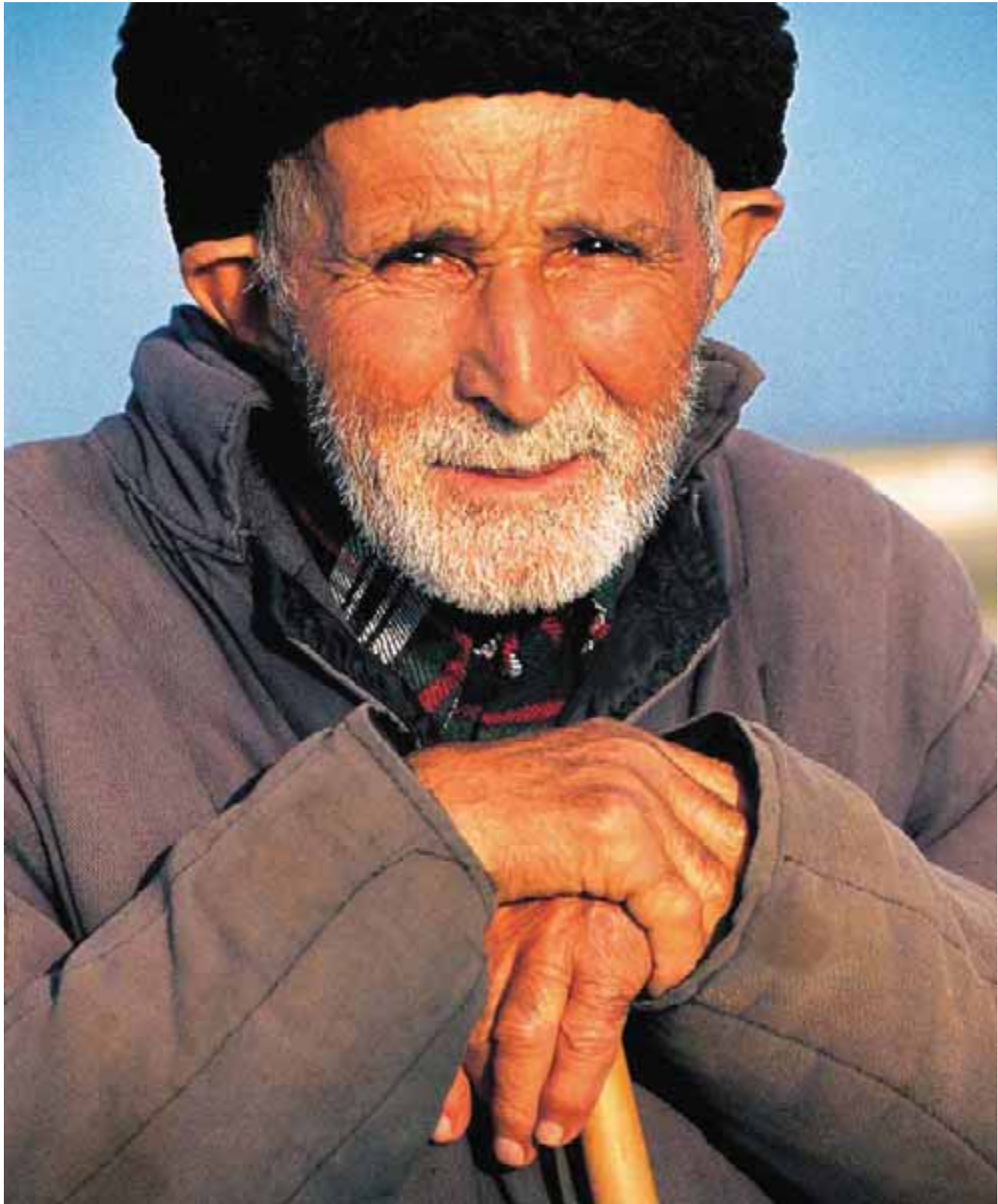
The absence of buffalo milk plants in Azerbaijan creates problems in the marketing of buffalo milk. Plants do not accept buffalo milk or try to buy it for a cheap price. For this reason, farmers prepare their own butter, cheese and *kefir* and sell their products directly at the market.

The reason for the slow development of buffalo products is that the market is poorly organized and potential consumers are not easily reached by producers.

Another reason for the slow development of buffalo products is linked to the need to improve the availability of the feeding base so as to maintain a stable milk production system throughout the year. For this purpose, at least one plant producing feed in Azerbaijan should be developed. In addition, good-quality sire buffaloes or buffalo semen should be made available to small farmers, as well as adequate education and a training programme related to the entire buffalo production chain (genetic resources, quality and quantity of forage and feeding resources, milk and meat production and processing).



Buffaloes are more rustic than cattle, more resistant to diseases and adaptable to temperature fluctuations, but their meat is very fibrous. Buffalo milk is high in quality and cheese and yoghurt would be much appreciated at markets, but the distribution chain is not sufficiently developed





THE BUFFALO FARMER YAVER BINI FARAJOV

by Marzio Marzot

A horseman rides by, rustling the weeds that shine warmly in the evening sun. The sun is setting and we are arriving at the huge *Yaver Bini oghlu* farm. We see and feel the magic around us: it extends as an endless valley with hundreds and hundreds of buffaloes, chewing away, that gaze at us with drowsy and docile eyes. With more than a thousand head, the entire area around the Xazar village (Neftçala) is full of them.

Yaver Bini Farajov, founder of the farm, comes to greet us. His more than eighty years do not show: his back is straight,

his gait steady, his eyes lucid and he rests upon his walking stick as any shepherd would, even at a young age. In keeping with Azerbaijan's hospitable spirit, we are invited to spend the night in Farajov's vast two-storey house built entirely in wood. Around us is a garden rich in fruit trees, small vegetable plots, beehives, chickens, geese, sheep and other animals.

The life story of Yaver Bini Farajov is both complicated and instructive. Farajov's satisfying results are due to study, courage and determination while taking part in a story of hardship

that includes consequences of the Second World War, a forced move from one region to another, working in the *kolkhoz* and the negative repercussions of the fall of the Soviet Union. In spite of – or perhaps thanks to – all this, Farajov today heads an exemplary farm where the core business consists of approximately 200 buffaloes. From their milk, various products are made, such as *pendir* cheese, yoghurt, ricotta (*shor*), cream and butter.

Business is going well and feeds not only Farajov's family but also another dozen families in the nearby Xazar village.





HORSES

Anthropological and archaeological investigations prove that horses were domesticated very early in the area around the Caspian Sea. Excavations in the Jalilabad region of Azerbaijan (Ali-komektepe monument, dating back to the fifth millennium BC), revealed animal bones with 7.5 percent of horse bones.

Horse breeding in Azerbaijan

The establishment of a hippodrome in Baku in 1923 was the first significant event in the development of horse breeding in Azerbaijan. Later, horse breeding farms were established in various regions and paved the way for development. Many years ago, nearly 15 games were played with horses. According to official statistics, at present there are more than 70 000 horses in Azerbaijan. About 400 thoroughbred horses are raised by individual farmers.

The Garabagh (Karabakh) horse is the oldest mountain saddle breed, named after the Garabagh region. Some historians believe that in the past this horse had significant influence on the development of the Arabian breed. The horse is well-proportioned and is golden and red. It significantly influenced the improvement of horse breeds in both the Southern and Northern Caucasus, and also of Don breeds. Garabagh horses have shapely heads, medium-high withers, straight backs and croups, wide breasts, thin limbs and a strong conformation.

The Dilbaz horse breed has analogies with Garabagh horses and was developed at the end of the eighteenth century by crossing local horses with Arab and Turkish breeds. It is used as a saddle and pull horse. It is usually grey or light-grey in colour, but white around the lips and nose. The hooves are usually white. The breed is widespread in the Ganja, Gazakh and Shaki-Zagatala regions. From 1944, state pedigree stables were established where Dilbaz horse breeds were improved by crossing them with Arab and Terek stallions.



Horses were domesticated very early in the Southern Caucasus and used for work, transport and in war. The region is proud of its beautiful animals, many of which are maintained by farmers for work and leisure. *Above: Shalala, a three-year-old Garabagh horse. Below: Sarin, a three-year-old Dilbaz horse*





Because of poor investments, today horse breeding programmes are neglected and the number of beautiful local horses is diminishing



Horse breeding in Georgia

Over the past 20 years, very little has been done to preserve and maintain horse genetic resources in Georgia. Breeding specialists need to receive training and information; the artificial insemination network is very poor.

The *Tushuri* horse has high endurance, courage, caution, good orientation, resistance to temperature changes, and light steps – all fundamental characteristics for living in the mountains. The horse is reared mainly in eastern Georgia. It is used for riding and as a pack animal, especially by nomadic shepherds, who



have problems in navigating roads. It is bred by herd methods on mountain pastures all year round.

The *Megruli* horse has been reared to feed on pastures since antiquity in the lowlands and around the Black Sea. The horse is mainly bay. It is a horse for riding and loading, is slow maturing and grows up to the age of six years. It is hard working and can carry loads of 100–130 kg. It has excellent resistance and works equally well in bogs and in mountains.

Horse breeding in Armenia

Horse breeding was widely developed in ancient Armenia. Domesticated animals had been used by Armenian farmers for agricultural work and transport over a long period. The Armenians mostly bred and improved local animals, which were muscular, light-footed and accustomed to the hilly terrain. Until the beginning of the twentieth century there was a horse breeding industry in Armenia, which was also engaged in breed selection; however, at present, horse breeding is the private occupation of individual farmers, and the head count has sharply decreased.





Sheep are widespread in the Southern Caucasus because they are well adapted to the ecosystem, resist cold and parasites, and tolerate low-quality forage. They provide wool, milk and high-quality meat. Today, there are more than 15 local sheep breeds in Azerbaijan

SHEEP AND GOAT BREEDING

According to archaeological data, the Southern Caucasus was one of the prehistoric centres of sheep breeding, where domestication of sheep goes back to 4000 BC. In the ancient Urartu state, fine-woolled and coarse-haired sheep breeds were known.

In the nineteenth century, sheep were improved and their number increased. Sheep breeds that are bred at present were produced as the result of cross-breeding of Southern Caucasian coarse-haired sheep breeds (*Mazekh, Balbas, Bozakh, Karabakh*) with fine-woolled male sheep. The new breeds are of two types:

semi-fine-woolled meat-wool-milk sheep, and semi-coarse-haired meat-wool-milk sheep. The famous Caucasian carpets highly appreciated for their quality and thickness are woven using this wool. Today, there are more than 15 local sheep breeds in Azerbaijan, and each breed produces a unique type of wool.

In the Southern Caucasus human rituals, both happy and sad, were tied up with sheep. It is clear from local folklore and traditions that it would be impossible for mountainous people to live without sheep.



Sheep and goats are inextricably linked to the life and culture of the Southern Caucasus

Tushuri sheep

The *Tushuri* sheep is a half fat-tail sheep breed. It is raised in nomadic conditions in east Georgia. The breed was obtained in the thirteenth-fourteenth centuries by crossing old Georgian sheep with other rough wool breeds. *Tushuri* sheep endure long journeys from summer to winter pastures (250–500 km) and can feed on poor pastures. Their meat and wool productivity increases considerably with improved feeding. The breed matures early and has high-quality meat and white, flexible, elastic and glittering wool, from which people knit prized quality rugs. A well-flavoured cheese produced from its milk is exported.

Imeruli sheep

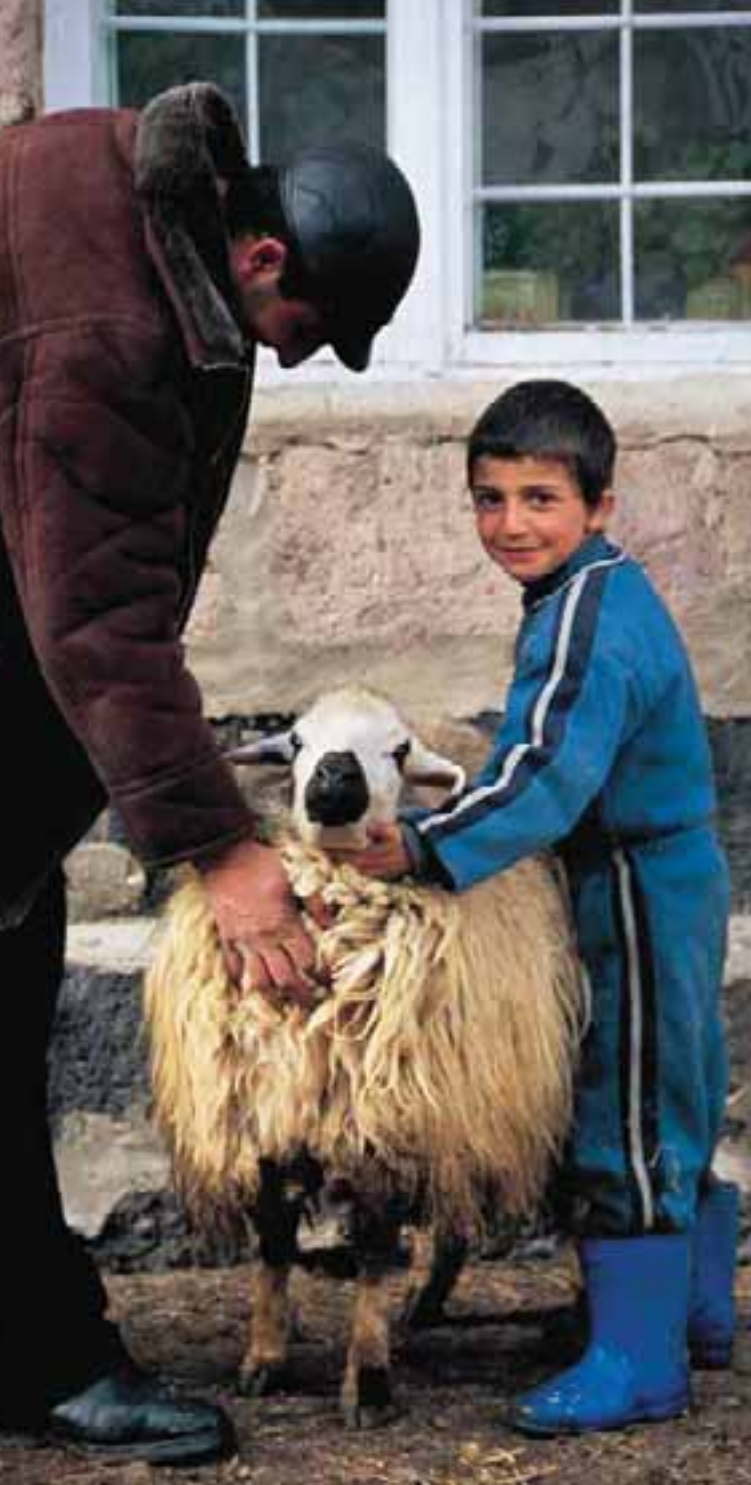
Imeruli sheep descend from old Georgian sheep. The unique breed of *Imeruli* sheep is characterized by an expensive biological-productive feature: it can be inseminated at the age of five to six months and multiplies in any season of the year. It gives wool of extra class and meat with a good taste and no odour.

The natural habitat of *Imeruli* sheep is shrinking because of the lack of village pastures. The breed is now preserved in Imereti, Racha and Svaneti.



A butcher in the Teze bazaar in Baku shows the impressive characteristic tail of a fat-tail sheep. *Below:* Summer pastures in the Mavush and Aragats mountains. In Armenia, Yesidis and Kurds are involved in sheep breeding together with Armenians; the former seasonally migrate to high pastures in summer and return to their settlements in winter





***Balbas* sheep**

Balbas sheep are a result of local selection and their wool is semi-coarse. They are strong, tall with a fat tail, long and divided into two parts. The head, neck and legs are without wool. On average, 1.8–2 kg wool is sheared from one ewe and 2.5–3.5 kg from one ram. The live weight of an ewe reaches 70–80 kg and its milk production is 125–135 kg. Every 100 ewes give birth to 125 lambs a year.

***Bozakh* sheep**

Bozakh sheep have been selected by crossing Garabakh and Tush sheep. They have long ears and a fat tail. The live weight of the ewes is 45–50 kg and they produce 1.8–2.5 kg wool. *Bozakh* sheep have a good milk production and the rate of giving birth to twins is 10–25 percent.

***Megruli* goat**

Two types of *Megruli* goats are bred for milk production in Georgia: mountain goats and lowland goats. Among the mountain goats, does reach a live weight of 40–45 kg and bucks 50–55 kg. The lowland goats are small but produce more milk. Sheep and goats often graze together in mixed herds.





Local animals are well suited to grazing on natural grasslands. To limit the state of degradation of many grasslands, appropriate policies must urgently be developed and pastoralists will need to be increasingly involved in maintenance of locally adapted genetic resources. In addition, animal stocking rates will have to be adjusted to the productive potential of grasslands. <<Left: two images of *Balbas* sheep and a typical *Megruli* goat



AZERBAIJAN CAMEL

Camel breeding is one of the most ancient branches of agriculture in Azerbaijan; one-humped (dromedary) and two-humped breeds of camels are common throughout. The body live weight of a four-year-old camel can reach 900 kg and the milk production 1 600–1 700 kg per lactation. Milk fat is 5–5.5 percent. Camel hair is more expensive than fine sheep's wool and on average 8–10 kg hair is obtained from one camel. Camel breeding has developed in the Apsheron, Beylagan, Barda and Bilasuvar regions of Azerbaijan. The two-humped camel is more active in a mountain and cold climate, while the one-humped camel is more productive in a desert environment.

According to Professor T.A. Bunyadov, the use of camels as a means of transport for people occupied with cattle breeding and living a half-nomadic life, as well as the demand for camels in wars taking place in the Caucasus in the eighth to sixth centuries BC, led to a rapid growth in camel breeding. The German traveller Adam Olerai, who visited Azerbaijan in the seventeenth century, noted that there were small camels as quick as horses.

According to statistics, there were 8 000 camels in Azerbaijan in 1921 but, according to registration by cattle farm workers carried out in 1935, camels were then 10 263 and dropped to 6 500 head in 1941, 500 head in 1968 and 200 head in 1984.

In an old saying, “camel-stature, horse-desire, buffalo-coral, sheep-sacrifice, goat-devil”, the camel enjoys universal esteem and love. Faith in the camel is described with great enthusiasm in the “Karvan” symphony, a masterpiece of Azerbaijan music, composed by Soltan Hajibeyov.

Wearing clothes made of camel hair has a beneficial effect in treating rheumatism. Camel milk is an exemplary medicine for treating coughs, sore throats, tuberculosis and gastrointestinal diseases.

There is a folk story about camel love.

The ruler of the country receives information that there is a poor man who has a very nice female camel with a lovely body. The ruler visits the village and looks at the camel. He thinks about how to get the camel from the poor man. He tells the poor man that he has lost his camel and this camel is his. The poor man swears on his conscience that he had not bought the camel from anyone and he has been rearing it for several years. But the ruler does not agree with him. At last they decide to show the distinctive signs of the camel in front of various people. The camel will belong to the person who can decipher these signs correctly. Both the ruler and the poor man show the distinctive signs of the camel exactly. The poor man demands that the ruler give an additional sign. The ruler is unable to do this but the poor man says that the camel has three wounds in its heart. Everyone is surprised and they agree to cut the camel and look at its heart. If the poor man is right, the ruler has to give him a camel, but if the poor man is not right he will give the ruler a camel. So they cut the camel. When looking at its heart they found three wound sites. The poor man said that the camel received these wounds from three births when she lost her calf at each birth.



Camels can weigh up to 900 kg and can produce up to 1 700 litres of milk per lactation and 10 kg of highly prized hair. This male from the Mughan region is 50 years old, a considerable age for a camel





WOOL PRODUCTION AND CARPETS IN THE SOUTHERN CAUCASUS

One of the best-quality sources for the yarns used in handmade rugs is lamb's wool. Lambs born in March are sheared in summer. Their wool is considered to have a higher value than that of lambs sheared in the spring or autumn. Lamb's wool is exceptionally soft and lustrous. Some of the best antique rugs were woven with this wool.

The most widespread folk art is carpet weaving. This craft made its way into the

everyday life of the people of the Southern Caucasus and became a symbol of the region.

Because of their high aesthetic value, with various patterns and designs, both fleecy carpets and those without pile are used to adorn the walls and floors of marquees, huts, homes, nomads' tents and other buildings.

Carpet weaving took place as early as the Bronze Age, as shown by a clay figure of a horse wearing a flower-patterned woven horse cloth, found in Maku and dating back to the second millennium BC.

Herodotus, Ptolemy, Xenophon and other ancient historians provided information on the development of carpet-weaving traditions in the Southern Caucasus. Weaving carpets with gold silk threads and jewelled decorations became a traditional activity during the sixteenth to seventeenth centuries. These very expensive carpets woven for the feudals were called *zerbaf*.

Anthony Jackinson, who visited Azerbaijan in the sixteenth century, reported that carpets were woven of gold silk threads in the summer residence of Abdulla Khan in Shamakhi.

From the twelfth to the fourteenth century, the Southern Caucasus exported many carpets and carpet products to foreign countries.

These carpets, attracting attention with their delicate patterns, are reflected in the works and miniatures of many European painters. In the fifteenth century, Flemish painter Hans Memling's tableau "Virgin with Child" incorporated a *Shirvan* carpet; in Van Eyck's "Saint Mary" there is a *Zeyva* carpet; in "The Ambassadors" (1533), by German painter Hans Holbein, a *Gazakh* carpet can be seen.



The various phases of the carpet manufacturing process: the wool is washed, teased, spun and finally woven. This work is done mostly by women





According to their technical specifications, Azerbaijan carpets are divided into fleecy carpets and those without pile (*kilim*). The first carpet patterns were *hesir* (matting), *cheten* and *buriya*. According to the style of weaving, the composition, the richness of the design and the colours, there are eight different patterns.

Azerbaijan weaving schools

Azerbaijan carpets are subdivided into seven carpet schools according to geographic composition, design, colour selection and technical specifications. These are *Quba*, *Baki*, *Shirvan*, *Ganja*, *Gazakh*, *Garabagh* and *Tebriz*.

The history of weaving different blouses, jackets, colourful socks, tablecloths, etc. from sheep and goat wool by women in the Southern Caucasus dates back many years and this indigenous knowledge has been transferred from generation to generation up to the present day.

Local people also make felt tents, blankets and mattresses from wool. There used to be a tradition that, when seeing a bride off to the house of her bridegroom, women relatives of the bride and neighbours would gather together and prepare a dowry that included these wool products.



SUSTAINABLE USE OF WATER RESOURCES

The Southern Caucasus is rich in water resources that have been exploited in the agriculture sector over time. In the fourth century AD, the total irrigated area in Armenia was estimated at about 100 000 ha; also Georgia has a long tradition of land improvement through irrigation and drainage. Yet, especially in the last 20 years, the three countries of the Southern Caucasus have experienced many of the typical problems related to poor management of water resources, such as deterioration of infrastructure and pumping equipment because of insufficient maintenance, inefficient water distribution and application, contamination of groundwater sources and salinization of soils.

In recent years, an effort has been made at both national and international levels to improve water management, with an eye also to environmental and health issues. New legislation, e.g. in Armenia, has introduced the concept of integrated river basin management, and the management of transboundary water resources.

As evidenced in the “Final Report on the Evaluation of FAO’s role and work related to water”, concerning water use for agriculture, the most common parameter measured is efficiency, but it must be properly defined. Conventionally, irrigation efficiency is the dimensionless ratio (m^3/m^3) of water available or utilized at one point to water delivered at some upstream point: for example, field irrigation efficiency is the ratio of water consumed by the plant to water delivered to the field. On the other hand, water-use efficiency is a productivity term (USD/m^3 or kg/m^3). The latter term is frequently misunderstood for, or indeed used in place of, the former.

The report highlights that today there is a consensus on moving away from “efficiency” terminology, using fractions (beneficial consumption, non-beneficial consumption, recoverable and



The efficient use of local resources and energies is an essential element for low carbon development and food security

non-recoverable fractions) rather than irrigation efficiency, and productivity instead of water-use efficiency. CROPWAT is the FAO standard reference on this topic, and FAO has now contributed to AquaCrop, a new tool to analyse yield response to water for top production under ideal circumstances. AquaCrop deals with the context of water scarcity as it embodies more complex plant-water relationships based on interactions with the Consultative Group on International Agricultural Research

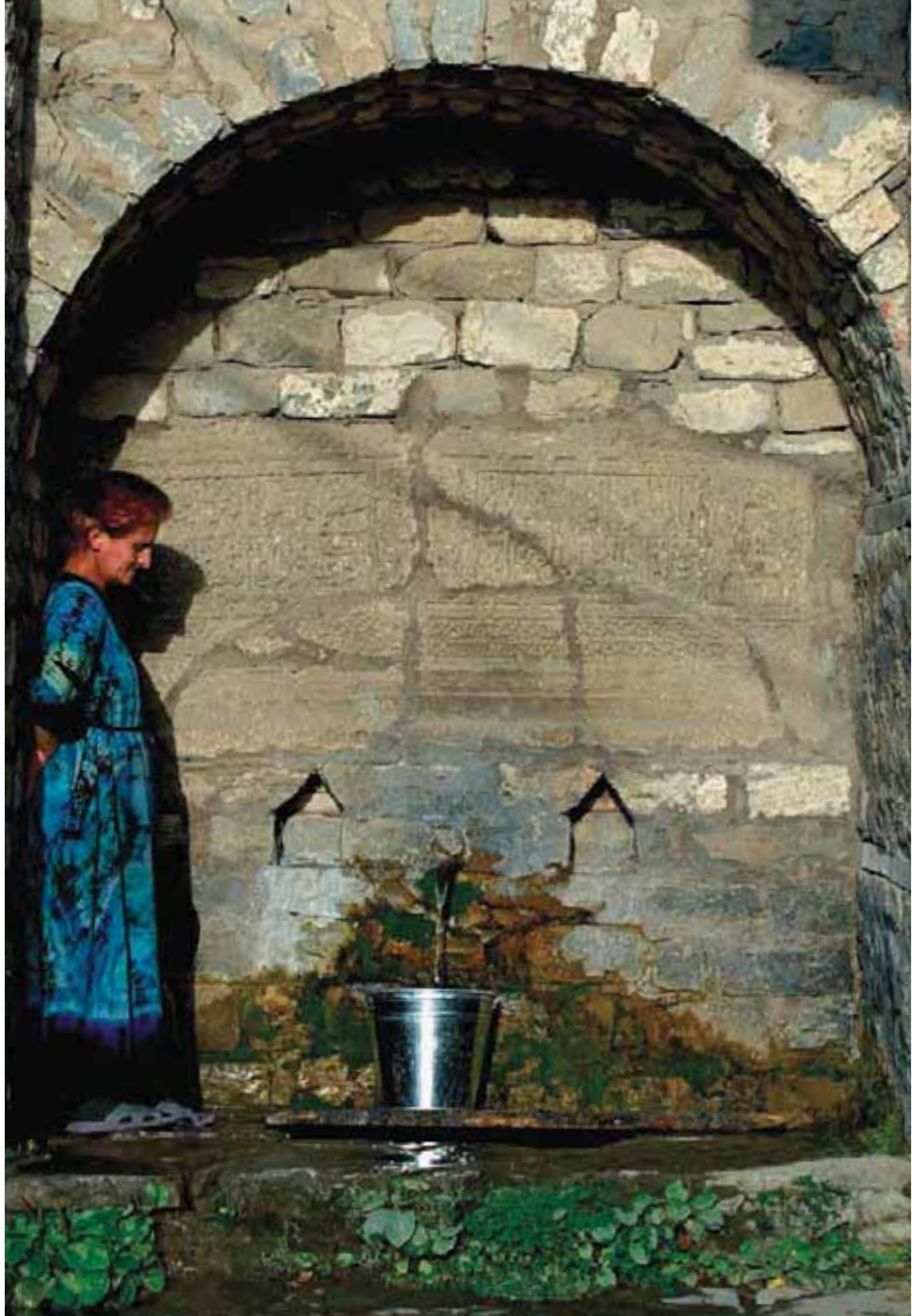
(CGIAR) crop centres and other specialist groups. The next necessary step will be to verify how AquaCrop can produce “realistic” rather than “ideal” recommendations for design of irrigation that are useful for farmers in specific agroclimatic areas. Maximizing the productivity of water and understanding how technology, water consumption and production interact are critical issues and establishing a culture of water saving and productivity should become a priority for policy-makers.



In order to survive in harsh environments, people must have an individual and collective commitment to use natural resources, including lakes and rivers, without jeopardizing biodiversity and ecosystem balance, avoiding wastes and pollution

According to Juvvá Lemet-Klemetti Näkkäljärvi, farmers and pastoralists have what can be described in a theoretical model as landscape memory. This contains elements of culture, professional and practical competence, and knowledge as well as perception models, cultural observation methods, and detailed classification of natural phenomena, land forms, plant and animal physiology, and behaviour and terminology. Building on this landscape memory to improve the sustainable management of waters while using scientific

and modelling tools and technologies will be necessary to face the new challenges related to water scarcity, water pollution and changing rainfall patterns. Therefore, farmers and pastoralists could be both subjects and informants of research. More training should be provided to scientists to study the traditional knowledge and traditional perceptions of the territory in order to have the foundations to develop innovative management practices for water, land, and wild and cultivated agricultural systems.





EXPLOITATION OF INLAND WATERS IN THE SOUTHERN CAUCASUS: THE CASE OF LAKE SEVAN

Lake Sevan is located in the northeast of the Armenian volcanic highlands, at the junctions of the Southern Caucasus and Near East regions, and its altitude is 1 900 m above sea level.

Lake Sevan is the largest lake in the Caucasus and one of the greatest freshwater high mountain lakes of Eurasia. It has a unique combination of size, high mountain location and comparatively “soft water” (700 mg/litre of mineralization). Its importance in the economy of Armenia can scarcely be exaggerated: it is the main

source of irrigation water and provides electricity, fish, recreation and tourism. Lake Sevan and the wetlands of the basin are significant breeding, resting, foraging and wintering areas for migratory waterfowl. The main economic activities in the basin are agriculture and fisheries. Approximately 20 percent of Armenian livestock are raised here and about 90 percent of fish catch and 80 percent of crayfish catch of Armenia come from the lake.

The biological diversity of plants is very high. Some 1 600 species of vascular plants have been registered in the basin, of which 48 species are in the *Red Data Book of Plants of Armenia*. There are also 276 species

of vertebrates, of which 48 species are in the *Red Data Book of Animals of Armenia*. In the past, reeds were harvested and used for thatching and structural building. Today, reeds are harvested for crafts, bedding material (litter) and fuel. Flexible willow branches are used for fish traps and in basket weaving. Willow wood and that of other smaller-sized trees and bushes is also used for fire production during the very cold winters.

Before human intervention dramatically changed this ecosystem, the lake was 95 m deep with a volume of 58 km³. Since the 1930s, the lake has been increasingly exploited for irrigation, hydropower and domestic water supply.

By 1972, its level had fallen by almost 19 m and its surface area had been reduced to 1 250 km², causing unforeseen changes in the lake’s ecology (loss of fish population), water quality (entrance of sewage) and microclimate (freezing of the lake in winter).

Since 1978, the government has attempted to raise the water level of the lake and reduce water take-off (for example, no water has been used during winter for hydropower since 1978); pumping stations have been built; and interbasin water transferred from the Arpa and Vorotan rivers. A link between the River Debed and Lake Sevan has been planned. Initially these measures were successful and the lake rose



about one metre between 1978 and 1990. However, demands on water increased more rapidly at the beginning of the 1990s, when electricity was again generated during the winter. This resulted in the one metre gained being lost again.

More pumping stations and balancing reservoirs are under construction to raise the level of the lake.

Especially because of the present energy shortages in the country, the construction of balancing reservoirs is both important and urgent, as hydropower production from Lake Sevan is mining its water at an alarming rate without the possibility of winter water being stored for irrigation in the

summer. If stored, some of this water would then allow summer releases from Lake Sevan to be reduced by a certain amount, depending upon electricity requirements in the summer.

In the last few years the level of the lake has actually increased, mainly thanks to the restoration of the Arpa-Sevan connection, and is expected to continue to do so, according to the Lake Sevan Committee.

Currently, the most important threats to the lake are the worsening of the water quality from pollutants, and biodiversity loss from overfishing and anthropogenic interventions.



- Abdullayev, M.** 1978. *Ways of developing sheep production in Azerbaijan*. Baku, Azerneshr Publishing House. 83 pp.
- Accorti, M.** 1992. L'apporto delle api all'equilibrio energetico in agricoltura. Zucchero e miele: produzioni alternative e compatibili. *Atti VI Convegno Internazionale dell'Apicoltura*, 19–54. [in Italian]
- Adighesal, B.M., Alakparov, U.K., Aliiev, G.A., Hajiyev, V.D., Isirafilov, S.A., Musaev, M.A., Mustafaev, I.D. & Safarov, I.S.** 1989. *Red Book of Azerbaijan*. 544 pp. [in Azeri and Russian]
- Alishan, G.** 1895. *Haybousak kam haykakan busabaratyun (Armenian botany or botanic glossary)*. Surb Ghazar, Venice. 624 pp. [in Armenian]
- Andgouladze, D.L.** 1971. *Apiculture en Géorgie*. Ministère de l'Agriculture RSS de Géorgie. 15 pp. [in French]
- Bayramov, U. & Abdullayev, M.** 1973. *Balbas sheep*. Baku. 9 pp.
- Biodiversity of livestock in Azerbaijan (genus, breeds). Joint Book.** 2004. Baku, Elm Publishing House. 308 pp.
- Buachidze, G.I., Vardigoreli, O., Vashakidze, B., Inaishvili, T., Kotrikadze, N. & Tsertsvadze, L.** 1998. *Thermal waters of Georgia*. Tbilisi, Epoka Publishers. 130 pp. [in English]
- Bunyadov, T.A.** 1969. *History of cattle raising in Azerbaijan*. Baku, Elm Publishing House. [in Azeri]
- Bunyadov, Z.M. & Yusifov, Y.V., eds.** 1994. *The history of Azerbaijan*. Baku.
- Burchak-Abramovich, N.I.** 1955. *The ancient cattle of Trialeti Ridge in Tsalaka district in Georgia*. G. Zardabu Natural History Museum, 9.
- CGRFA (Commission on Genetic Resources for Food and Agriculture).** 2007. *Plant genetic resources of grasslands and forage species*. Background Study Paper 40. <ftp://ftp.fao.org/docrep/fao/meeting/014/k0182e.pdf>
- FAO.** 1997. *Irrigation in the countries of the former Soviet Union in figures*. Water Report 15. Rome.
- FAO.** 2003. Biodiversity and the Ecosystem Approach in Agriculture, Forestry and Fisheries. Satellite event on the occasion of the Ninth Regular Session of the Commission on Genetic Resources for Food and Agriculture. Rome 12-13 October 2002. Proceedings. Rome. [in English]
- FAO.** 2008. *Rapid Assessment of Pollinators' Status*. Pollination Services for Sustainable Agriculture. Rome.
- FAO.** 2010. FAOSTAT. <http://faostat.fao.org/>
- FAO.** 2010. *Evaluation of FAO's role and work related to water*. Final report. Rome. (in English)
- Farajov, Ch., Abdullayev, O.O., Eminov, F.O. & Mammadov, A.M.** 2004. *Local animal breeds of Azerbaijan*. Baku, Ministry of Agriculture of Azerbaijan. 32 pp.
- Gallai, N., Salles, J.-M., Settele, J., Vaissière, B.E.** 2008. Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological Economics*, doi:10.1016/j.ecolecon.2008.06.014.
- Genetic Resources Institute of National Academy of Sciences of Azerbaijan.** 2003. *National report on the state of the animal genetic resources in Azerbaijan*. Baku. <ftp://ftp.fao.org/docrep/fao/010/a1250e/annexes/CountryReports/Azerbaijan.pdf>
- Goyushov, R.** 1986. *Azerbaijan archaeology*. Baku, Ishig Publishing House.
- Hajiyev, V.J. et al.** 1969. *Forage plants of hayfields and pastures*. Baku, Elm Publishing House. 163 pp. [in Azeri]
- <http://care4sevan.wordpress.com/2010/01/29/>
<http://www.nhm.ac.uk/research-curation/research/projects/bombus/>
- Ismayilov, A.** 1978. *Garadolag sheep*. Baku, Elm Publishing House. 56 pp.
- Ismayilov, A.** 1979. *Ontogenesis of some sheep of Azerbaijan*. Baku, Elm Publishing House. 171 pp.
- Karjagin, I.I., ed.** 1950–1961. *Flora of Azerbaijan*. Vols I–VIII. Azerbaijan National Academy of Sciences Press.
- Kartvelishvili, K. & Mchedlishvili, K.** 1993. *The state, conservation and sustainable use of Georgian animal genetic resources. Gene pool, protection and use of Georgian agricultural plants and animals*. Georgian Scientific Academy of Agriculture.
- Khaliyaddin, K.** 1989. *Camels as a wealth*. Baku. 48 pp. [in Azeri]
- Kitabi-Dada, G.** 1962. *Baku*. Azernashr Publishing House.
- Klein, A.M., Vaissière, B.E., Cane, J.H., Steffan-Dewenter, I., Cunningham, S.A., Kremen, C., Tscharntke, T.** 2007. Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society*, 274, 303–313.
- Korakhashvili, A. & Agladze, G.** 2000. *Grass landraces of Georgian arid pastures*. In L. Maggioni, P. Marum, N.R. Sackville Hamilton, M. Huldson & E. Lipman, compilers, *Report of a Working Group on Forages: Seventh Meeting*, pp. 96–98. Elvas, Portugal, 18–20 November 1999. Rome, International Plant Genetic Resources Institute (IPGRI). [in English]
- Ministry of Agriculture of Armenia.** 2003. *Country report on the state of Armenia's animal genetic resources*. [in English]
- Ministry of Agriculture of Georgia.** 2003. *Country report on the state of the world's animal genetic resources - Georgia*. Tbilisi. <ftp://ftp.fao.org/docrep/fao/010/a1250e/annexes/CountryReports/Georgia.pdf>
- Rajably, Kh. A. & Safarov, N.M.** 2005. *Dilbaz horse*. 152 pp.
- Rollov, A.H.** 1908. *Wild plants in the Caucasus*. Tbilisi, Caucasian Committee of Phyllosera. 600 pp. [in Russian]
- Rukhkyan, A.** 1960. *Armenian semi-fine-woolled fat-tailed sheep*. Yerevan.
- Sadigov, M.** 1965. *Sheep breeding*. Baku, Education Information Centre. 147 pp.
- Sumbatadze, A.S.** 1958. *Agriculture of Azerbaijan in the XIX century*. Baku. 363 pp. [in Azeri]
- Tortladze, L.A.** 2005. *Diversity of Georgian local cattle*. Tbilisi. [in English and Georgian]
- Tsertsvadze, D.** 2005. *Diversity of Georgian local sheep breeds*. Tbilisi [in English and Georgian]
- Urdulashvili, A.** 2004. *Cattle breeding in Georgia in the XIX–XX centuries*. [in Georgian]
- Vamosi, J.C., Knight, T.M., Streets, J., Mazer, S.J., Burd, M. & Ashman T.-L.** 2006. Pollination decays in biodiversity hotspots. *Proceedings of the National Academy of Sciences*, 103: 956–961.
- Verdiyev, Z.G.** 1974. *Zebu breeding*. Moscow, Kolos Publishing House. 152 pp.
- Voskanyan, V.** 1987. *Cattle breeding in Armenia*. Yerevan. 412 pp.

THE GUARDIANS OF BIODIVERSITY

THE DIFFERENT LANDSCAPES OF THE SOUTHERN CAUCASUS HAVE DEFINED THE ACTIVITIES OF FARMERS AND PASTORALISTS, AND GIVEN THEM FOOD, FIBRE AND ENERGY. IN RETURN, PEOPLE HAVE LEARNED TO USE THESE NATURAL RESOURCES, INCLUDING LAKES AND RIVERS, ACCORDING TO THEIR POTENTIAL. THEY HAVE SELECTED ANIMALS ADAPTED TO TEMPERATURE FLUCTUATIONS AND LOW OXYGEN LEVELS IN MOUNTAINOUS AREAS. THIS HAS ENABLED THEM TO MAKE A LIVING IN A DIFFICULT ENVIRONMENT WITHOUT JEOPARDIZING ITS BIODIVERSITY AND NATURAL RESOURCES.

Farmers and pastoralists have managed their plants and animals in order to keep risk to a minimum, choosing those that ensure they maintain their livelihoods under local conditions, but where high yields are not the overriding criterion. However, at present, many of these landscapes are no longer available for agriculture and pastoral production; natural resources are degraded; and the need to intensify production may reduce the working opportunities of the traditional landscape managers, confining them to a situation with little hope for a sustainable livelihood in the near future.

Farmers and pastoralists will need to be increasingly involved in management decisions related to their territories. They will need reliable agrometeorological information tailored to their farms and grazing lands, scientific information on agro-ecological farming practices, and new technologies to improve their production efficiency. They will need to become an integral component of social and economic development and maintain a balance between the production of their individual farms and care for the surrounding landscape. Their daily work, their understanding of the landscape in which they operate, and their daily agricultural practices will need to be the building blocks of food security.



