

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 SEASONS

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

Հաղթահարելով տարվա եղանակների վայրիվերումները

Բժսիլերի առօրյա սպասարկում

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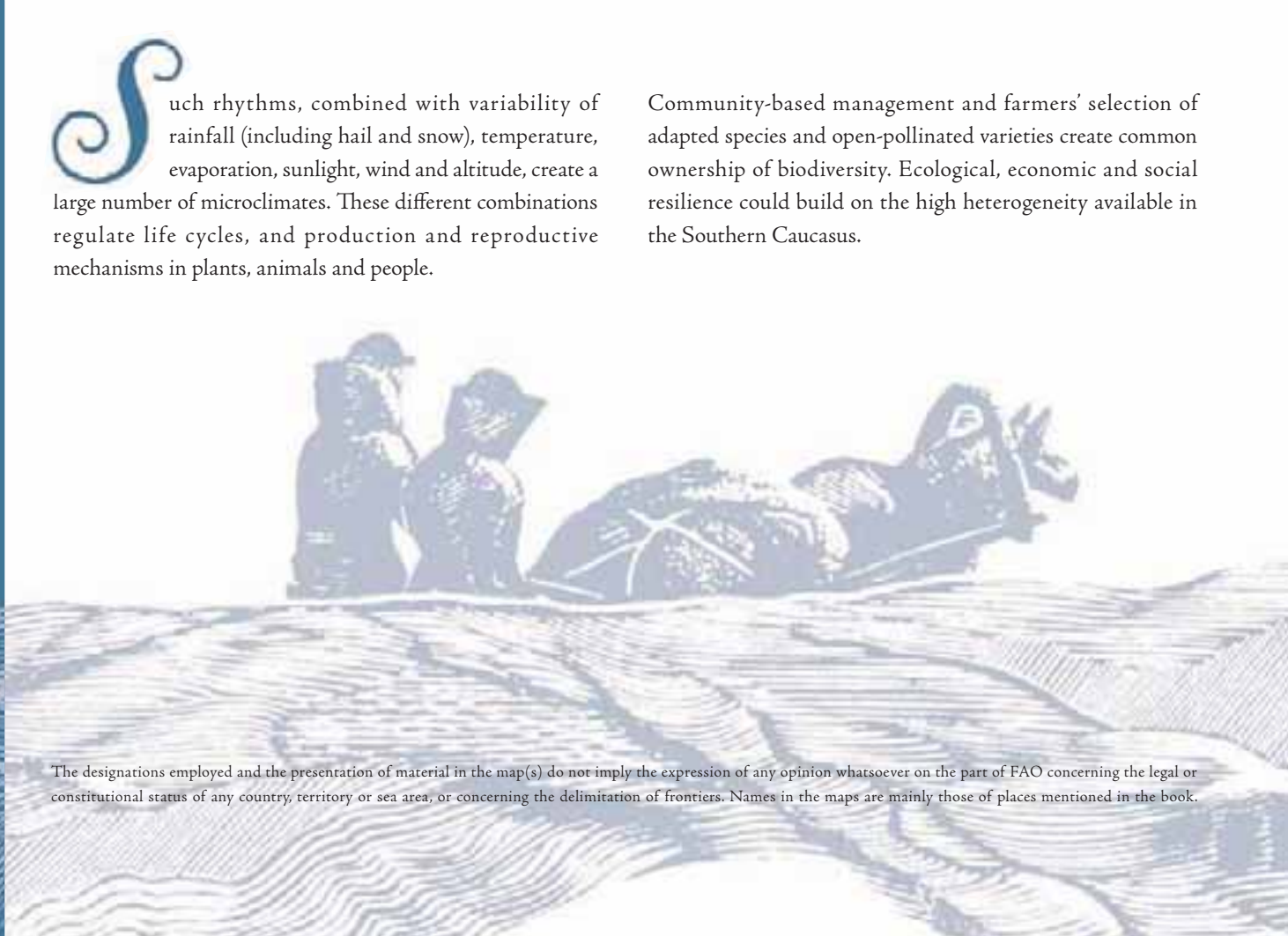
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## INTRODUCTION

THE SOUTHERN CAUCASUS IS CHARACTERIZED BY DIFFERENT CLIMATIC PATTERNS, DEPENDING ON ALTITUDE, INFLUENCE OF MOUNTAIN RANGES AND WATER BASINS, BUT ALL THE REGIONS SHARE ONE IMPORTANT FEATURE: SEASONALITY. IN FACT, THE TERRITORY SPREADS OVER A LIMITED RANGE OF LATITUDES, BETWEEN 38° AND 43°N, WHICH MEANS THAT FROM SUHUMI IN NORTHWESTERN GEORGIA TO LANKARAN IN SOUTHEASTERN AZERBAIJAN, THERE ARE MANY CHANGES IN LANDSCAPES, CLIMATE, FAUNA AND FLORA. YET DAY BY DAY THE SUN RISES AND SETS AT PRACTICALLY THE SAME TIME, AND ALL THE LIVING ORGANISMS HAVE HAD TO ADAPT TO THE SAME RHYTHMS OF THE SEASONS: SPRING, SUMMER, AUTUMN AND WINTER.

Such rhythms, combined with variability of rainfall (including hail and snow), temperature, evaporation, sunlight, wind and altitude, create a large number of microclimates. These different combinations regulate life cycles, and production and reproductive mechanisms in plants, animals and people.

Community-based management and farmers' selection of adapted species and open-pollinated varieties create common ownership of biodiversity. Ecological, economic and social resilience could build on the high heterogeneity available in the Southern Caucasus.

A blue-tinted photograph showing a mountainous landscape. In the foreground, there are terraced fields. In the middle ground, a pack animal, possibly a mule or horse, is carrying a large load. Two people are standing near the animal, one appears to be leading it. The background shows more mountains under a clear sky.

The designations employed and the presentation of material in the map(s) do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal or constitutional status of any country, territory or sea area, or concerning the delimitation of frontiers. Names in the maps are mainly those of places mentioned in the book.



**The Southern Caucasus lies in the temperate zone. Its climate is characterized by the rhythm of the four seasons: spring, summer, autumn and winter. *Overleaf: winter and summer views of the same apple orchard (left) and family garden (right)***

## SEASONAL FLUCTUATIONS AND FOOD PRODUCTION

Farmers have chosen crops and agronomic management practices in order to produce sufficient and good-quality food and ensure food security on a yearly basis. The purpose of food stability is to ensure adequate food at all times for their households and cope with climate risks. Early- and late-producing fruit trees have been grown in order to extend the period of availability of fresh fruits and adapt to climate variability and unpredictable weather conditions such as late frosts, storms and prolonged droughts. Cereals, fruits and vegetables suitable for preservation have been cultivated in order to have good-quality food

particularly throughout the long winters. Plants and animals have been chosen with specific characteristics of resistance to pest and disease attacks, as well as for their capacity to mature on poor soils, and their adaptability to make the best use of solar radiation in the climate of the Southern Caucasus.

New challenges that may be faced by agriculture through the negative effects of climate change could build on the experience gained by farmers and the genetic resources they have maintained.













# ADAPTATION OF PLANTS TO SEASONAL CYCLES

## ACCLIMATIZATION

Annual crops such as wheat and rye have had to develop adaptive mechanisms in order to survive low winter temperatures, defined as acclimatization. At the end of the warm season, plants are mere seedlings and their crowns are located about 5 cm below the soil surface. The acclimatization process is regulated by the temperature at that level. When temperatures fall below 10 °C, the crowns gradually harden and growth stops. The plants can then survive the cold season.

At the beginning of spring, when the temperature in the soil rises again, the crowns gradually soften and growth restarts. The degree of low temperature tolerance depends on the genetic potential of the plant. If the temperature becomes very low and the soil freezes, the crowns will be damaged and most of the plants will die. The acclimatization process is gradual because the temperature in the soil is more stable than at the soil surface; this helps the plants to survive sudden changes in temperature that may occur, especially at the beginning and at the end of the cold season.

## SOLAR RADIATION AND EVAPOTRANSPIRATION

*by Michele Bernardi*

The development of green plants, which form the basis of the world's agricultural systems, is regulated by light duration and intensity through chlorophyll synthesis, the process that transforms solar radiation into biochemical products.

In temperate areas, the duration of useful solar radiation reaches 16–18 hours during the summer, as compared with the duration of only 10–12 hours over the year in tropical areas.



Plant species in the Southern Caucasus are well adapted to seasonal cycles. Acclimatization is the process through which annual crops can survive the cold season







**The experience gained by farmers, the genetic resources that they have maintained, the efficient use of energy and nutrients and waste management are essential to adapt agricultural production systems to climatic variations**

Furthermore, at higher altitudes the solar radiation intensity is higher; in contrast, in tropical monsoon areas, cloudy weather decreases light intensity. These differences explain why some summer basic food crops such as maize, rice and sorghum can reach production rates of up to 10 tonnes of grains/ha in 100 days in temperate areas, while 150 or more days are needed to reach the same yield in tropical areas.

The Southern Caucasus, with its combination of seasonal cycles and relatively high altitudes, experiences a high level of sunshine hours and consequently has great production potential for summer crops.

Evapotranspiration measures the amount of water that vaporizes from soil, waterbodies and plant cover. Evaporation and transpiration occur simultaneously and there is no easy way of distinguishing between the two processes. Apart from the water availability in the topsoil, the evaporation from a cropped soil is mainly determined by the fraction of the solar radiation reaching the soil surface. This fraction decreases over the growing period as the crop develops and the crop canopy shades more and more of the ground area. When the crop is small, water is predominantly lost by soil evaporation, but once the crop is well developed and completely covers the soil, transpiration becomes the main process.





**Selection and cultivation programmes have to work on a larger number of species and varieties to ensure resilience of agriculture to climatic variations**

Weather parameters, crop characteristics, management and environmental aspects are factors affecting evaporation and transpiration. The principal weather parameters affecting evapotranspiration are radiation, air temperature, humidity and wind speed. Density and type of vegetative cover, soil moisture and root depth also affect evapotranspiration. As a consequence, evapotranspiration rates follow seasonal cycles, but may vary significantly from site to site even within the same region. Farmers in the Southern Caucasus harbour a traditional knowledge of the variations of solar radiation and evapotranspiration that influence their crop production and they select their crops accordingly.

## CLIMATIC VARIATIONS

According to the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, the “warming of the climate is unequivocal”, and therefore adaptation of agriculture is unavoidable. The Caucasus is especially vulnerable to droughts because it is highly dependent on snow melt and on rainfall variability and, at the same time, its economies are highly dependent on agriculture and there are few and poorly localized hydrometeorology observation stations. Summer droughts and increased temperatures will put additional stress on irrigated and perennial crops such as grapes. Intense rains and snow melt may increase the risk of slope erosion and soil degradation.



**An efficient use of natural resources: a sulphuric hot water spring near Khudat, Khachmaz province, Azerbaijan (left) is used to heat a greenhouse in which vegetables such as cucumbers are produced (right)**

There is a need to acquire a better understanding of the mechanisms that can increase resilience of agriculture and capture synergies between food security, adaptation and mitigation in order to add value to the work of those farmers who adopt them in their farms and family gardens. Some factors, such as unfavourable temperatures, droughts and soaring global food prices are beyond the control of farmers, while others can be influenced by them. For example, many farmers influence biological nitrogen fixation through legume cropping, and a progressive shift from nitrogen (N) fertilizers to N-fixing legumes could be more widely adopted, given sufficient technical and market support and information.

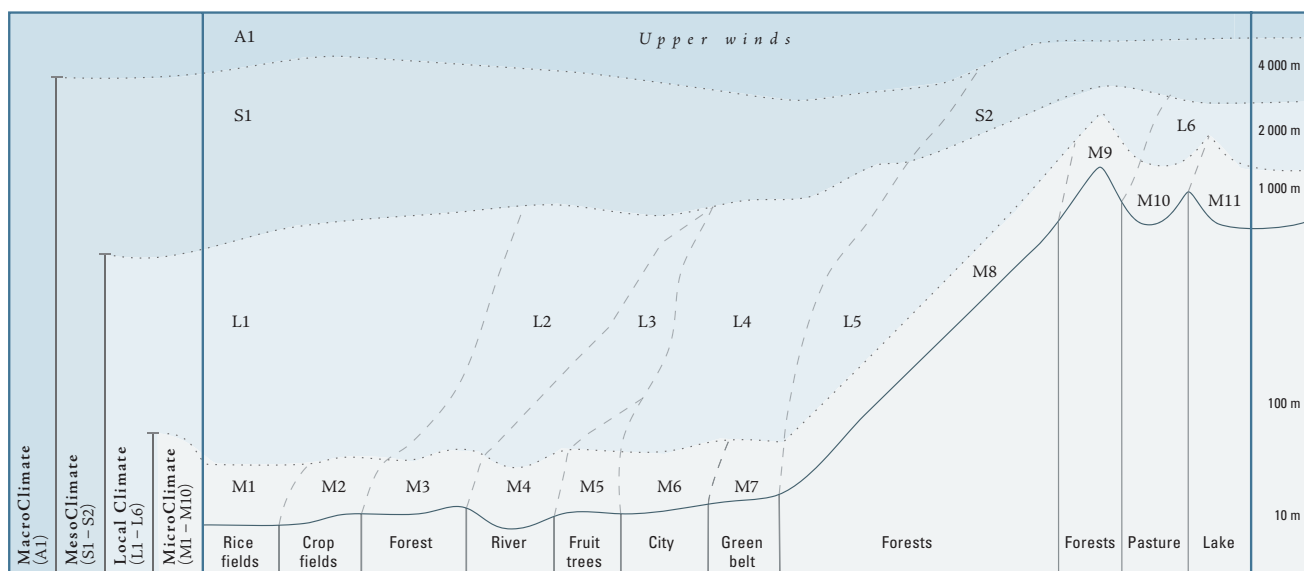
Well-motivated farmers also have the potential to adopt more ecological management practices for their machinery (such as tractors, hay dryers, water pumps) to help contain costs, minimize energy consumption, lower carbon dioxide emissions and increase the adoption of technologies and biological

processes using renewable energies. Efficient technologies and machinery need to be developed that respond to the needs of small farmers and are adapted to operate in their ecological and social context. Rehabilitating degraded grassland and adopting improved grazing land management practices have also much to offer to food security, rural development and mitigation. The World Summit on Food Security Declaration, FAO, Rome, 18 November 2009, states:

*“It is necessary to enable all farmers to adapt to, and mitigate the impact of, climate change through appropriate technologies and practices that improve the resilience of farming systems, thus enhancing their food security.”*

To achieve such goals, the global community should engage in developing models that are able to predict performance from different farming systems, including carbon dioxide accounts; provide information about adaptation and mitigation capacity





**Models are needed to predict performance and provide information about adaptation capacity at local farm level. The figure depicts the relationship of climatic phenomena on the macro, meso, local and micro scale**

Source: Bernardi, 2008, adapted from Yoshino, 1978

at local and national level; acquire a better understanding of synergies between adaptation, food security and mitigation and consider them as priority options for the required financing and possible elements in designing country agricultural implementation processes; and enhance investments in rural areas to allow countries to increase their capacity for producing sufficient and good-quality food for their citizens, while minimizing the impacts of climate change.

Crop seed selection is an important component of agriculture adaptation. Many underutilized and wild cereals, fruits and forages mentioned in this book are likely to assume greater importance as some of the current staples might become displaced. Selection and cultivation programmes have only worked on a very limited number of species and varieties up to now (e.g. out of the almost 10 000 existing grassland species, to date no more than 45 have undergone some form of selection and cultivation; and only four crops account for more than

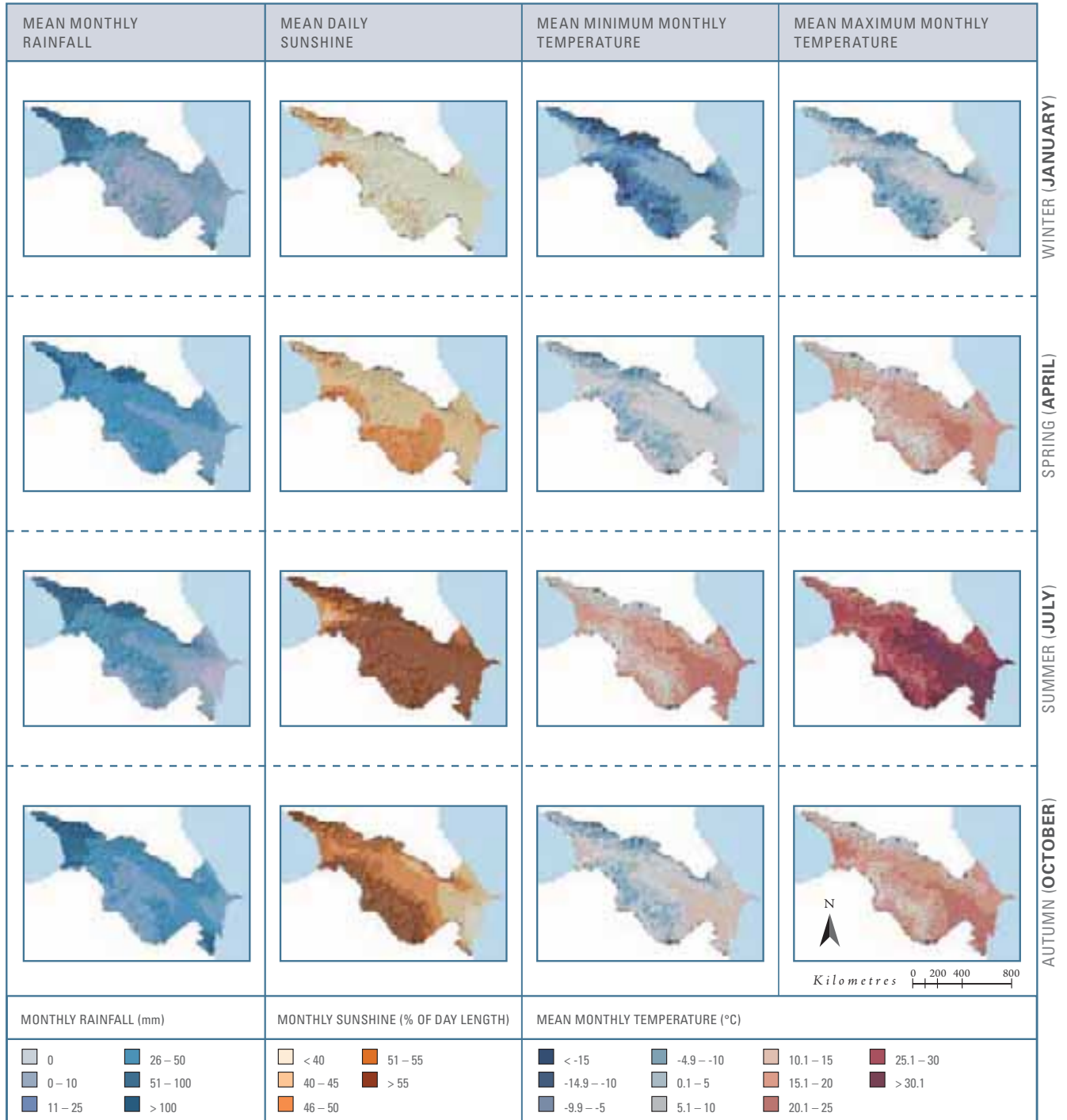
50 percent of human calorie intake). It is therefore important to change this trend and characterize and evaluate a wider range of germplasm for avoidance, resistance or tolerance to major stresses associated with climate change, such as drought, heat, waterlogging and soil salinity. Research will also be needed to gain a better understanding of the physiological mechanisms, biochemical pathways and genetic systems involved in such features in order to enhance the natural capacity of plants to adapt to climatic variations. There will be a need to acquire information on the role of non-genetic inheritance in adaptation. These will be acquired through learning processes of phenotypic plasticity and epigenetic inheritance and ecological studies to complement our knowledge obtained under laboratory conditions. For this to happen it is necessary to adopt new research and development programmes and additional financial resources to screen and maintain germplasm for key agronomic systems now, as results are expected to be available in the next ten years.



The Caucasus thanks to the high level of sunshine hours has a great production potential of summer crops. Meanwhile, the region is particularly vulnerable to drought owing to the fact that it is dependent on snow melt and on rainfall variability and, at the same time, its economy is dependent on agriculture. Summer droughts and increased temperatures put additional stress on irrigated and perennial crops, and intense rains and snow melt may increase the risk of slope erosion and soil degradation. >>*Right:* four seasonal climatic maps showing the geographic distribution of monthly climatic variables: mean rainfall, mean daily sunshine and mean temperature



## CLIMATIC MAPS



Resolution 10 arc minutes (16 km at the equator). Source data: CRU 2.0, HWSD derived SRTM DEM



## ADAPTATION BY PEOPLE: FOOD PRESERVATION

The ability to process and preserve agricultural products locally is a fundamental component of food security because it provides good-quality food for rural people in non-productive seasons at a low cost and with limited energy consumption.

Many different techniques are used to preserve various types of products. Some examples are described in the following sections.

### GURUT

*Gurut* is a milk product widely used in the western parts of Azerbaijan. In order to prepare *gurut*, yoghurt or *ayran* (a liquid separated when making fresh butter using traditional techniques) is filtered through a cloth until it becomes thick; it is then salted, shaped into a ball and dried. *Gurut* may be preserved for a long period of time and is consumed as a liquid, adding hot water and garlic.

### DRIED MEAT

For a long time, people in the Southern Caucasus have consumed dried meat prepared from mutton or beef, especially during the long winters. After skinning the animal, the meat is salted. Then, it is cut into pieces (in order to facilitate the process of drying), rubbed and salted. The meat is often covered with gauze and then hung to dry.

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**Elene Gabidauri shows a container of salted sheep meat in Batsara-Babaneuri, Akhmeta district. >>Right: fruit preserves on sale at Teze bazaar in Baku. Many methods of preserving food have been developed in order to withstand the long winters, and with additional investment into improving traditional techniques and technologies, sanitation issues can also be addressed**

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Preserved fish can frequently be found in markets and represents a good and affordable source of proteins

## PRESERVED FISH

Freshwater fish caught in the inland waters of the Southern Caucasus is generally only cleaned and then sold directly along roadsides or at local markets.

The dynamic fish processing industry, which once could be found along the Georgian Black Sea coast (Kutaisi, Batumi and Suhumi) and, to a lesser extent, also in Azerbaijan, has largely ceased operations.

Nowadays, to preserve marine and brackish water fish, only two traditional methods are commonly used: after cleaning, the fish may be salted and hung, or it is smoked. While there are modern and hygienic sturgeon (caviar) processing facilities in Baku, which process the legal catch of this species, a significant part of sturgeon caviar is sold on the black market; smoked sturgeon meat is considered a delicacy by many Caucasians.





Traditional sun-drying technique of sigfish caught in Lake Sevan



**PROFESSOR  
NARIMAN ZAMANOV**

*by Marzio Marzot*

At Banka village, on the left bank of the River Kür, a few kilometres away from the sea, there is a small cooperative for the preservation of fish by smoking. The site is currently closed and looks abandoned. All activities have ceased because fishing vessels prefer to deliver their fish to large-scale factories. It seems that all the small local firms

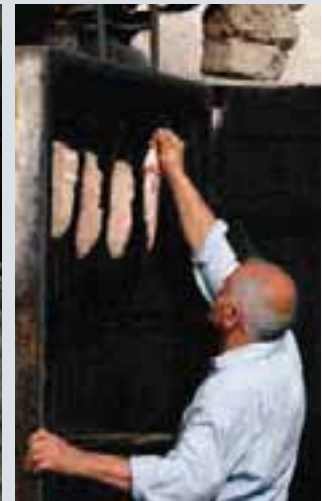
such as this one will also disappear, because there is no state support.

Professor Nariman Zamanov is a prominent member of this cooperative. He is a scientist, an expert in sturgeon breeding and caviar production. He proudly shows us the certificate that states his affiliation to the Russian Inventors' Association, as well as other documents and newspaper cuttings that talk about his discoveries and the awards he has received

regarding sturgeon and caviar. At the end, the professor kindly agrees to illustrate all the phases of the fish-smoking process: a very old tradition that – he affirms – dates back to prehistoric times. The fish he uses for the demonstration consist of some slices of beluga and a few carp.

First, the fish are washed in running water. Then the entrails are removed, the fish are salted and left to rest for five to eight days. The salt dries the flesh,

favouring preservation and adding flavour. The larger fish are then cut into slices and either hung in special cupboards or laid on horizontal trellises. As a rule, two days of smoking are sufficient. The substances absorbed by the flesh inhibit bacteria reproduction almost totally. Different types of wood give slightly different aromas. Smoking has antiseptic, antioxidant and antimicrobial properties, and gives the flesh a particular flavour that is highly appreciated by consumers.















**A remarkable number of wild and cultivated forage plants are to be found in the Southern Caucasus. *Trifolium pratense* L., *Phleum pratense* L., *Trifolium repens* L., *Alopecurus pratensis* L.** [ Source: Newton, J. 2001. *Organic grassland*. Southampton, UK, Chalcombe Publications ]

## HAY

Hay is the oldest and most important preserved fodder, and can be made with simple equipment, manually or with mechanization. Farmers make hay to carry livestock through long winters. Crop residues, straw and stovers of the main field crops represent half of the biomass produced; in addition, hay is produced from mowing natural grasslands and is also widely cultivated (alfalfa, clover and vetch) in crop rotations and permanent pastures. Haymaking involves reducing the moisture content of cut forage from an initial 70–90 percent to 15–20 percent, which is highly dependent on the weather and demanding skills and judgement by the farmer.

The quality of hay varies greatly depending on the composition of the grasslands (generally legumes have a higher crude protein content than grasses and forbs), the timing of harvesting (early production of hay generally results in better-quality hay but less quantity) and soil types (influencing micronutrient content and species composition).

Hay production in the Caucasus is the basis of meat, milk and wool production and provides a good income. It is also important to maintain a healthy environment, good soils and abundant biodiversity in natural ecosystems. In Azerbaijan, it was found that in pastures subject to moderate and severe erosion, the quality of plant cover has become worse. Especially legumes (alfalfa, sainfoin, clover, lupin and sweet clover) disappear. Only those plants that are resistant to trampling and drought remain in the plant cover. Usually weeds (*Senecio* spp. and thistles) replace useful grasses in such pastures. It is important to improve regulations and grazing management practices to protect and restore the productivity of natural pastures.

Since drying reduces digestibility and animal intake of hay, new conservation methods such as ensiling have been introduced in recent years. But this is laborious without heavy machines and silage is not suitable for transport and marketing.



**In recent years, the growth in the price of hay has made its production increasingly interesting as a source of income but its market value is still poorly known and analysed**



In the mountainous region of Svaneti in Georgia, where machines cannot be used, farmers still use scythes to mow the grass. On the steepest slopes, farmers are tied to each other to prevent falling; they all climb together and swing their scythes simultaneously – a really remarkable scene.

In recent years, the rapid growth in animal stocks together with the decrease in productivity of natural pastures have caused an increase in the price of hay, making its production more and more interesting as a source of income.

The price of one tonne of hay is about USD270 in Armenia, USD120 in Azerbaijan and USD260-300 in Georgia.





*Tklapi* is an ingenious way of preserving fruit and is widespread not only in the Southern Caucasus but also in surrounding areas such as the northern Islamic Republic of Iran. Below: the family of Alkan Garayev show their production of preserves in a “Terra Madre” Presidium

## JAM, SYRUP AND *TKLAPI*

Besides being eaten fresh, many fruits are preserved for winter. Like most farming cultures, families in the Southern Caucasus are masters in the art of making sure that nothing is wasted and that every available source of food and sustenance is either used immediately or preserved for later consumption. There are numerous local recipes for preparing jam from plums, apricots and wild berries. Some varieties are also cultivated for their processing suitability. Apples are fermented to make cider, alcohol or vinegar. One significant example of this approach is a preparation passed down through generations as a way of consuming excess fruit grown by the household or collected in the wild: *tklapi* a layer of boiled and sundried mulberries (or plum or other fruit), as thin as a sheet of paper.











In Mr Iadzet's household, Manana and Shushana prepare *churchella*, a type of *tklapi* made from mulberries

#### A GEORGIAN RECIPE FOR *TKLAPI*

The following recipe for *tklapi* originates from Georgia and is based on mulberries, but can be adapted to almost any kind of fruit; it is also diffused in Armenia and Azerbaijan. The mulberry fruit is first chopped finely to a pulp. It is then sieved and boiled until it is reduced to one-tenth of its original volume.

In a separate pan, a thick paste of wheat flour and water is prepared and added to the fruit concentrate at a ratio of 0.5 kg flour to three litres of fruit. After mixing well, the dense concentrate is spread over a clean linen cloth laid on the table. It is then left to dry in the sun for about a day.

When the mixture is ready, the opposite side of the cloth is lightly dampened, and the dried concentrate is lifted off and rolled up, and can be stored at room temperature for a long time. *Tklapi* can also be made without flour.





## ADAPTATION BY PEOPLE: CULTIVATION OF CEREALS, FRUITS AND FORAGES

In order to obtain fresh quality food throughout the year, farmers maintain a mixture of different species and varieties. The main purpose is not to maximize total market production, but to ensure a continuum of production for consumption in the household.

### COLD-RESISTANT CEREALS

The following two examples of cereals, rye and barley, have been cultivated for millennia for their resistance to cold winters and rusticity, respectively.

Some Caucasian varieties and wild species have not yet been fully studied and are of great selective value.

### Rye (*Secale cereale* L.)

Armenian	<i>Ashora</i>
Azeri	<i>Chovdar</i>
Georgian	<i>Chvavi</i>

An important cereal that has adapted to the low temperatures of the mountainous regions in the Southern Caucasus is rye (*Secale cereale* L.). The scientist P. Zhukovsky has frequently mentioned the importance of the Southern Caucasian rich gene bank of rye (up to 23 subspecies) for selection purposes. *S. cereale* L. (2n=14) is the only cultivated variety. It has an annual cycle, occasionally biannual, and the grain is easily detached. Zhukovsky believes that this species originates from *S. segetale* Roshev. (2n=42), a species that is found in wheat fields in the mountains and hills, and is widespread in the region of Leric. There are also two varieties of *S. segetale*: the perennial *Pereunans decoprelebur*, which can be found in the three countries in weed-infested areas and on roadsides and *Rubebluiri* Roshev, found in wheat fields.





**There are many wild species of rye in the mountains of the Southern Caucasus that would deserve research and protection because of their great potential to increase resilience to cold and long winters**

An endemic species of rye is *S. vavilovii* Grossh. ( $2n=14$ ), also called Caucasian rye. This species grows in sandy soils of volcanic origin in the hills at 600–900 m above sea level. *S. montanum* Guss. s.l. is on the list of those plants that have not yet been fully studied and are not used in the national economy. Many of its valuable subspecies were used in the past to obtain hybrids of perennial wheat. It is important to protect this variety, especially in its largest natural habitats, e.g. in Tsaghkadzor, Geghard, Jermouk and Nakhchivan.

### Barley (*Hordeum* spp.)

Armenian	<i>Gari</i>
Azeri	<i>Arpa</i>
Georgian	<i>Keri</i>

Barley (*Hordeum vulgare* L.) is one of the most important cereals in the Southern Caucasus. It has been cultivated for thousands of years because of its rusticity and resistance to extreme seasonal

variations. Although populations of old local variety of barley are still preserved in different parts of the Southern Caucasus, barley-sown areas have diminished. In Armenia, seven wild species of barley can be found. The Armenian varieties and their intraspecific diversity have not been fully studied to date. They are normally used as forage crops, although they also have great selective value. Some interesting ones are the following.

*H. violaceum* Boiss. et Huet – purple barley. The crop usually grows in moist meadows. It is a valuable forage crop.

*H. bulbosum* L. – bulbous barley. This crop grows widely at altitudes of 700–2 200 m above sea level. Local people use the bulbs in the preparation of food. Different species also grow in some areas and have a height of over 2 m.

*H. spontaneum* C. Koch. – two-row wild barley. This crop is significant in terms of phylogenetic studies and was only recently discovered in Armenia.





**A fruit orchard in spring in Baxili village. Unpredictable weather conditions such as early or late frost can severely affect fruit production. The selection of varieties in the Southern Caucasus should therefore be directed towards increasing resilience to climatic fluctuations**  
*Below: fruits on a persimmon tree (*Diospyros kaki*)*



Photo by A. Gasanov

## FRUITS THROUGHOUT THE YEAR

The following three examples of perennial fruit trees, apple, cherry and cornelian cherry, help guarantee food for families throughout the year. Some Caucasian apple varieties can be stored for several months during the winter, while some cherry varieties have late-ripening characteristics and remain on the tree long after ripening.



## Cherry (*Prunus* spp.)

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Armenian	<i>Baleni</i> (sweet cherry), <i>Keraseni</i> (sour cherry)
Azeri	<i>Gilas</i> (sweet cherry), <i>Albali</i> , <i>Gilenar</i> (sour cherry)
Georgian	<i>Bali</i> (sweet cherry), <i>Alubali</i> (sour cherry)

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The cherry is a member of the *Prunus* genus and consists of two edible species – the *avium*, sweet cherry and the *cerasus*, sour cherry. The two species have also been classified as *Cerasus avium* Moench., in the case of the sweet cherry, and *C. vulgaris* Mill., in the case of the sour cherry. Both names are clearly derived from Kerasus, the city on the Black Sea from which this fruit was introduced to ancient Rome as early as 2 000 years ago. These distinctive trees are a feature of the Southern Caucasus landscape and culture. The species are used extensively in the region. One important feature of the cherry is that many varieties do not ripen simultaneously and therefore offer a continuum of fresh fruits over several months.

The sweet cherry is eaten both fresh and dried and is also used to make syrups and preserves or fermented to make liqueurs. The varieties found in Armenia, Azerbaijan and Georgia differ very little from each other. One common feature is that the cherries of the Southern Caucasus can be propagated by suckers, as well as by grafting. In Armenia, cherry trees tend to grow at random rather than in plantations. They are often planted at the edges of farms and smallholdings. The trees are extremely vigorous, growing to a height of 12 m, and they bear fruit from an early age, usually in the third year. The fruit generally weighs between 2.5 and 6 g, making it smaller than that of selected varieties grown intensively in plantations. Local varieties are also sensitive to late frosts and have a relatively low yield.

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**The varieties of cherry have been selected so that they ripen at different times during the season, thus ensuring fresh fruits over a longer period. Here, Gurgen Hovhannisyan harvests white cherries in his garden**

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**The cherry is widespread throughout the Southern Caucasus. Besides being eaten fresh, the fruits are used to make syrups and conserves or fermented to make liqueurs. Women are incomparable in making preserves from fruits; family recipes are an important component in the cultural and social identity of families in the Southern Caucasus. <<Left: Voghchabert Village, Armenia, Lucine sells fresh cherries along the road – a very popular habit among small farmers**

The fruit starts ripening towards the end of May, with the season lasting until the beginning of July. This type of cherry has a variegated colour and is eaten either fresh or dried.

The sour cherry is less common than the sweet cherry. In harsh winters in the Ararat Valley, where temperatures can plunge below  $-30^{\circ}\text{C}$ , the tree can survive, although the harvest may be compromised. The sour cherry is richer in vitamins than the sweet cherry. Hybrids have been obtained by crossing the sour cherry with non-suckering sweet cherry varieties, which are propagated by grafting, either on to the sweet cherry or on to the *Mahaleb* cherry. These produce excellent fruit. In harsher climates, and especially in the Eastern Caucasus, where soils are arid, stony and calcareous, both types of cherries have been crossed with the *Mahaleb* cherry. Generally, their names derive from the places where they are grown. In the late nineteenth century, many selected varieties were imported from Russia and Europe. Nevertheless, local varieties continued to be prized for their particularly sweet and aromatic flavour.

A niche market for certain early-maturing cherry varieties, such as the Georgian *Kakha bali*, could be developed. The local improved variety does not have large fruit but could be used to improve other varieties genetically, in order to transmit the late-ripening characteristic to the offspring. In some varieties, the fruit remains on the tree long after ripening. This quality has been lost in many improved varieties, but the characteristic could prove useful in smallholdings and gardens, where growers may appreciate this natural way of drying or preserving fruit that is still fresh on the tree. Traditional preservation techniques, as well as germplasm collection, should be reinstated.

The cherry tree provides many gifts. The *Mahaleb* cherry (*P. mahaleb* Mill.) is used for decorative purposes, because of the particular shape of its flowers. Its wood is hard and aromatic; once refined and polished, it is used for furniture and for small objects, such as pipes or walking sticks. Infusions made from this wood have traditionally been used as a diuretic, while the leaves and fruit are distilled to produce an aromatic liquid used in the preparation of cosmetics.



A small farmer selling his own production of cornelian cherry in Teze bazaar in Baku

### Cornelian cherry (*Cornus mas* L.)

Armenian	<i>Hon, Zokhal</i>
Azeri	<i>Zogal</i>
Georgian	<i>Shindi</i>

The cornelian cherry (*Cornus mas* L.) genus belongs to the Cornaceae family and grows in the wild in the Greater and Lesser Caucasus mountains in the Samur-Davachi and Alazan-Ayrichay valleys in Azerbaijan, from the plains up to medium mountain belts, in a composition of forests and shrubs, to 1 500 m above sea level.

Growing together with cherry-plum trees, sloe, hawthorn, dog roses, apples, pears, quinces, medlars, hazelnuts, elms, Christ's thorn trees and other plants, it forms impassable thickets. These thickets house multicoloured high-yielding forms with large fruits and small kernels.

The fruits are oblong, round, oval, pear-shaped or cylindrical with a light-yellow, yellow, red, dark-red or black-red colour. By cultivating this valuable wild form, local people have developed a number of folk selection varieties such as *Gara zogal*, *Sari Kabraba zogal*, *Irimyvali zogal* and *Armudu zogal* as well as more than 40 other forms.

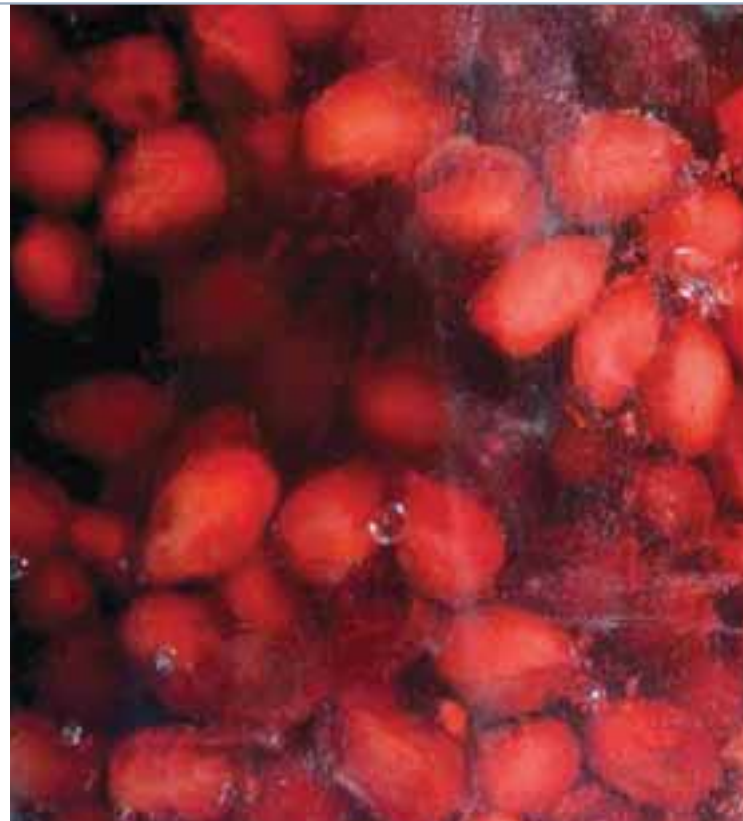




The fruits of the cornelian cherry have a slightly sour taste and are used to prepare jam, liqueurs and brine

The forests of Georgia are rich in wild varieties of cornelian cherries, such as *Cornus typica* Sanadze, var. *pyriformis* Sanadze with red fruit and var. *flava vest* with yellow fruit, ripening from the end of August to the middle of October. There is a folk tale about the pale colour of yellow cornelian cherry fruits:

*Once upon a time, the cherry said to the cornelian cherry: “You have only one colour to be proud of, but see how multicoloured and tasty I am”. The cornelian cherry grieved about this, and its fruits became paler and paler. But it started to multiply in order to tease the cherry trees.*





**A more standard quality of fruit production can be reached by spreading rare local varieties, such as the Georgian Sinap apple, with its characteristic elongated shape**

## Apple (*Malus* spp.)

Armenian	<i>Kbndzoreni</i>
Azeri	<i>Alma</i>
Georgian	<i>Vashli, Majalo</i> (wild)

The apple belongs to the genus *Malus* Mill., which covers a number of species. The name comes from the Greek *melon*, a generic word used to describe not just the apple, but any kind of soft-skinned fruit.

The apple is grown throughout the Caucasus. Studies on the origin of the species have identified four centres of genetic differentiation – central Asia, western Asia, China and North

America. In the Caucasus, two species have been identified – the *Malus orientalis* Uglitz, a polymorphous species, whose main characteristic is its vigorous growth and which is generally used as a rootstock; and the *Malus pumila* Mill., which includes the “paradise” and “doucin” botanical varieties used in the selection of the famed dwarfing rootstock East Malling series.

Popular selection in Georgia has identified genotypes whose characteristics include adaptability to the Georgian climate, productivity, pleasing appearance and the ability to keep well and to tolerate transportation. Indeed, such is their quality that many of the genotypes selected – among them *Kekhura*, Georgian Sinap and *Semir-Alma* – are still grown today.





**Irina Kokhreidze in her garden in Dzevera village, Georgia, with a basket of “winter” apples: these fruits may be stored in the home pantry for several months and consumed during the winter**

One feature shared by all Georgian cultivars is the flesh, which is soft, coarse and aromatic. Apples have a medium sugar content of between nine and ten percent, and acidity levels of less than one percent. Most Georgian varieties of apple resist the cold, although the climate varies widely throughout the country, with temperatures plunging to  $-30^{\circ}\text{C}$  in some places, a factor that can damage buds and hence subsequent yields. For the cultivation of apple trees on poor soils, vigorous rootstocks must be used, especially in wind-exposed areas where weaker rootstocks can only be adopted with the help of supporting poles. In humid areas, the apple tree is prone to a number of diseases, including *Venturia inaequalis*, *Podosphaera leucotrica* and rust; some local varieties are more vulnerable than others.

Common features of the apples of the Southern Caucasus are thick skins, which makes them good for handling and hence for transportation. One indirect indicator of this latter quality is the fact that many varieties heal readily after their skin has been damaged, with no ill effects for their long-term conservation.

Many local varieties, such as the Georgian *Kekhura*, can be kept for a year and even longer at room temperature in cool cellars. Negative characteristics of some local apples include the rough, grainy quality of their flesh and the low level of acidity and tannin, two organoleptic parameters that lower their commercial value.



**Popular selection has favoured varieties that tolerate handling, transportation and storage**

In forest areas of Sheki-Zagatala, Quba-Khachmaz and Nakhchivan, a great richness of wild forms is found and old varieties obtained by popular selection are preserved and cultivated in gardens.

This genetic richness has favoured the constitution of winter improved varieties (*Azerbaijansky*, *Nasimi*, *Samed Vurgun* and *Shargi*), which are resistant to pests and can be preserved from four to eight months under natural conditions. In the past, selection favoured types suited to certain conditions – including different soil types, varying altitudes and different degrees of humidity – as well as types that were resistant to diseases. Today, this genetic patrimony has been dispersed throughout the territory.

In some cases, it may have been preserved in germplasm collections, while in others it may have been perpetuated, unknown to the rest of the world, in some small private garden.

Selected varieties brought in from Europe have been widely grown and have replaced the traditional varieties. However, due to post-Soviet conditions, which make it difficult and expensive to procure the pesticides on which the successful cultivation of such imported varieties depends, many old local varieties are being readopted, not just because they are more hardy, but also because of their flavour. Indeed, some traditional products and dishes can only retain their proper flavour if local varieties of apple are used. With this in mind, the sustainable development of apple growing in the Caucasus may be furthered if attention





is focused on cultivating certain old varieties with a clear market potential, alongside the established European cultivars. These could include *Kekhura*, *Ivory*, *Emishackndzor*, *Karmrkeni* and *Shakarkeny*. To ensure local production of a more standard quality, certain agronomic practices will, however, need to be introduced, such as thinning out fruits to ensure the apples are of a more uniform size.

Resistance to the cold is a characteristic of almost all varieties found in Georgia, while in Armenia it is particularly marked in the *Vardaguin shertavor*, *Ameh*, *Arevshat*, *Goar* and *Leninakanskaja posniaja* apples. Some varieties can be eaten straight after picking – and therefore have no need for post-harvest ripening – both in summer and in autumn.

Some old varieties are of low vigour, a useful characteristic when it comes to establishing high-density plantations. These include *Turashauli*, *Gomavashli* and *Aksca Kialbadjafar*. One particular group of varieties, known as the *Khomanduli*, are unusual in that they regularly transmit certain agronomic characteristics to their progeny from seed, which is why, in the past, they were widely grown in the rural areas of Georgia.

From a pomological standpoint, these varieties do not represent the future of apple growing in the Caucasus, but they could have a use as cloned uniform rootstock obtained from seeds. Another common feature of a number of varieties in the Caucasus is the ability of the fruit to self-heal lesions, a factor that is useful for handling and transportation.



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

## FORAGES ADAPTED TO CLIMATIC FLUCTUATIONS

Natural grasslands adapt to the variations of climate and the availability of soils, water and sun, by varying species composition and length of growing period. Farmers have observed these adaptation mechanisms and selected some of the most plastic species in order to grow forages for their animals. Their selection criteria were to obtain good-quality and highly nutritious forages, able to resist cold winters and dry hot summers, and able to maintain and increase soil fertility and to reproduce safely, making the best use of local pollinators. Alfalfa has all these characteristics and was therefore one of the first forage species domesticated by farmers in the Southern Caucasus.

## Alfalfa (*Medicago spp.*)

Armenian	<i>Arvuit</i>
Azeri	<i>Yonja</i>
Georgian	<i>Ionja</i>

Alfalfa (lucerne) is a highly nutritious and versatile forage crop that exists in the wild in the Southern Caucasus and has adapted to its seasonal variations. It has been used and selected for millennia in the region. Alfalfa was the first species to be cultivated as a forage crop. It probably fed the horses that pulled chariots in the second millennium BC. Today, alfalfa is grown throughout the world.



It is cultivated over more than 30 million ha, in the United States of America, Argentina, Canada, China and many other countries. It is an important source of income for smallholder farmers in the Southern Caucasus, who sell it on local markets.

The Caucasus is considered to be the centre of origin of the winter-hardy, disease-tolerant *Medicago falcata* species, while *M. sativa*, which has adapted to warm, dry conditions, originated in Central Asia. The hybridization between the two, which produced *M. media*, probably occurred in Eastern Europe. Alfalfa is a drought-resistant and winter-hardy plant that can withstand soil temperatures as low as  $-20^{\circ}\text{C}$ . The hardening process is associated with the induction of dormancy, brought about by shortening days, as well as declining temperatures. Light (radiant energy) controls the rate of photosynthesis and influences branching, flowering, cold hardiness, stem elongation and other processes under photomorphogenic control. Alfalfa stem elongation ceases earlier in autumn in winter-dormant, cold-climate types. Winter-dormant types are generally more responsive to shortening photoperiods in autumn than less winter-dormant ones – a perfect mechanism for adapting to the severe winters of the Caucasus. Alfalfa also grows well in the dry summers of the region. In the early stages of drought, there is a reduction in light interception which, in turn, exacerbates reduction in shoot growth. Therefore, alfalfa is more tolerant to drought than most other temperate forage legumes – another perfect mechanism of adaptation.

Alfalfa is pollinated by bees (honey bees, short-tongued cutter bees and *Megachile rotundata*, alkali bees and bumblebees), which are prevalent throughout the Caucasus – this synchronicity is a further perfect mechanism of adaptation to the Southern Caucasus environment since the region is the centre of origin of the Caucasian bee.

Several wild *Medicago* species occur in western Asia: *M. cancellata*, which is used as a gene source for adaptation of *M. sativa* to poor soils, *M. dzhawakhetica*, found in Georgia and *M. glutinosa*, found in the Caucasus and also used as a gene source for crop improvement. A. Grossheim mentions 19 species of alfalfa with rich intraspecific diversity. Not all of them are of economic value today and are not yet fully studied, but they still constitute a huge source of genetic material holding potential for future agricultural production systems.

*M. falcata* L. – falcate or yellow alfalfa – is a perennial crop ( $2n=16$ ), which is distinguished by its resistance to drought and cold. It is also salt-tolerant. It grows and develops very slowly, without blooming the first year. It grows mainly in the wild.

The *M. pauciflora* Led. variety is typical only of the dry steppe zone of Azerbaijan, whereas *M. glutinosa* M.B. (including its three subspecies) is typical of mountain meadows (1 200–1 500 m above sea level) in Georgia.



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**Alfalfa is considered to be the first forage species to have been cultivated in the world. The Southern Caucasus is the centre of origin of the variety *Medicago falcata*, perfectly adapted to the region's long winters and summer droughts**

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# FARMERS CAN PRODUCE SEED ADAPTED TO CHANGES

FOR THOUSANDS OF YEARS, THE CAUCASUS PROVIDED SEED ADAPTED TO THE RHYTHMS OF THE SEASONS AND MAY PROVIDE IN THE FUTURE VITAL GENETIC MATERIAL TO THE ENTIRE WORLD TO MEET THE CHALLENGES OF THE EFFECTS OF GLOBAL WARMING AND A LESS PREDICTABLE CLIMATE.

In a region characterized by seasonal changes, low rainfall and extremes of temperature, a wide variety of genetic material, including cereals, fruits and legumes, exists and its genetic adaptation may well hold the key to crops of the future. Scientists are studying these adaptation characteristics and those farmers growing a mixture of crops to adapt to the rhythm of the seasons, to offset risks and to stabilize yields, know how to maintain a high level of heterogeneity in their seed stocks and perform what scientists call “population breeding”, a technique of maintaining a cluster of genotypes to ensure that the population has as many different genes as possible. In this way, it has the plasticity to respond and produce in varying conditions (droughts, pest attacks, wind and floods).

Predicted climatic changes will likely result in a demand for large quantities of seed adapted to changing conditions and farming practices that will need to make a more efficient use of solar energy, soil biological processes and water resources.

Thanks to their agricultural knowledge, the farmers of the Southern Caucasus who have managed and maintained this treasure of local genetic resources adapted to risks could be ready to become active producers of seeds adapted to future site-specific needs and risks. But they will need political and economic support to enhance the production and exchange of seeds at the local level and improve their capacity to distribute their seeds at markets.





