

Importance of biodiversity of fruit crops and their wild relatives for food and nutritional security in Azerbaijan

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ABSTRACT

The Azerbaijan Republic considered being primary or secondary center of origin, domestication and diversity of many indigenous varieties of folk selection of fruit crops and their crop wild relatives (CWRs). The wild relatives of major fruits and nuts like grapevine, apple, pear, quince, medlar, pomegranate, fig, cherry, apricot, almond, hazelnut, walnut, chestnut, pistachio and others are presented along with many genera of the flora of Azerbaijan. The activity of Genetic Resources Institute (GRI) of the Azerbaijan National Academy of Science (ANAS) is collections, reproduction, studies, documentation and conservation of the gene pool of local resources of landraces of fruit plants, including their crop wild relatives (CWRs). The CWRs in Azerbaijan are conserved in protected areas and botanical gardens, as well as ex-situ and on-farm conservation in field collections of the National Genebank. Despite broad utilization of native varieties in the conventional agriculture the traditions of usage of crop wild relatives for food, food additives or environmental purposes still kept among populations like fresh fruit consumption, as a raw material for processing and making of traditional food ('Doshab', 'Behmez', 'Narsharab', 'Nardancha', 'Ahta', 'Lavashana' and others), including in a food chain as a feed for domestic animals, initial materials for breeding. Except fruit utilization the wild relatives are operate as rootstocks and for live fences; they are honey, decorative and medical plants, suitable for making anti-erosion and wind-brake line plantations, forest garden construction. For the purpose of collecting aboriginal varieties and their wild relatives of fruit crops a number of expeditions were organized in different regions of our Republic, their areal was determined, biological-agricultural traits of collected varieties and forms were evaluated. Collected materials were maintained in the national gene bank enriching the collections. Therefore, conservation of plant genetic diversity, selection, evaluation and protection are of high importance nowadays. It is expected that increasing public awareness of CWR by publication and events, will enhance protection and conservation of important species for further utilization.

Keywords: Biodiversity, conservation fruit species, folk selection, traditional cuisine,

The Azerbaijan Republic is located on the South-East of the Caucasus Mountains and on the North-West of the Iranian Plateau, at the crossroads of Eastern Europe and Southwest Asia. Chiefly Azerbaijan is a mountainous country. Its surface is extremely diverse. Along with lofty mountain ridges (for example: Bazarduzu – 4466 m; Shahdagh – 4251 m; Tufandagh – 4197 m and others) rising beyond snow-line, there are also vast plains and lowlands some areas of which are located 27 m below the ocean-level here. Extreme diversity of the soil and climatic conditions of Azerbaijan support a very rich diversity of plant genetic resources. Flora of Azerbaijan contains more than 5000 species of vascular plants, including 800 ether-oil yielding, 600 medicinal, 500 spices-aromatic, 500 of vitamin-important, 850 dyeing and 1500 species with tannin, have been revealed, 237 of which are endemic. They sprout at Major and Minor Caucasus slopes and in subtropics of Talish.

During archaeological excavations nearby Nakhchivan, scientists found charred half-million-

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year-old grapevine leaves. Historically wild fruits were used by people for food, as medicinal crops and other purposes. Azerbaijan is considered one of the evolution centers of cultivated plants. Archaeological findings prove that horticulture and viticulture in Azerbaijan have at least 6000-7000 years of history. Practically all present major cultivated species appeared for the first time in Azerbaijan several millennia B.C. As example are signs of farming and ancient horticulture discovered in a settlement westward of Goy-Gol town from the early second millennium B.C. Fruit crops (apple, pear, apricot, pomegranate, quince, fig, almond, walnut, hazelnut, etc.) and grape have been cultivated to meet the demand of the population for foodstuff and other products. Most of these crops are considered major agricultural crops of the country. Historical facts and excavations carried out in Gazakh, Agstafa, Agdam, Mingechevir and other areas of Azerbaijan have shown that cultivation of fruit crops in Azerbaijan during the bronze age (middle of the second millennium B.C.) attained a high developmental stage (Asadov and Asadov, 2001; Mammadov, 2000)

MATERIALS AND METHODS

Plant materials for the study including local varieties and wild relatives of fruit crops were obtained from collections of the GRI and ANAS and by farmers in different regions of the country. Phenological phases, growth, bio-morphological description and productivity, fruit quality traits, resistance to disease and pests were studied using the common description methods for fruit plants (Mammadov, *et al.*, 2000; Michurinsk, 1973)

RESULTS AND DISCUSSION

CWR of fruit crops

Plant biodiversity of the South Caucasus is defined due to diversity of climatic and soil. As the last glaciations did not enter the South part of the Caucasus due to the presence of the Greater Caucasian Mountain barrier, the flora is extremely rich in Azerbaijan.

One hundred forty nine (149) fruit crop species from 39 genera and 15 families are distributed in the territory of Azerbaijan. The large number of genera and species of wild fruit and fruit-berry plants are found in forests and rural regions providing the greatest diversity of fruit crops: *Amygdalus communis* L., *Armeniaca vulgaris* Lam., *Berberis vulgaris* L., *Castanea sativa* Mill., *Cerasus avium* L. Moench, *C. vulgaris* Mill., *Cornus mas* L., *Corylus avellana* L., *Crataegus orientalis* Pall. ex M. Bieb., *Cydonia oblonga* Mill., *Ficus carica* L., *Fragaria vesca* L., *Hippophae rhamnoides* L., *Juglans regia* L., *Malus domestica* Borkh., *Mespilus germanica* L., *Morus* L., *Persica vulgaris* Mill., *Pistacia mutica* Fisch. & C. A. Mey., *Pistacia vera* L., *Prunus cerasifera* Ehrh., *P. domestica* L., *P. spinosa* L., *Punica granatum* L., *Elaeagnus angustifolia* L., *Pyrus communis* L., *Rubus* L., *Vitis vinifera* L. subsp. *sativa* D.C., *V. vinifera* L. subsp. *sylvestris* (C. C. Gmel.) Hegi etc. One can find many wild forms of apple (*Malus* L.) in large tracts of forest, in river valleys and other places. Wild forms of quince are found in coastal forest area of Caspian Sea. These forests represent service tree (*Sorbus* L.) with 11 species (5 of them are endemic to the Caucasus); hawthorn (*Garataegus* L.) has 9 species; plum (*Prunus* Mill.) – 3, almond (*Amygdalus* L.) – 2, cherry (*Cerasus* Juss.) – 5, blackberry and raspberry (*Rubus* L.) – 14 and currant (*Ribes* L.) with 2 species. Furthermore, one can found wild medlar (*Mespilus germanica* L.), sloe (*Prunus spinosa* L.), alycha (*Prunus divaricata* lebed.), pomegranate (*Punica granatum* L.), sweet cherry (*Cerasus avium* L.

Moench.), dog-rose (*Rosa* sp.), sea-buckthorn (*Hippophae rhamnoides*), cornel (*Cornus mas* L.), grape (*Vitis sylvestris* Gmel.), nuts and other fruit and fruit-berry crops in the forest and shrubberies and in mountainous and foothill regions of the Republic (Asadov and Asadov, 2001; Akparov and Musayev, 2012; Akparov *et al.*, 2010; Maghradze, 2012; Safarov, 1979; Negri *et al.*, 2012)

Among 27 Caucasian pear species 19 grow in Azerbaijan (*Pyrus boissieriana* Buhse., *P. phycana* Fed., *P. grossheimii* Fed., *P. communis* L., *P. caucasica* Fed., *P. eldarca* A. Grossh., *P. voronovii* Rubtz., *P. syriaca* Bioss., *P. salicifolia* Pall., *P. zangezura* Maleev, *P. elata* Rubtz., *P. raddeana* G. Woron, *P. serotina* Rehd., *P. nutans* Rubtz., *P. vsevolodi* Heidemann., *P. oxyprion* G. Woron., *P. complexa* Rubtz., *P. medvedevii* Rubtz. vY *P. georgica* K. uth.), having a number of spontaneous hybrids (Flora Azerbaijan, 1954).

In Azerbaijan there were more than 400 land races only of pear and half of them were endangered (10). Here are included some varieties of pear (*Pyrus communis* L.) – Abbasbeyi, Aghgulabi, Aghagormez, Aghsacharmud, Akhundarmudu, Bildirchinbudu, Jirnadiri, Hazararmud, Letenzi, Nar armud, Nelbekiarmud, Peyghambariarmud, Shekeri, Sulu armud, Tir armud, Turshsiniarmud, Turshmalasiarmud, Usunarmud, Usun sap armud, Yagarmud, etc. These varieties differ for ripening time (summer, autumn and winter), size, taste quality, productivity and a variety of other different factors.

The wild medlar (*M. germanica* L.) widely spread together with wild pomegranate (*P. granatum* L.) and quince (*C. oblonga* Mill.) in Talish region of Azerbaijan. Some of cultivates medlar varieties have names like ‘Khan ezgili’, ‘Nelbeki’, ‘Kitil’, ‘Aghezgil’, ‘Arkivanezgili’. By Zhukovski’s (1964) opinion, the medlar was domesticated by Caucasian inhabitants, especially in the Talish region of Azerbaijan.

Cornelian cherry (*C. mas* L.) is widely spread in the countries and used in local cuisine. It grows in forest with other fruit species like cherry plum, sloe, hawthorn, dog-rose, apple, pear, quince, medlar, hazelnut, currant, raspberry and others. There are variations of cornelian cherry in Azerbaijan having different color, size and shape of fruits. It was selected more than 40 forms (Mammadov and Musayev, 2011)

The Common (syn. Persian, English) walnut *J. regia* L. wildy grows in Azerbaijan in lower and

middle slopes of the Major and Minor Caucasus and in subtropics of Talish Mountains. According to Safarov, 1981 the total surface of walnut forests is more than 25000 ha in Azerbaijan. Being based on fossils it is approved that the walnut was spread in Azerbaijan during the Tertiary Period and it is a relict plant of Cretaceous Period (Mamedov and Aleskerov, 1988)

The local wild forms of *J. regia* being in basis of native walnut germplasm. The Azerbaijan selective forms 'Kaghizi', 'Katankoynak', 'Araz', 'Disar', 'Darvishpapag', 'Nazikgabig' are known out of the country too: 'Evrica' and 'Blemer' cultivars had been selected from 'Kaghizi' cultivar (Ibrahimov, 2007)

Wild grapevine - *V. vinifera* L. subsp. *sylvestris* (C. C. Gmel.) Hegei., the wild ancestor of the cultivated grapevine *V. vinifera* ssp. *sativa* D.C., is a typical plant of flora in Azerbaijan, spread widely in large areas and in the banks and shores of river, lake and sea and mountain slopes. This wild grapevine together with native varieties is interesting, while the Azerbaijan - as one of the main centre of origin and domestication of cultivated grapevine. Confirmations of this opinion are high number of autochthonous varieties with ample diversity of berry colour and technological aptitudes; historical information; linguistic and folk data; and certainly, rich palaeobotanical artifacts and archaeological findings discovered since "*Shomutapa culture*", dated back to VI-IV millennium BC (Akparov et al., 2010).

At the same time as it may be concluded that wild grape spread on the whole territory of Azerbaijan is very ancient formation. In general, more than 3000 samples of wild grapes were found in expeditionary regions and phytocenotic features of their spreading areas were described. Wild grape - *V. vinifera* L. subsp. *sylvestris* (C. C. Gmel.) Hegei of Azerbaijan is distinguished with specific characters. It is spread on the territory of Azerbaijan from 12 m below sea-level (Kyr riverside, Salyan region) to 2000 m above sea-level (Gusar region). There are two kinds of wild grape in Azerbaijan: *typical* Negr. (with hairs) and *aberrans* Negr. (hairless). In Nabran forests of Guba-Khachmaz region dark and dark purple coloured grape forms were found. While expedition in Guba-Khachmaz region it was known that, Guba region is enriched with wild grape. In forests of this region (Uzunmeshe, Alpan, Khujbala, Digah, Aghbil, SusayGishlag, Dallakand villages) along Guruchay, Gusarchay, Gudyalchay rivers lots of wild grape forms were found. In forests of Khachmaz (Pir forest), Shaky (Oraban), Lankaran (Seligavul) and Gabala (Shongar)

regions small seedy dark wild grape varieties were also determined. On the banks of Kondalanchay river in Fuzuli region dark, dark red, dark purple coloured grape seed forms were observed.

Our investigations revealed that different populations of wild grape are spread mainly in two formations - tugay (streamside forest) and typical broad-leaved forests. On the banks of Kungut river (Oraban village) of Sheki, Guruchay, Gusarchay, Gudyalchay rivers (Uzunmeshe, Alpan, Khujbala, Digah, Akbil, SusayGishlag, Dallakand villages) of Guba region wild grapevines spread mainly in tugay forests densely and widely. But typical forest formation of wild grape was found in Agharehimoba, Godekli, Gimilgishlag, Gadashoba, Nerecan and etc. villages and forests (forest number 1, Pir forest) of Khachmaz region, Seligavul forest of Lankaran region and Shongar spring of Gabala region.

Wild grape samples distinguish each other for their biomorphological traits. As rule male grapevines are strong, functional female grapevines are weak. All samples of wild grape can be divided into 4 groups for leaves bigness: very small (length up to 4.0-8.0 cm), small (length up to 8.0-12.0), medium (length 12.0-15.0 cm) and large leaved (length more than 15 cm). Most of studied varieties are involved to small and medium leaved group. Wild grape samples can be divided into 3 groups for leaves sub-sections: whole, medium and cross-section leaves. Some samples are covered with white net-shaped blooms, but in some cases under surface are bare. Samples are distinguished for leave sides. Sides are mainly sharp, triangular and round shaped. Stalk hollows are namely lira-shaped, but rarely sides are parallel and bottom is flat. Wild grape samples are two housed, that is they have male or female flower groups.

Self-pollinated bisexual flower groups of wild grape samples were not met. According to some researchers' opinions, types of flower groups of wild grape are very important morphological trait for defining grape origin, because wild grape is two housed subspecies. Bunch flowers of wild grape can be distinguished each other for their forms, they are small or medium sized. As a rule, the bunch flowers of male grapevines are big and cone-shaped. But bunch flowers of female grapevines are small, cone-shaped-cylindrical or cylinder-shaped.

Bunches of wild grape are small, with a length of 7.0-13 cm and 6-8 cm width. There are 1-2 bunches on productive shoots. Bunches are mainly set on 3-5th churn-stuffs of new shoots. Skin of separate seeds of

grape is dark or reddish dark. Seeds are oval-shaped. The surface is covered with thick wax layer. Most of wild grape varieties are resistant to mildew and oidium disease (Akparov *et al.*, 2010, Maghradze, 2012; Pipia *et al.* 2012; Salimov and Musayev, 2007)

Sea-buckthorn (*Hippophae rhamnoides* L.) various parts of sea-buckthorn are widely used as medicine, food and feed source, technical purposes, in establishing of protective belt, live fences, as well as in planting of greenery, in prevention of erosion and soil recultivation. Sea-buckthorn fruits consist of a number of vitamins (A, C, B1, B2, B6, E (α , β , γ), K, P etc.), 15 microelements, acids, irreplaceable oil in medicine and etc. In general, there are 190 various biologically active matters in sea-buckthorn. Taking into account the national economic importance of biodiversity, the GRI and ANAS have started to restore the gene pool collection of 1972 in order to create high-yield and qualitative varieties of sea-buckthorn from local forms and introduced Altai varieties. As a result, 80 different samples of sea buckthorn which have an important role in the development of advanced forms and varieties were collected and the place of their distribution and density were identified. These forms sharply differ in many morphological characteristics - shape, color, size of fruit, bush shape, thorniness degree, as well as taste, etc. Wild sea-buckthorn brushwoods are widely spread in most regions of the Republic - Guba-Khachmaz, Shaky-Zagatala, Shirvan, Talysh, Garabagh, Nakhchivan AR and etc. While natural sea-buckthorn populations are mainly spread in Ismayilli, Shamakhi, Aghsu, Gabala, Shaky, Gakh, Zagatala, Guba, Gusar and etc. regions. In Azerbaijan the height of sea-buckthorn is 2-5m, sometimes 10m and it is tree or bush. Trunk diameter is about 30cm. The weight of 100 fruit is 8-25g, sometimes 30-35g. Fruits of local forms are small, barrel shaped, longish and round, yellow, yellow-orange colored. Seeds are big, less juicy, and thorny. Fruits ripen after 20th October. Productivity is low, 3-5 kg, sometimes 7-8 kg per bush. Populations of sea-buckthorn existed in the different regions were characterized for their morphological, biological and biochemical traits.

The use of ecologically-separated forms of sea-buckthorn for hybridization allowed us to create a rich hybrid material. As a result of experiments the cultivars 'Shafa', 'Zafarani' and 'Tozlayan', which are suitable to local soil and climatic conditions, have been created. These are high-yield varieties (18 - 25 t ha⁻¹), big-fruited (each fruit's weight is 50 - 60 g), weak-thorned (Zafarani, Tozlayan) or thornless

(Shafa). In the natural brush woods of the Azerbaijan environment, sea-buckthorn fruits ripen towards the end of October. The new cultivars have different maturation periods (from early August to the second half of October) and are resistant to diseases and pests. These new varieties of the sea-buckthorn are of universal character: they can be used as fresh fruits, to prepare jam, juice, oil, liqueur, stewed fruit and much more. Thanks to positive bio-economical peculiarities, the profitability level for the products is high. From a recent hybridization between forms of different origin (Siberia x Azerbaijan) three varieties of sea-buckthorn with early maturation (ultra scope matured) fruits (July) and with oil content of 7.1% were obtained [Negri *et al.* 2012, Musayev, 2007; Musayev and Akparov, 2012)

Crop domestication

Each region of Azerbaijan has its own specific and qualitative fruit varieties. For instance, Shirvan is famous for its pomegranate and quince; Nakhchivan for its apricot and peach; Shaki-Zagatala for its walnut and hazelnut; Ganja-Gazakh for its grapevine, cornelian cherry and cherry; Absheron for its almond, pistachio, fig and grapevine; Guba-Khachmaz for its apple and pear. Walnut, hazelnut, chestnut, persimmon (*Diospyros kaki* L., *D. lotus* L.), dogwood and tens of other species available in southern slopes of Caucasus mountains are used by people as food. Landraces of these species are available to the local farmers. A large diversity of apple, pear, mulberry, medlar, dogwood and other crops is widespread in this territory. The Lankaran-Astara region contains valuable varieties of blackberry, fig, pomegranate, bush cherry, plum, dog-rose and citrus plants, while Absheron contains varieties of grape, fig, pistachio, almond, oleaster (*Elaeagnus angustifolia* L., *E. caspica* Grossh.), mulberry, quince and pomegranate where these crops grow naturally or cultivated by farmers in their holdings and orchards. Distribution areas of wild grape, blackberry, raspberry, and other berries over the territory of the republic are known. At once a number of fruit crops like cornel, sweet cherry, cherry, pomegranate, quince, fig (*Ficus carica* L., *F. hircana* Grossh.), pear, grape (*Vitis vinifera* L.) and other fruits were widespread in the territory occupied by Armenia, which were used by local people. In Guba-Khachmaz region more than hundred varieties of apple – Sari tursh, Jirhaji, Sikhijani, Ayyubi, Shirvangozeli, Jibir, Gand alma; pear – Nar armud, Abbasbayi, Jirnadiri, Ispigi, Kurduku, Nargila, Bildirchinbudu, etc. were spread widely in fruit gardens, especially in amateur gardeners' courtyards. More valuable varieties of

grapevine, stone-fruits are cultivated in wide areas of Nakhchevan AR. Especially are famous some varieties of apricot (*Armeniaca vulgaris* Lam.); varieties of peach (*Persica vulgaris* Mill.) – Salami, Zafarani, Juyur, Aghkustu, Aghnazli; varieties of plum – Garaalbukhara, Sari albukhara, Khatini; alycha (*Prunus cerasifera* Ehrh. var. *divaricata* (Ledeb.) L.H. Bailey) – Goychasultani, Shabrani, Payizmalasi, Aghalycha; walnut – Sugra, Seyfi, Araz, Disar and etc. A number of local varieties of pomegranate (*Punica granatum* L.) – Guloysha, Malas, Shahnar, Balmursal, Girmizigabig, Nazikgabig and etc.; of quince (*Cydonia oblonga* Mill.) – Jardam, Garaheyva, Sari heyva, Armuduheyva, Qaraman as well as of alycha, plum, sloe, grapevine and etc. are cultivated in Shirvan region. Aboriginal varieties of olive (*Olea europaea* L.) – Shirinzeytun, Azerbaijan zeytunu, Armuduzeytun, Bakizeytunu; of fig (*Ficus carica* L.) – Absheron sari injiri, Buzovburnu, Goy injir, Garainjir, Bozinjir, Sumakhinjiri, Payizinjiri; of almond (*Amygdalus communis* L.) – Nazikgabig, Sarayi, Mardakan; of pistachio (*Pistacia vera* L.) – Amirjan, Bulbula, Narinji, Zumurud and etc. are cultivated in Absheron region. In Shaki-Zagatala region ancient landraces of hazelnut (*Corylus avellana* L.) – Ata-Baba, Yaghlifindig, Sachaglifindig, Ganja findigi; of walnut (*Juglans regia* L.) – Jar, Dundi, Gum, Tala, Zagatala; of chestnut (*Castanea sativa* Mill.) – Khanlig, Ashig, Farash, Barguvara and etc. are grown. A number of landraces of apple, pear, quince pomegranate, grapevine plants are cultivated in courtyards in Garabagh. There are many aboriginal varieties of stoned-fruits and berries and subtropical fruits as well as grapevine, for example, cornelian cherry (*Cornus mas* L.) – Armuduzogal, Challakzogal, Girdazogal, Dilimlizogal, Garazogal, Sari Kahrabazogal, Irimeyvalizogal in Ganja-Gazakh region. Besides above-mentioned fruit varieties, tea and citrus plants as well as various varieties of feijoa are grown in courtyards and farms in Lankaran-Astara region. Recently 7 varieties of feijoa (*Feijoa sellowiana* (O. Berg) O. Berg) – Khazar, Astara, Mahsuldar, Sachagli, Lankaran, Irimeyvali and Girkan were created. These were first feijoa varieties in Azerbaijan (Hasanov and Aliev, 2007; Imamaliyev, 1988)

Usage

Despite broad utilization of native varieties in the conventional agriculture the traditions of direct usage of CWR for food, food additives or environmental purposes still kept among populations within the Azerbaijan.

- i) Direct fresh fruit consumption like almond, pear, medlar, wild strawberry, raspberry, blackberry, barberry, hawthorn, sea-buckthorn, hazelnut, walnut, cherry plum, cornelian cherry, chestnut, mulberry, Caucasian persimmon, pomegranate and others;
- ii) As a raw material for processing and traditional cuisine like wild fig, mulberry, pomegranate, walnut, sloe, apple, pear, apricot, cornelian cherry, persimmon, oleaster, ash berry, bilberry, current, cherry plum, cherry laurel, gooseberry, hazelnut, hawthorn, Caucasian persimmon, sea-buckthorn, snowball, quince, wild rose and others. The fruits used for preparation juice, syrup ('Behmez', 'Doshab'), puree, preserve ('Muraba', 'Compote'), dried fruits ('Achta', 'Movuc', 'Alana', 'Mianpur'), dried layers ('Lavashana'), jam, morse, alcoholic (wine, 'Arak, liqueur) and non-alcoholic ('Limonade') beverages, candy, species and souces per dishes ('Lavangi', 'Abgora, 'Sujuq', 'Narsharab'), surrogates (tea, coffee), marinade, 'Kiesel', confectionery ('Badambura', 'Halva', 'Shakarburu', 'Pakhlava', 'Fasali'), others;
- iii) Including in a food chain as a feed for domestic animals like sea-buckthorn, mulberry, nuts and others;
- iv) In breeding, when the old autochthonous varieties took origin from the native WR of apple, pear, apricot, pomegranate, cherry plum, quince, grapevine, sweet cherry, fig, hazelnut; and when the advanced forms for cultivation were selected within cornelian cherry, cherry plum, pear, walnut, almond in the XX century;
- v) In rootstock selection, while the WR of pear, apple, *Pirus salcifolia*, quince, cornelian cherry, cherry plum, sloe, Caucasian persimmon, wild rose, hawthorn are used;
- vi) For live fences - blackberry, barberry, sea-buckthorn, hawthorn, oleaster, cherry plum, sloe, *Pyrus salicifolia* and others;
- vii) As honey, decorative and medical plants, suitable for making anti-erosion and wind-brake line plantations; forest garden construction.

Collecting of plant genetic resources of fruit-berry crops and grape has been enhanced in the last years. At present 2490 accessions of fruit plants are maintained in field collections of GRI. Nearly 300 grape landraces

and about 50 samples of wild grapes have been collected by scientists of GRI through individual trips and local expeditions, and new gene pool gardens were established. GRI also maintains valuable collections of almond, pomegranate, pistachio, sea-buckthorn and other crops. As CWRs are many forms that formed in long phylogenetic development of fruit plants that harbor valuable genes. Their determination and utilization in breeding as donor material is important.

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